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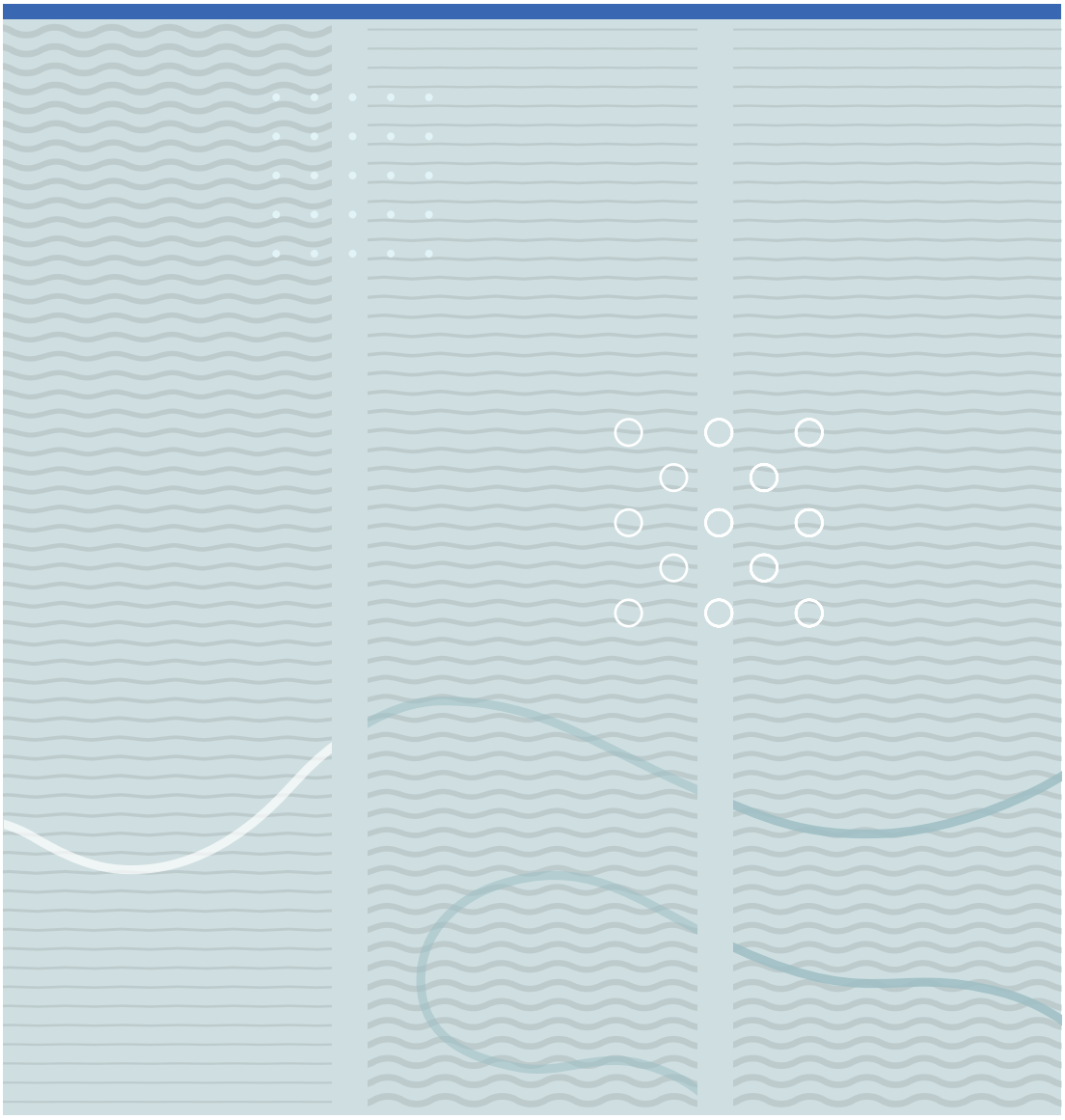
Fiona M. Flynn

Promoting clinical excellence and patient safety in nurse anaesthesia education



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Promoting clinical excellence and patient safety in nurse anaesthesia education

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Training to become a nurse anaesthetist in 1999-2001 was one of the most exciting and transforming periods of my life. The complexity of striving to administer the perfect anaesthesia has continued to fascinate me and endeavoring to inspire students to aim for excellence, has been my constant goal as an educator of nurse anaesthetists. The subject of this thesis is therefore very close to my heart.

My interest in non-technical skills was sparked by Henny-Mari Devold Hagen, who had taken part in a course at the Danish Institute for Medical Simulation (now CAMES). After talking to Helle T. Lyk-Jensen and Doris Østergaard at CAMES, Kjersti Sandaker and I decided to customize a translation of Anaesthetists Non-Technical Skills (ANTS) to be used by nurse anaesthetists. This appears to have triggered an interest in training and assessing non-technical skills in Norway, which will hopefully continue to grow.

There have been many people who have helped and supported me on this five-year journey. I am particularly grateful to my two main supervisors, Pia Bing-Jonsson and Berit Taraldsen Valeberg, and my co-supervisor Siri Tønnessen for their knowledgeable guidance and invaluable support along the way. In addition, Ragnhild Sørum Falk helped me with some of the statistical analyses and patiently answered my questions, Knut A. Hagtvet provided invaluable help on generalizability theory and Anne Marit Lyberg helped me to understand content analysis. Britt Sætre Hansen and Doris Østergaard provided insightful feedback at my midterm evaluation and Tone Rustøen with regard to this thesis.

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Abstract

Background: There has been increasing international focus over the past couple of decades, on the importance of non-technical skills such as situation awareness, decision-making, task management and teamwork in developing clinical excellence and ensuring patient safety in anaesthesia. However, non-technical skills are currently not systematically integrated in nurse anaesthesia education and there is a need for standardized and reliable instruments for developing and assessing these skills. The structured behavioural assessment instrument Nurse Anaesthetists' Non-Technical Skills-Norway (NANTS-no) was adapted for nurse anaesthetists in Norway and may be appropriate for this use.

Aim: The primary aim of this research is the systematic development and assessment of non-technical skills using a validated structured behavioural assessment instrument, as a means of promoting clinical excellence and patient safety in nurse anaesthesia education. The following objectives were identified:

- To evaluate the psychometric properties of NANTS-no (Study I)
- To explore how NANTS-no enables a systematic development and assessment of student nurse anaesthetists' non-technical skills in clinical practice (Study II)
- To explore the experiences of using NANTS-no in clinical practice during nurse anaesthesia education (Study III)

Theoretical perspectives: This research is positioned within a pragmatist research paradigm.

Methods: A sequential multimethod design was chosen where the findings in each study influenced the design of the following one. The first two studies used quantitative methods while the third study had a qualitative approach. The research was carried out between October 2017 and September 2020. Participants were student nurse anaesthetists attending the master's program in nurse anaesthesia at a Norwegian university, and their mentors and clinical supervisors at the various hospitals where they had clinical practice.

Study I had an explorative design. 46 nurse anaesthetists involved in clinical supervision attended a 6-hour workshop on non-technical skills. Afterwards they rated non-technical skills displayed by nurse anaesthetists in video-recorded simulated scenarios and completed a questionnaire. The instrument's psychometric properties were evaluated using generalizability and classical test theory.

Study II was a cohort study with longitudinal design. 20 student nurse anaesthetists' non-technical skills were assessed at three time-points during their nurse anaesthesia education. The NANTS-no five-point rating scale was used by the students, their mentors and clinical supervisors to perform the assessments, and the data was analyzed using linear mixed effect models.

Study III had a descriptive design. The experiences of using NANTS-no in clinical practice were collected through semi-structured interviews with four focus groups comprising 12 student nurse anaesthetists and 13 mentors and clinical supervisors. Data was analyzed using qualitive content analysis.

Results: NANTS-no demonstrated high reliability and dependability in a controlled setting and was regarded as a useful instrument for use in clinical supervision. It also demonstrated reliability when assessing non-technical skills in clinical practice. The student nurse anaesthetists demonstrated a systematic development of non-technical skills during nurse anaesthesia education, achieving near excellence when assessed with NANTS-no. Using NANTS-no was described in the interviews as a means of promoting excellent non-technical skills and cooperative learning. However, there was a need to promote further acceptance of the instrument in the working environment.

Conclusion: NANTS-no appears to be a reliable instrument that can be used for development and standardized assessment of non-technical skills in clinical practice. Using NANTS-no appears to promote the development of excellent non-technical skills, as well as a professionalization of clinical supervision and transformative learning. There is however a need for strategies to improve implementation of the instrument.

List of papers

Paper 1

Flynn FM, Valeberg BT, Tønnessen S, Bing-Jonsson PC. (2021) Psychometric Testing of a Structured Assessment Instrument for Non-technical Skills (NANTS-no) for Use in Clinical Supervision of Student Nurse Anesthetists. Journal of Nursing Measurement, 29(1):E59-e77.

Paper 2

Flynn FM, Bing-Jonsson PC, Falk RS, Tønnessen S, Valeberg BT. (2022) Educating for excellence: A cohort study on assessing student nurse anesthetists' non-technical skills in clinical practice. AANA J, 90(1):7-15 Note: This article is omitted due to copyright policy

Paper 3

Flynn FM, Valeberg BT, Bing-Jonsson PC, Lyberg AM, Tønnessen S. (2022) Experiences using an instrument for non-technical skills in nurse anaesthesia education: a focus group study. BMC Medical Education, 22:243

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Abbreviations

ACRM	Anaesthesia Crisis Resource Management
ANTS	Anaesthetists' Non-Technical Skills
ANTSdk	Anaesthetists' Non-Technical Skills (Danish version)
ANTS-AP	Anaesthetic Non-Technical Skills for Anaesthetic Practitioners
ASA	American Society of Anesthesiologists
AS-NTS	Anesthesiology students' Non-Technical Skills
CRM	Crew Resource Management
CS	Clinical Supervisor
ECTS	European Credit Transfer and Accumulation System
ERIC	Expert Recommendations for Implementing Change
ICN	International Council of Nurses
IFNA	International Federation of Nurse Anesthetists
M	Mentor
NANTS-no	Nurse Anaesthetists' Non-Technical Skills-Norway
N-ANTS	Nurse Anaesthetists' Non-Technical Skills (Danish version)
NOTSS	Non-Technical Skills for Surgeons
NOTSSdk	Non-Technical Skills for Surgeons (Danish version)
NTS	Non-technical skills
SPLINTS	Scrub Practitioners' List of Intraoperative Non-Technical Skills

SPLINTS-no	Scrub Practitioners' List of Intraoperative Non-Technical Skills-Norway
SNA	Student Nurse Anaesthetist
WHO	World Health Organization

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1 Introduction

Over the past decade or more, there has been increasing international focus in anaesthesia on aspiring to excellence rather than settling for a minimum standard of competence (Flynn et al., 2017; Larsson, 2017; Shelton & Smith, 2013; Smith & Greaves, 2010). Clinical excellence in anaesthesia is closely interwoven with ideas of professionalism, but ultimately also with patient safety (Smith & Greaves, 2010; Wong, 2012). There is now a general acceptance that a high number of adverse events in healthcare internationally are a result of human factors and could have been prevented (De Hert, 2021; Jones et al., 2018). Surgery and anaesthesia are particularly high-risk areas where simple mistakes can have fatal consequences (Catchpole et al., 2008; De Hert, 2021; Doumouras et al., 2017; Jones et al., 2018; Kennerly et al., 2014).

This has led to an awareness that academic excellence and technical proficiency alone are not sufficient. Excellent and safe practice is also dependent on well-developed non-technical skills, such as situation awareness, decision-making, task management as well as communication and teamwork (Jepsen et al., 2015; Larsson, 2017). These cognitive and social behavioural skills enhance technical skills and are seen as the key to *"consistently high performance"* in the best practitioners, while reducing the likelihood of errors (Flin & Maran, 2015; Flin et al., 2008). Promoting clinical excellence through a systematic focus on on-technical skills, however, requires an investment at all levels in both educational and healthcare institutions to ensure that qualified practitioners aspire to and achieve a high level of expertise (Smith & Greaves, 2010; Wong, 2012).

There is a wide variation in nurse anaesthesia education and scope of practice globally, with the nurse anaesthetist role differing according to national needs and legislation (AANA, 2020; Herion et al., 2019; Ringvold et al., 2018). Since clinical practice is a major part of the training, nurse anaesthesia education in Norway relies heavily on cooperation between educational and healthcare institutions. However, a national report on the quality of clinical practice in the education of healthcare professionals highlighted the need for a closer and mutually binding cooperation to raise educational

standards in clinical practice (The Norwegian Association of Higher Education Institutions, 2016).

Traditionally, nurse anaesthesia programs have focused on ensuring students acquire high levels of theoretical knowledge and develop the necessary technical proficiency (Flynn et al., 2017; Jeon et al., 2015; Lyk-Jensen et al., 2016). However, recent focus on patient safety has made the systematic integration of non-technical skills in education and anaesthesia practice high priority internationally (Johnson & Aggarwal, 2019; Lyk-Jensen et al., 2016; Moll-Khosrawi et al., 2019; Sevdalis et al., 2012; Smith & Greaves, 2010). Although there is some interest in Norway (Flynn et al., 2017), a rapid search of the nurse anaesthesia programs at five major universities/university colleges shows that non-technical skills only appear to be an integrated part of the program at one of these universities. This does not preclude an implicit focus on non-technical skills, as all the programs mentioned teamworking and communication among other skills in their learning outcomes.

Several factors are essential to ensure the systematic development of non-technical skills; a challenging but safe environment that stimulates active learning (O'Donnell et al., 2016) as well as a standardized and reliable conceptual model with a common taxonomy for observing, discussing and assessing non-technical skills (Lyk-Jensen et al., 2014). The Nurse Anaesthetists' Non-Technical Skills-Norway (NANTS-no) is a structured behavioural assessment instrument that was specially adapted for use by nurse anaesthetists in Norway (Flynn et al., 2017). Although NANTS-no showed high reliability in a simulation setting (Flynn et al., 2017), it had not been validated for use in clinical supervision in nurse anaesthesia education.

Therefore, the focus of this thesis is to explore whether NANTS-no provides a usable taxonomy for non-technical skills in clinical practice and is a reliable instrument for developing and assessing these skills in nurse anaesthesia education. It also focuses on how the student nurse anaesthetists and the nurse anaesthetists involved in clinical supervision experience using the instrument.

1.1 Aim and objectives

The primary aim of this research is the systematic development and assessment of non-technical skills using a validated structured behavioural assessment instrument, as a means of promoting clinical excellence and patient safety in nurse anaesthesia education. The following objectives were identified:

- To evaluate the psychometric properties of a structured behavioural assessment instrument NANTS-no (Study I) by:
    - exploring whether experienced nurse anaesthetists involved in clinical supervision can reliably and accurately assess non-technical skills in video-recorded simulated scenarios using NANTS-no, after participating in a workshop
    - estimating whether each individual mentor is able to provide a reliable assessment of non-technical skills in video-recorded simulated scenarios
    - exploring whether NANTS-no is perceived as an acceptable and usable instrument for developing and assessing student nurse anaesthetists' non-technical skills in clinical practice
- To explore how NANTS-no enables a systematic development and assessment of student nurse anaesthetists' non-technical skills in clinical practice (Study II)
- To explore the experiences of student nurse anaesthetists, their mentors, and clinical supervisors with using NANTS-no in clinical practice during nurse anaesthesia education (Study III)

1.2 Structure of the thesis

The first part of the thesis is divided into seven chapters outlining the background for the research and the theoretical perspectives underpinning the research methodology. It also includes a description of the methods used in the three studies and a summary of the results. A discussion of the research findings and methodological considerations as well as recommendations for further research concludes this section. The second part of the thesis is a presentation of the three papers based on the studies.

2 Background

This chapter explores the importance of non-technical skills in developing clinical excellence and ensuring patient safety in anaesthesia. It also presents the structured behavioural assessment instruments that can be used to develop and assess these skills. Finally, it looks at nurse anaesthesia education and scope of practice nationally and internationally and the ways in which educational and healthcare institutions collaborate to aid the development of clinical excellence through clinical supervision and assessment.

2.1 Clinical excellence, professionalism and non-technical skills

Aspiring to excellent clinical skills in anaesthesia is now regarded as a prerequisite for the best practitioners (Flynn et al., 2017; Larsson, 2017; Shelton & Smith, 2013; Smith & Greaves, 2010). However, excellence is not just a higher level with competence as a minimum standard on a grading scale, it implies "*something qualitatively different*" (Smith & Greaves, 2010). In addition to having acquired basic knowledge of the field and technical skills, clinical excellence appears to be associated with personal attributes, ideas of professionalism and well-developed non-technical skills (Glavin, 2009; Smith & Greaves, 2010).

The attributes defining clinical excellence are described in one study as primarily personal qualities, such as being flexible and innovative, reliable and supportive, and a good communicator (Smith et al., 2011). Excellent practitioners are enthusiastic about the profession and interested in educating and inspiring others, while academic excellence per se was seen as less important than being able to apply knowledge in a relevant manner (Smith et al., 2011). In another study, excellent anaesthetists are described as structured, responsible and focused, informative, humble, patient-centred, calm and clear in critical situations, and able to maintain an overview (Larsson & Holmstrom, 2013). Most importantly, excellence is regarded as the desire to strive for perfection continually by actively engaging in new and challenging situations while simultaneously reflecting and learning from these situations in order to improve one's practice (Larsson, 2017; Smith et al., 2011).

Clinical excellence is seen as closely related to professionalism (Smith & Greaves, 2010; Wong, 2012). The International Federation of Nurse Anaesthetists (IFNA) describe professionalism in nurse anaesthesia as providing safe and patient-centred care based on current best practice (Herion et al., 2019; IFNA, 2016). The IFNA standards of practice describe the professional competencies expected in a nurse anaesthetist to ensure high standards of safety and quality in clinical practice and the education of nurse anaesthetists (figure 1). They are based on the Canadian Medical Education Directions for Specialists (CanMEDS) Framework and were adopted by the Norwegian Association of Nurse Anesthetists in 2017 (ALNSF, 2016; Herion et al., 2019; IFNA, 2016).

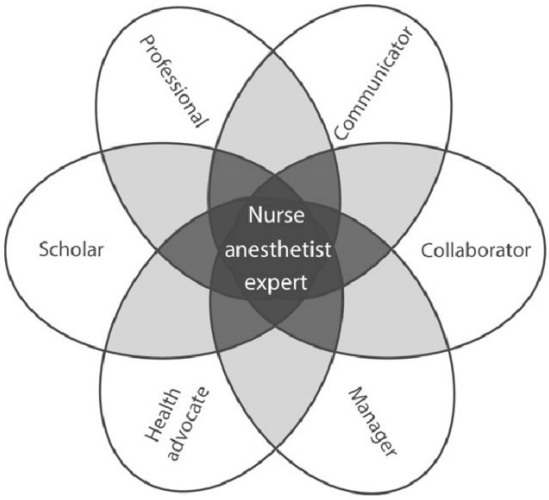

Figure 1: IFNA professional competencies of a nurse anaesthetist (adapted from the CanMEDS Physician Competency Diagram. Copyright©2009)

Professionalism encompasses recognizing and accepting responsibility for maintaining high levels of knowledge, skills and professional values as well as demonstrating an active commitment to self-appraisal and continuous professional development (Herion et al., 2019; Solymos et al., 2020). Thus professionalism is more than technical capability, it involves core values such as personal integrity, respect and accountability as well as a commitment to furthering best practice and advancing the discipline (Smith & Greaves, 2010). It also requires vigilance, the ability to work in a team and communicate with others (Solymos et al., 2020). It is all these qualities that combine the various elements

of professional practice into *"a coherent performance*" (Larsson & Holmstrom, 2013; Smith & Greaves, 2010), ensuring excellence and patient safety in anaesthesia.

Many of the aspects of excellence are regarded as tacit qualities or non-technical skills that can be more difficult to acquire if they are not made explicit or formally taught (Smith & Greaves, 2010). These non-technical skills are not new but often regarded as vague and implicit (Glavin, 2009). They encompass the way in which humans process information, perform tasks and simultaneously interact with others, and deficiencies in these non-technical skills threaten patient safety by increasing the likelihood of errors and adverse events (Glavin, 2009; Jones et al., 2018).

The role of nurse anaesthetists has been characterized by highly-developed cognitive and social skills which encompass keeping in touch with and watching over the patient during anaesthesia, being prepared for and adapting to changes in the patient's situation, and communicating with other professionals in a way that promotes optimal team-work (Nilsson & Jaensson, 2016; Schreiber & Macdonald, 2010; Sundqvist & Carlsson, 2014). Working in a dynamically changing context requires situation awareness, the ability to make fast decisions on the patient's behalf and prioritize tasks in an optimal way, while working in a team (Lyk-Jensen et al., 2014; Nilsson & Jaensson, 2016). Therefore, these non-technical skills are an essential part of developing clinical excellence as a nurse anaesthetist and increasing patient safety. This is elaborated further in the next section.

2.2 Patient safety and non-technical skills

Patient safety has emerged as a global concern in the last twenty years or more with the recognition that the complex nature of healthcare systems can provoke human error with potentially disastrous consequences (Donaldson, 2002; Kohn et al., 1999; WHO, 2021). Human factors can both enhance clinical performance and prevent errors occurring but can also threaten patient safety and lead to adverse patient outcomes, that is, iatrogenic injuries resulting from the process of care and unrelated to underlying disease (Jones et al., 2018; Jung et al., 2019). In high-income countries an average of one in ten patients suffers adverse events in hospitals, while it is estimated that around 134

million adverse events resulting from unsafe care occur in hospitals in low- and middle-income countries annually (WHO, 2021). In Norway, 13.7% of somatic hospitalized patients in 2017 suffered harm as a result of their stay (Helsedirektoratet, 2019).

The World Health Organization (WHO) defines patient safety as:

> *"a framework of organized activities that creates cultures, processes, procedures, behaviours, technologies and environments in health care that consistently and sustainably lower risks, reduce the occurrence of avoidable harm, make error less likely and reduce its impact when it does occur."* (WHO, 2021)

This wide definition places responsibility for reducing the risk of adverse events and improving global patient safety on governments, healthcare facilities and stakeholders such as patient organizations, professional bodies and academic and research institutions, under the guidance of the WHO (2021). Measures such as improving systems for reporting and learning from adverse events (Global Trigger Tool), the use of checklists like the WHO Safe Surgery Checklist, as well as team-training, performance monitoring and feedback have been implemented in many countries with varying levels of success (Jones et al., 2018; Preckel et al., 2020; Sevdalis et al., 2012). The Norwegian Directorate of Health's recent plan for patient safety and quality improvement (2019) highlighted poor communication and patient flow systems as problematic areas. In addition, there was a need for better management, cultures and systems to ensure that healthcare professionals work together to prevent harm occurring to patients (Helsedirektoratet, 2019).

Globally, an estimated 230 million patients undergo anaesthesia for surgical procedures per annum (Preckel et al., 2020). Anaesthesia and surgery are regarded as high-risk areas where 44-54% of perioperative adverse events occurring in high-income countries could have been avoided (Jones et al., 2018; Preckel et al., 2020). The European Society of Anaesthesiologists (ESA) recently reviewed the 2010 Helsinki Declaration on Patient Safety in Anaesthesiology and presented a status report on many different issues relating to safety in anaesthesia (Preckel et al., 2020). These included preoperative assessment, incident reporting, medication safety, monitoring standards, handovers,

and the use of cognitive aids. Strategies for teaching patient safety, encouraging speaking up when patient safety is threatened, and learning from excellent performance rather than just adverse event reports, were highlighted as focuses for improving patient safety (Jones et al., 2018; Preckel et al., 2020).

However, mitigating the effect of human factors on perioperative adverse events is dependent not only on putting effective organizational systems in place, but also on the individual healthcare provider's skills and performance in the surgical team (Flin et al., 2008; Sevdalis et al., 2012). Although human error is prevalent, individual healthcare providers provide the last line of defence on a daily basis in preventing system errors through resilience and expertise (Reason, 1995). Therefore, the individual's non-technical skills are recognized as crucial to providing safe and efficient anaesthesia care and reducing errors and adverse patient outcomes (Boet et al., 2018; Jones et al., 2018). The following section is a review of current research into non-technical skills in anaesthesia and other related healthcare professions.

2.2.1 Non-technical skills

The term *non-technical skills* comes originally from the aviation industry where it was used to describe airline pilots' behavioural skills during flight operations (Flin & Maran, 2015). Although training non-technical skills has been an integral part of maintaining high standards of safety in aviation for several decades and they are recognized as playing a major part in ensuring quality and safety in healthcare, non-technical skills are still not systematically integrated in healthcare (Flin & Maran, 2015; Johnson & Aggarwal, 2019; Sevdalis et al., 2012).

Non-technical skills are defined as *"cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance"* (Flin et al., 2008). This definition is used widely, although there is some concern that the term *non-technical skills* lacks precision, implies subordination to technical skills and oversimplifies the complexity of clinical performance (Cooper et al., 2010; Gaba, 2011; Higham et al., 2019). However David Gaba (2011), a major force in simulation training in anaesthesia for many years who originally used "behavioural skills" to describe the

cognitive and social skills involved in clinical practice, argues that although the term is imprecise, healthcare providers appear to understand what is meant by non-technical skills.

Recently, the Copenhagen Academy for Medical Education and Simulation (CAMES) which has spent many years researching into various healthcare professionals' non-technical skills, has started referring to them as social and cognitive competencies for patient safety (CAMES, 2021). This is possibly a more precise term and may mean changes in the way these skills are regarded and taught in the future. However, since the term non-technical skills and the definition given above is established, they are used in this research.

Flin et al. (2008) defined seven skills that are important for safe and efficient performance in high-risk settings; situation awareness, decision-making, communication, teamwork, leadership, and coping with fatigue and stress. They argue that these skills are not only important in the aviation industry but also crucial in other areas where the individual worker's behaviour can affect safety. However, although some non-technical skills are generic, they cannot necessarily be transferred from one field to another, and it is recommended that they are defined specifically for each professional field (Fletcher et al., 2002; Flin & Patey, 2011; Pires et al., 2017).

In anaesthesia, non-technical skills such as situation awareness, decision-making, task management and teamwork are regarded as essential for safe clinical practice (Boet et al., 2018; Fletcher et al., 2003; Flin et al., 2010; Flynn et al., 2017; Lyk-Jensen et al., 2014), and are described in more detail below. Although leadership and communication are important skills, they are closely associated with how professionals work in a team and are therefore often incorporated as part of teamwork (Flin et al., 2010). Both stress and fatigue can adversely affect cognitive skills and thus patient safety, by reducing situation awareness and the ability to make well-founded decisions (Flin & Maran, 2015). The coping mechanisms used to counter stress and fatigue can be difficult to judge but are to some extent included under task management (Flin & Maran, 2015; Flin et al., 2010).

2.2.1.1 Situation awareness

As a concept, situation awareness originated from the military and aviation, and was introduced into the field of anaesthesia in 1995 (Gaba et al., 1995). It is a cognitive skill defined as an individual's "*perception* of elements of the environment within a volume of time and space, the *comprehension* of their meaning and the *projection* of their status in the near future" (Endsley, 1995). In anaesthesia, situation awareness is associated with vigilance and continuously monitoring the patient's state, recognizing cues, identifying changes and understanding their impact (Flin & Maran, 2015). It is therefore regarded as a core skill for ensuring optimal and safe anaesthesia care in a dynamic and complex environment (Flin & Maran, 2015; Schulz et al., 2013).

Endsley's model defined three ascending levels of situation awareness and highlighted the importance of goals and expectations in directing the individual's attention, the role of long-term and working memory, and the use of pattern recognition and mental models to understand the situation and enable decision-making (Endsley, 1995, 2015). When applied to anaesthesia, the first level of situation awareness encompasses the extent to which changes in the patient's current state are perceived from information gathered from various sources (Endsley, 1995; Schulz et al., 2013; Tower et al., 2019). The second level involves the process of interpreting and comprehending these changes, integrating the gathered information with knowledge stored in long-term memory to form mental models, in order to make sense of the current status (Endsley, 1995; Flin & Maran, 2015; Schulz et al., 2013). The highest level of situation awareness is associated with being able to project expected future developments in the patient's status in order to take adequate and relevant action (Schulz et al., 2013; Tower et al., 2019). Endsley (2015) underlines that perception, comprehension and projection are not separate entities or a linear process, rather that they are general descriptions of processes that are closely interwoven.

The ability to develop mental models is dependent on being able to see the analogy between the current status and stored memories that can be intuitively accessed, so-called pattern recognition (Schulz et al., 2013). While expert professionals are able to do this almost automatically, novices have to consciously analyse the situation making

heavy use of limited working memory (Flin et al., 2008; Larsson, 2017). Nurse anaesthetists described highly-developed situation awareness as *"a fine almost musical feeling of what is going on in the theatre"* (Lyk-Jensen et al., 2014). Interruptions, distractions, heavy workloads, and tiredness can all disrupt situation awareness and lead to wrong or no decisions being made (Flin & Maran, 2015; Schulz et al., 2016). In a study of critical incident reports in anaesthesia, 81% involved errors relating to situation awareness, with the majority being attributed to lack of perception and/or comprehension (Schulz et al., 2016).

Endsley's approach focuses on describing situation awareness in the individual and how it can be shared to develop team situation awareness. It has however been argued that team situation awareness involves more than the individual team members (Schulz et al., 2013). The concept of distributed situation awareness focuses on systems and the analysis of dynamic interactions between the humans in the operating theatre, monitoring systems, equipment and mechanisms involved (Fioratou et al., 2010; Schulz et al., 2013). Establishing shared mental models enables the team to adapt to changes, facilitates decision-making and the prioritization of tasks (Gjeraa et al., 2017). To summarize, a highly-developed situation awareness is regarded as essential for good decision-making and ensuring optimal anaesthesia care (Flin & Maran, 2015; Schulz et al., 2013).

2.2.1.2 Decision-making

Decision-making is a cognitive and dynamic process that involves determining and selecting an appropriate action to satisfy the requirements of a given situation (Flin & Maran, 2015; Flin et al., 2008). The start of this process is closely interwoven with the higher levels of situation awareness, where the problem that needs resolving to avoid undesirable consequences from the current situation affecting the patient's future state, is identified (Tower et al., 2019). Determining which decision-making technique is employed depends on the circumstances and is primarily associated with pattern recognition, rules or an evaluation of options, where time pressure, level of acuity, feasibility of the options, availability of resources and experience of the anaesthetist will

play a major role (Flin & Maran, 2015; Gjeraa et al., 2017; Larsson, 2017). An experienced healthcare professional may often recognize a pattern and act intuitively, while the novice may need to actively employ analytic reasoning to make a judgement (Larsson, 2017; Stiegler & Tung, 2014; Tower et al., 2019). In acute situations time is limited, and heuristic solutions such as the use of algorithms are often employed to gain control over the situation (Flin et al., 2008; Stiegler & Tung, 2014).

Various cognitive factors can influence decision-making and threaten patient safety, for example, overconfidence, tunnel vision, misremembering important information, various forms of bias towards a possible action, as well as emotional involvement (Stiegler & Tung, 2014). Technical expertise and familiarity with handling critical situations have a significant effect on decision-making, while stress, fatigue, noise and distractions can disrupt concentration during the process and cause mistakes (Flin et al., 2008). Thus, feedback and re-evaluation are an important part of problem-solving and ensuring that actions taken have had the desired effect. Decision-making is therefore a cyclical process encompassing situation assessment, selecting a course of action and re-evaluation (Flin & Maran, 2015; Stiegler & Tung, 2014).

2.2.1.3 Task management

Implementation of the selected action(s) or tasks is part of the decision-making process and is directly linked with task management (Moll-Khosrawi et al., 2019). Task management incorporates planning, prioritizing and utilizing available resources in an optimal way and is considered primarily to be a cognitive skill, although the tasks themselves require technical competence (Fletcher et al., 2002). The relationship between non-technical skills and technical skills in anaesthesia has been described as intertwined, although there is no consensus as to whether there exists a correlation between them (Gjeraa et al., 2016).

A lack of appropriate planning and poor resource and task management can threaten patient safety in the operating theatre (Gjeraa et al., 2016; Jones et al., 2018) by directly impinging on situation awareness, decision-making and teamworking capabilities (Flin et al., 2008). Working in a structured manner, approaching work tasks in a focused way,

and having a "plan B" in mind were all regarded as signs of excellence and ensuring patient safety (Rutherford et al., 2012). Planning and communicating the plan to other team members is also an important aspect of leadership (Flin et al., 2008; Jones et al., 2018; Sevdalis et al., 2012).

Acute situations require anaesthesia personnel to multitask and prioritize correctly (Riem et al., 2012). However, high cognitive load as well as stress and fatigue may affect the individual's ability to manage tasks within the expected timeframe (Flin et al., 2010; Riem et al., 2012). Stress can lead to certain tasks being abandoned owing to difficulties concentrating on several tasks simultaneously (Flin et al., 2008), while cognitive load can affect non-technical skills when carrying out technical procedures under critical conditions (Doumouras et al., 2017). Utilizing the available resources appropriately by delegating tasks and coordinating and supporting other team members in their work contributes to ensuring a well-functioning team (Rutherford et al., 2012).

2.2.1.4 Teamwork

Teamwork encompasses social and interpersonal skills relating among other things to communication, cooperation, and task coordination, and has been shown to have a major impact on patient safety (Flin & Maran, 2015). Salas (1992, p. 4) defines a team as:

> *"a distinguishable set of two or more people who interact, dynamically, interdependently and adaptively towards a common and valued goal/objective/mission, who have each been assigned specific roles or functions to perform, and who have a limited life-span of membership."*

The surgical team is a collection of highly skilled professionals each with their own individual performance goals, however teamwork involves utilizing all their capabilities to work towards a common goal so that the sum is greater than its parts (Flin et al., 2008; Jones et al., 2018). Patient safety depends on the team displaying mutual trust and respect for each other's tasks and responsibilities, open and effective communication, and an active engagement towards achieving the goal (Hanssen et al.,

2020; Jones et al., 2018; Sevdalis et al., 2012). Exchanging information and having shared and accurate mental models within the team, contributes to effective decision-making and the anticipation of future potential problems (Gjeraa et al., 2017; Jones et al., 2018; Sevdalis et al., 2012). Moreover, a team that collaborates well gives the patient a feeling of security (Hanssen et al., 2020).

On an individual level, team skills contributing to effective team performance involve adaptability, supporting other team-members, conflict-resolution, and the ability to coordinate activities in an optimal way (Rutherford et al., 2012; Sevdalis et al., 2012). Assertiveness in critical situations is crucial in the prevention of mistakes, but hierarchy, fear of being wrong or retribution, avoidance of conflict, and other factors often prevent healthcare personnel from speaking up when they disagree with a course of action (Jones et al., 2018; Rutherford et al., 2012).

As has been shown, situation awareness, decision-making, task management and teamwork are all essential non-technical skills for providing safe anaesthesia care, it is therefore important that developing and assessing these skills is an integrated part of nurse anaesthesia education. In order to facilitate this, educational and healthcare institutions need reliable and usable instruments for assessing non-technical skills. Over the past couple of decades, several instruments for developing and assessing individual and team non-technical skills have emerged.

2.3 Behavioural assessment instruments for non-technical skills

The field of anaesthesia has led the way in training and assessing non-technical skills in healthcare settings based on research and experience from training aviation crews (Flin & Maran, 2015). Gaba and colleagues were the first to adopt the Crew Resource management (CRM) team training concept in the 1990s, which was developed to train air crews to understand the effect of human factors on behaviour, and manage routine situations in a safe manner (Flin & Maran, 2015; Flin & Patey, 2011; Gaba et al., 2001). The emphasis of Anaesthesia Crisis Resource Management (ACRM) however was more on the surgical team's management of critical situations, and behaviour that improved teamwork (Flin & Patey, 2011; Østergaard et al., 2011). Both CRM and ACRM have since

been used widely in team-training courses for healthcare professionals in simulation centers (Flin & Maran, 2015; Flin & Patey, 2011; Gaba et al., 2001).

In 2003, the first structured behavioural assessment instrument for anaesthetists' non-technical skills was developed by a team of psychologists and anaesthesiologists in Aberdeen, based on experiences with developing a similar instrument for the aviation industry (Fletcher et al., 2003; Flin & Patey, 2011). The Anaesthetist's Non-Technical Skills (ANTS) is a behavioural marker framework with four skill categories describing good anaesthesia practice and was developed using grounded theory after reviewing existing literature, conducting interviews with anaesthesiologists, and then testing and revising the prototype (Fletcher et al., 2003). It has been rigorously tested in simulation-based settings and found to have reasonable accuracy and reliability when rating anaesthetists' non-technical skills (Doumouras et al., 2017; Fletcher et al., 2003; Flin & Patey, 2011; Graham et al., 2010; Marshall & Mehra, 2014; Yee et al., 2005). Whereas ACRM focused on training anaesthetists' behaviour in crises as part of a team, ANTS is concerned with developing and training the individual's routine behaviours (Flin & Patey, 2011).

ANTS has been translated into several languages and adapted for use in various countries around the world in simulation training (Flin et al., 2010). It was designed to be used in the clinical environment as an instrument for observing and assessing non-technical skills once an anaesthetist had acquired the basic technical skills, although gaining widespread acceptance for this has proved challenging (Flin & Maran, 2015; Flin & Patey, 2011). ANTS has also spawned behavioural assessment instruments for other healthcare professionals, such as the Non-Technical Skills for Surgeons (NOTSS) (Yule et al., 2006) and the Scrub Practitioners' List of Intra-operative Non-Technical Skills (SPLINTS) for theatre nurses (Mitchell et al., 2012), which have been translated and customized to other languages (Mykkeltveit & Bentsen, 2020; Spanager et al., 2013). In the field of anaesthesia, there is now both a Norwegian and Danish version of Nurse Anaesthetists' Non-Technical Skills (Flynn et al., 2017; Lyk-Jensen et al., 2014) as well as the Anaesthetic Non-Technical Skills for Anaesthetic Practitioners (ANTS-AP) in the UK (Rutherford et al., 2015). The Anaesthesiology students' Non-Technical Skills (AS-NTS) is

a recent adaptation and simplification of ANTS for use in training and assessing undergraduates' non-technical skills (Moll-Khosrawi et al., 2019).

A major consideration when using instruments for assessing non-technical skills in a clinical setting is reliability. Two recent reviews highlighted some of the problems (Boet et al., 2018; Higham et al., 2019). Firstly, there is a need for greater standardization of design and testing of the instruments to enable reliability comparisons (Higham et al., 2019). Although the non-technical skill domains are similar in a general sense, there is currently no generic instrument with standard definitions for non-technical skills and benchmarks for adequate practice (Higham et al., 2019; Jepsen et al., 2015; Johnson & Aggarwal, 2019). Secondly, feasibility testing is often not included and this is an important factor for implementation (Johnson & Aggarwal, 2019). Finally, observing and assessing these skills reliably can be challenging and at risk of bias, thus adequate training is essential (Boet et al., 2018; Jepsen et al., 2015). The "gold standard" recommendations are two full days' training, but this is often difficult to achieve (Hull et al., 2013; Klampfer et al., 2001).

There is therefore a need for further research into the reliability of structured behavioural assessment instruments generally (Boet et al., 2018), and with regard to nurse anaesthesia education specifically. Although many of the behavioural instruments have been psychometrically evaluated (Boet et al., 2018; Higham et al., 2019), there is little research into how many raters are necessary to provide a reliable summative assessment (Spanager, Konge, et al., 2015). Moreover, there is little research that has tested instruments for non-technical skills in a clinical setting (Spanager, Dieckmann, et al., 2015), and no studies so far that have used these instruments in clinical practice to assess student nurse anaesthetists' non-technical skills. A further research gap is how using these instruments in clinical supervision is experienced (Sirevåg et al., 2021).

2.3.1 The Nurse Anaesthetists' Non-Technical Skills-Norway (NANTS-no)

The Nurse Anaesthetists' Non-Technical Skills – Norway (NANTS-no) structured behavioural assessment instrument (Appendix 1), was adapted from an approved Norwegian translation of ANTS in 2014 to suit the context in which Norwegian nurse

anaesthetists work (Flynn et al., 2017). The adaptation process is described in section 2.3.1.1. NANTS-no has a hierarchical structure with four skill cateories; *Situation awareness*, *Decision making*, *Task management* and *Team working*, and fifteen elements (Figure 2) similar to ANTS and other instruments for assessing non-technical skills (Fletcher et al., 2003; Lyk-Jensen et al., 2014; Rutherford et al., 2015; Spanager et al., 2013).

Figure 2: The NANTS-no structured behavioural assessment instrument

Each element has a list of behavioural examples of good and poor practice that are practical and contextually relevant. The examples for the first element *Gathering information* in the *Situation awareness* category are shown in Table 1.

Table 1: NANTS-no element "Gathering information" – behavioural markers

Behavioural markers for good practice	**Behavioural markers for poor practice**
Obtains and documents relevant patient information preoperatively	Unconcentrated and reduces level of monitoring because of distractions
Continually scans the patient, fluids, drugs, patient monitors and other medical devices	Does not customize physical layout of workspace to improve visibility
Collects information from the team to identify potential problems	Unstructured and fragmented collection of information
Is aware of what is happening in the surgical site	Does not ask questions to orient self to situation during hand-over
Cross-checks information to increase reliability	

In addition, NANTS-no has a five-point numerical rating scale (1-5) as shown in Table 2. The scale is used to rate each element and category and to provide a global score. In cases where behaviour is not observed for an element, "N" for "not observed" is used.

Table 2: NANTS-no numerical rating scale

Score	**Behaviour**	**Descriptors**
5	Excellent	Exemplary high professional standard
4	Good	Consistently good standard that safeguards patient safety
3	Acceptable	Acceptable standard with room for improvement
2	Marginal	Grounds for concern, considerable need for improvement
1	Poor	Patient safety risk, comprehensive need for training and support
N	Not observed	Behaviour not observed in this situation

2.3.1.1 Adapting NANTS-no from ANTS

The adaption process primarily involved making the behavioural examples in NANTS-no relevant to the context in which Norwegian nurse anaesthetists work (Flynn et al., 2017). A certain amount of inspiration was drawn from the Danish instrument for nurse

anaesthetists, particularly with regard to the organization of categories and elements (Lyk-Jensen et al., 2014). In ANTS the *Task management* category comes first, followed by *Team working*, *Situation awareness* and *Decision making*, whereas in NANTS-no the order was changed so that *Situation awareness* is the first category, since situation awareness is regarded as a key skill and the foundation of the other skills (Schulz et al., 2016; Wright & Fallacaro, 2011). For example, becoming aware of changes in the patient's condition is a prerequisite for making a decision and prioritizing tasks in collaboration with others in the team to improve the patient's situation. ANTS has a four-point rating scale, and this was modified to a five-point scale in line with the Danish instrument for nurse anaesthetists (Lyk-Jensen et al., 2014).

The instrument's face and content validity were tested using a panel of four Norwegian nurse anaesthetists with considerable experience in the field, which resulted in minor language and content changes (Flynn et al., 2017). There was however a consensus that NANTS-no defined Norwegian nurse anaesthetists' professional areas of good practice well (ALNSF, 2016; Gisvold et al., 2002). NANTS-no was primarily intended to provide a common taxonomy for non-technical skills in nurse anaesthesia, that could be used by qualified nurse anaesthetists to reflect over and evaluate their own performance. However, there is also a need for this kind of instrument in nurse anaesthesia education as will be shown in the next section.

2.4 Nurse anaesthesia education

Nurse anaesthesia education in Norway relies on collaboration between educational and healthcare institutions. It is currently either a two-year master's program (120 ECTS) or an eighteen-month postgraduate specialist training (90 ECTS), with clinical practice comprising 45 ECTS of both alternatives. In order to comply with new regulations (Norwegian Ministry of Education and Research, 2021), all educational institutions providing nurse anaesthesia education must offer a master's program.

Several benefits of master's level education for healthcare practitioners were highlighted in a recent review (Madi et al., 2019). Firstly, it contributes to heightened critical reasoning skills and increased use of research evidence that improves clinical

skills such as assessment, decision making and patient management. Furthermore, it aids graduates in articulating and justifying their decisions, improves their credibility with other professions, and promotes increased confidence and motivation in clinical practice (Madi et al., 2019). Despite persuasive argumentation regarding the value of master's level education, the relevant authorities in Norway have decided to allow nurse anaesthetist students to finish their education after completing 90 ECTS without writing a master's thesis, if they so wish. This decision is presumably associated with financial considerations owing to an ageing population of qualified nurse anaesthetists, as well as a certain reluctance in governmental departments and upper management level in healthcare institutions to accept the need for master's level education (Norwegian Ministry of Education and Research, 2021).

The International Council of Nurses (ICN) recognized the role of nurse anaesthetist globally in their new practice guidelines on advanced practice nursing (ICN, 2021). The purpose of the guidelines is to clarify and facilitate a common understanding of the role for stakeholders such as government bodies, healthcare and educational systems and the general public. Anaesthesia has been provided by nurses for over 150 years in many different settings; public, private and military hospitals as well as ambulatory settings such as pain clinics (ICN, 2021). The ICN (2021) defines a nurse anaesthetist as an advanced practice nurse that has completed general nursing training and a recognized educational program in anaesthesia at post-graduate level (minimum of master's degree), with a curriculum that includes both theory and clinical experience. It also highlights the nurse anaesthetist's dedication to continuous professional development to improve and broaden their knowledge and expertise. However, the nurse anaesthetist's scope of practice varies considerably on a global level (Herion et al., 2019).

2.4.1 Scope of practice

Nurse anaesthetists in the Nordic countries, Switzerland and United States have historically had an independent role (Vickers, 2002). Although scope of practice in the Nordic countries is similar, nurse anaesthesia education varies greatly between the

countries (Jeon et al., 2015). In contrast, in the United Kingdom, Australia and New Zealand among other countries, anaesthetic assistants assist anaesthesiologists in the operating room, and may not even be nurses (Rutherford et al., 2012; Vickers, 2002). In many low-income countries on the other hand, nurse anaesthetists are often the sole providers of anaesthesia (Herion et al., 2019; ICN, 2021).

In Norway, roles and responsibilities are regulated by the Norwegian Standard for Anaesthesia, and the nurse anesthetist has a high level of autonomy (Ringvold et al., 2018). While clinical responsibility lies with the anaesthesiologist, a nurse anaesthetist is qualified to independently administer general anaesthesia to patients classified by the American Society of Anesthesiologists (ASA) as healthy or with mild systemic disease (ASA I or II) (2020). However, when administering anaesthesia to patients with severe systemic disease (ASA III or IV), the nurse anaesthetist works together with an anaesthesiologist (Ringvold et al., 2018).

This level of responsibility, combined with increasing requirements for professional accountability to ensure patient safety in anaesthesia (Boet et al., 2018), highlight the need for high standards of clinical supervision and assessment to ensure that nurse anaesthetists achieve the required level of clinical expertise during their education.

2.4.2 Clinical supervision

Clinical supervision is an essential part of educating nurse anaesthetists and developing a new professional identity as a nurse anaesthetist. It is regarded as bridging the gap between educational and healthcare institutions and integrating theory and practice into professional competence (Dobrowolska et al., 2016; Jokelainen et al., 2011). There is however wide variation in the organization, employment patterns and standards of clinical supervision internationally (Dobrowolska et al., 2016; Jokelainen et al., 2011). In addition, there are differences in how clinical supervision and mentorship is defined in clinical practice literature (Jokelainen et al., 2011; Meno et al., 2003; Scott-Herring & Singh, 2017).

Lyth (2000) describes clinical supervision as an overarching term for the process of professionals providing support and guidance that enables the enhancing of knowledge

and clinical skills in a safe environment, and it is used as such in this thesis. Terms such as *mentor*, *preceptor*, *nurse educator* or *supervisor* are used inconsistently and interchangeably in the literature, making it challenging to compare the way in which clinical supervision is carried out in different countries (Jokelainen et al., 2011; Lyth, 2000; Scott-Herring & Singh, 2017).

The term *mentor* in clinical practice literature is applied to both ad-hoc arrangements as well as more formalized monitoring and assessment and is often used interchangeably with preceptor (Fowler & Cutcliffe, 2011; Jokelainen et al., 2011). In this thesis, *mentor* is used to describe an experienced postgraduate nurse anaesthetist who is responsible for providing one-to-one guidance on a daily basis and facilitating the learning of clinical skills. The mentor's role is multifaceted and involves a range of competencies in addition to creating a safe environment that facilitates relevant learning situations. These include carrying out formative and summative assessments, and role modelling evidence-based practice (Rylance et al., 2017; Scott-Herring & Singh, 2017). Mentors also teach effective decision-making, aid the development of team-working and communication skills, and assist students in setting priorities (Jokelainen et al., 2011). A major challenge facing mentors is ensuring patient safety, while simultaneously guiding student nurse anaesthetists through complex, dynamic and critical situations in a highly technical environment (Jølstad et al., 2019).

The relationship between student and mentor is important in promoting professional and personal development by encouraging critical reflection and self-awareness (Jokelainen et al., 2011). Taking part in postgraduate education of students is considered an obligation in healthcare trusts (Ozga et al., 2020). Nonetheless, recruiting mentors who are motivated and have the right qualities and competencies can often be challenging (Dobrowolska et al., 2016). Although many mentors lack training in adult learning principles and educational theory, qualities such as calmness during stressful situations, using clear and non-threatening communication and allowing students to make decisions independently were regarded as important by student nurse anaesthetists (Elisha & Rutledge, 2011). Interpersonal skills and the ability to provide formative feedback that is constructive, honest and non-judgemental is also seen as

important in mentoring (Jokelainen et al., 2011). Furthermore, excellent role models are seen as affirming others and being willing to share their craft or knowledge (Perry, 2009).

The *clinical supervisor* or nurse educator acts as a link between the educational and healthcare institution, organizing clinical practice for all the student nurse anaesthetists at a hospital trust, teaching and supporting students and mentors, and taking a major role in the assessment of clinical skills. Various employment frameworks are in use internationally, with some clinical supervisors being employed as healthcare providers, while others are teachers employed by the educational institution (Dobrowolska et al., 2016). The challenge for both alternatives is maintaining enough academic and clinical experience to ensure legitimacy as a teacher and assessor of evidence-based clinical skills (Dobrowolska et al., 2016). Since a major part of nurse anaesthesia education is carried out in a clinical environment there is a need for dedicated personnel with specialist advanced competencies in both anaesthesia and supervision. Establishing positions for clinical supervisors where both educational and healthcare institutions share the employee, has been suggested as a means of improving quality and relevancy (The Norwegian Association of Higher Education Institutions, 2016). This recommendation is intended to increase cooperation and commitment between educational and healthcare institutions in the education of healthcare professionals.

Although a few countries have national standards for clinical supervision and mandatory formal training, these do not currently exist in Norway and many other European countries (Dobrowolska et al., 2016; Jokelainen et al., 2011; Jølstad et al., 2019). There is a need to develop special education programs for formalizing the training of mentors, based on cooperation between educational and healthcare institutions (Dobrowolska et al., 2016). This was also proposed in national recommendations for improving quality in clinical supervision, and educational institutions were regarded as having a particular responsibility for facilitating this (The Norwegian Association of Higher Education Institutions, 2016). An educational program aimed at raising the academic and pedagogic standards of specialist nurses involved in clinical supervision found that it facilitated professional growth and identity as a mentor, as well as increasing their

communication and reflective skills (Jølstad et al., 2019). This resulted in a shift in the way they mentored their students and managed their dual role as mentor and clinical specialist.

A final consideration in providing good clinical supervision is the managerial role in clinical practice. While benefits such as providing support and feedback, promoting autonomy, and ensuring control and monitoring of competence have been emphasized (Lyth, 2000), both mentors and students have described a general lack of time allocated to mentoring (Jølstad et al., 2017; Rylance et al., 2017). Leadership style, increasing demands for efficient production, allocating adequate resources, and providing support have all been highlighted as organizational and managerial concerns that need to be addressed (Jokelainen et al., 2011; Jølstad et al., 2017; Ozga et al., 2020). In addition, establishing incentives to encourage recruitment as well as preparing and rewarding mentors for the extra responsibility, are all factors that should be considered by managers and policymakers (Dobrowolska et al., 2016; Rylance et al., 2017).

Clinical supervision encompasses both formative and summative assessments of the student's proficiency (Rylance et al., 2017; Scott-Herring & Singh, 2017). In nurse anaesthesia education, assessments are carried out by both the mentor and clinical supervisor to promote a high degree of objectivity and accountability.

2.4.3 Assessing clinical competence

Assessment in education is regarded as essential for stimulating learning and defining expectations, as well as ensuring that students have acquired the necessary knowledge and skills (Miller, 1990; Wong, 2012). It is also essential as a means of demonstrating accountability to stakeholders and regulatory bodies since education requires an investment of time and resources at many levels (Elisha et al., 2020). However, high-stakes summative assessments potentially resulting in a candidate's dismissal, demand standardized and validated instruments with high psychometric reliability (Collins & Callahan, 2014; Elisha et al., 2020; Wong, 2012). Although there are standardized means of testing theoretical knowledge in education, assessing clinical competence is more challenging as Miller indicated more than 30 years ago (1990).

Miller's pyramid for clinical assessment has four levels, with Knowledge (knows) forming the base (1990). Knowledge can be evaluated through academic examinations, but documenting Competence (knows how), Performance (shows how) or the final level, Action (does) remains a challenge (Miller, 1990; Wong, 2012). A recent study suggested extending the pyramid to include Identity (is) as a fifth level (Figure 3), where the student demonstrates the attitudes, behaviour and values connected with professionalism (Cruess et al., 2016).

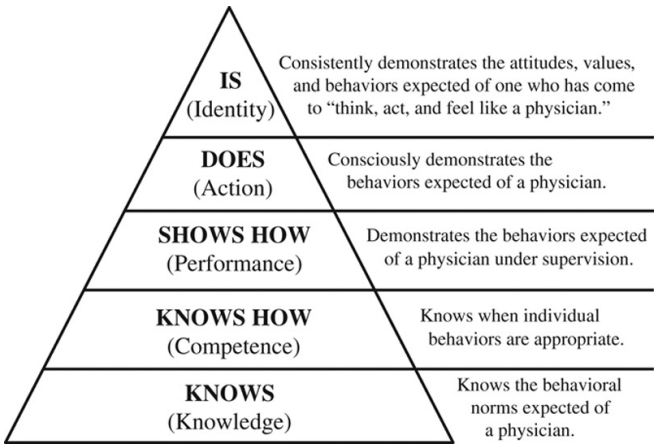

Figure 3: The amended version of Miller's pyramid. *Source: Creuss et al. 2016.*

Various assessment methods such as simulation, written assignments, work-based and peer assessments are implemented as means of testing clinical skills, and the objective structured clinical examination (OSCE) is widely used in medical and nursing education (Boet et al., 2018; Dexter et al., 2020; Helminen et al., 2016; Newble, 2004; Taylor et al., 2019). However, these are often task driven and more concerned with technical proficiency than the practitioner's attitudes and behaviour since these aspects are more difficult to assess reliably (Lyk-Jensen et al., 2014; Miller, 1990; Newble, 2004; Taylor et al., 2019). Issues such as inconsistencies in the assessment process, subjectivity and bias, as well as overcomplicated and unsuitable evaluation forms, are cited as making assessments potentially unreliable (Helminen et al., 2016; Miller, 1990).

Continuous clinical evaluation in nurse anaesthesia education is carried out in the form of *formative* and *summative* assessments. Formative assessment is described as an ongoing process that continues throughout the student's clinical training and is based

on feedback that is intended to aid the student in achieving the expected level of competency (Helminen et al., 2016). It is regarded as playing a major role in learning and improving performance, increasing self-awareness and changing behaviour (Wong, 2012). Self-assessment that allows practitioners to evaluate their own performance through critical reflection is regarded as essential for life-long learning (Arora et al., 2011). However, its value depends on whether self-perceptions are accurate and in line with expert assessments (Arora et al., 2011). Self-awareness is an important factor here, and in a study with intensive care nurses, poor performers tended to overestimate their performance while high performers underestimated theirs (Ballangrud et al., 2014).

Summative assessment is regarded as determining whether a practitioner is fit to practice and meets standards of quality and patient safety (Helminen et al., 2016). Identifying which students may be at risk of failing and where the problem lies, is an important factor in aiding professional growth and demonstrating accountability (Helminen et al., 2016). Moreover, attrition resulting from academic failure, dismissal or withdrawal from the educational program, all represent a waste of individual and institutional resources and should be prevented if possible (Burns, 2011; Collins & Callahan, 2014). Summative assessments for certification purposes require a high degree of reliability in the instrument used, with a generalizability coefficient ≥ 0.90 considered an appropriate measure (Dexter et al., 2020; Spanager, Konge, et al., 2015). However, institutionally derived clinical evaluation tools for nurse anaesthetists are common in Norway and internationally, and these may lack the necessary reliability and/or validity (Collins & Callahan, 2014). There is therefore a need for reliable instruments that can ensure an objective and standardized assessment of clinical skills.

2.4.4 NANTS-no in nurse anaesthesia education

There are currently few instruments that provide a standardized taxonomy for developing and assessing non-technical skills in some form in nurse anaesthesia education (Lyk-Jensen et al., 2016; Schierenbeck & Murphy, 2018). There is therefore a need for instruments that enhance learning and professionalism while motivating

practitioners to perform to the best of their ability, and furthermore facilitate an objective assessment of the skills which promote clinical excellence and patient safety.

NANTS-no may provide a taxonomy for use in clinical supervision, by both encouraging self-awareness and critical thinking in student nurse anaesthetists and presenting mentors and clinical supervisors with objective criteria for giving formative feedback on students' non-technical skills. Since deficient non-technical skills are associated with poor and unsafe anaesthesia care (Johnson & Aggarwal, 2019; Jones et al., 2018) and a common reason for students' failing to meet guideline expectations for clinical performance (Collins & Callahan, 2014; Tower et al., 2019), the NANTS-no numerical rating scale may be useful as a means of assessing these skills. However, using the instrument for summative assessments in a clinical setting presupposes that it meets the rigorous requirements for instrument reliability. Currently few instruments for non-technical skills have been tested in a clinical setting (Boet et al., 2018; Higham et al., 2019).

NANTS-no has been tested in a simulation setting (Flynn et al., 2017), however, prior to using it in nurse anaesthesia education it needs first to be validated. The first step in this research is therefore to explore the instrument's psychometric properties, before testing it in clinical practice.

3 Theoretical perspectives

This chapter looks at the ways in which ideas of person-centredness and transformative learning can be applied to nurse anaesthesia education. It then presents the ontological, epistemological and methodological assumptions that underpin the research project, starting with a review of pragmatism's position as a science of philosophy. Finally, it considers pragmatism as a research paradigm for this project.

3.1 Person-centredness in nurse anaesthesia education

The concept of person-centredness is based on the idea of personhood as a complex collection of attributes, capabilities, needs, feelings, vulnerabilities and desires, which makes each of us a unique person (McCormack & McCance, 2016), and is rooted in the humanistic approach to psychology of Carl Rogers among others (McCance et al., 2011). Person-centredness recognizes the importance of respecting the person in relation to others and existing in a social context, as well as respecting that which really matters to the individual as a person (McCormack, 2004). Various characteristics are associated with the concept of "person", including the ability to reason, communicate and act intentionally, self-awareness and self-regulation, as well as a desire to both preserve and develop one's self and identity (Entwistle & Watt, 2013). In order for a person to flourish they need to feel valued, respected and involved (O'Donnell et al., 2016). In this research the primary focus is on the student nurse anaesthetist as a person learning within the context of clinical practice in the operating room. However, the nurse anaesthetists involved in clinical supervision, and ultimately also the surgical patient the mentor and student are responsible for, are all "persons" integral to the implementation of the research.

3.1.1 Person-centred practice and education

The term person-centred practice is often used interchangeably with for example people-centred health care (WHO, 2007) or patient-centred care (Kitson et al., 2013). The Norwegian government (Norwegian Ministry of Health and Care) called for a more holistic or "patient-centred approach to health-care" in 2013, a strategy that reflects

both quality of care and patient safety. It is clear therefore that these concepts are all closely linked and not mutually exclusive. McCormack & McCance (2016) have defined person-centred practice in the following way:

> *"…the formation and fostering of healthful relationships between all care providers, service user and others significant to them in their lives. It is underpinned by values of respect for persons, individual right to self-determination, mutual respect and understanding. It is enabled by cultures of empowerment that foster continuous approaches to practice development."*

This definition draws on holistic ideas and international principles of human rights and dignity (WHO, 2007), and applies both to patients and the healthcare professionals involved in providing their care. It also highlights the importance of relationships in person-centredness that are built on mutual trust and understanding and involve sharing knowledge and power (McCance et al., 2011). This encompasses relationships between professionals and their patients, as well as interactions between professionals in multidisciplinary teams or with the students they mentor (McCormack & McCance, 2010; Nolan et al., 2004).

McCormack and McCance have attempted to operationalize person-centredness by developing a practice framework that comprises four constructs; the *prerequisites* or attributes of the healthcare professional, the *care environment* or the context in which care is given, the *process* of delivering care in a person-centred way and expected person-centred *outcomes* (2010, 2016). The person-centred framework can be approached at an individual, local or structural level. Although the purpose of this research is ultimately to effect a change in nurse anaesthesia education, its focus is on developing the competence of the individual student nurse anaesthetist. Thus, it is the prerequisites of the individual student nurse anaesthetist and how they can be developed, which are relevant here.

The prerequisites for a healthcare professional providing person-centred care were defined as being professionally competent, having developed interpersonal skills, being committed to the job, having clarity of beliefs and values, and knowing one's self

(McCormack & McCance, 2010). These attributes are regarded as equally important within the framework and require a commitment to continually strive towards developing and learning expert practice and advanced communication skills. They also involve increasing one's self-awareness through critical reflection and being prepared to go beyond the call of duty (McCormack & McCance, 2016). In a perioperative setting these qualities involve the nurse anaesthetist protecting the patient by being vigilant, keeping one step ahead and optimising the patient's functions during anaesthesia. They also comprise gathering and sharing information in a way that promotes teamwork, as well as preserving the patient's dignity and integrity by building a trusting relationship and providing holistic care (Aagaard, Sorensen, et al., 2017; Schreiber & Macdonald, 2010; Sundqvist et al., 2018).

Developing professional competence, interpersonal skills, self-awareness and a commitment to life-long learning in student nurse anaesthetists encompasses ideas of person-centredness as well as clinical excellence and patient safety. A person-centred approach to education aims at creating a safe but challenging learning environment where students and educators collaborate through a power-sharing process of dialogue, formative feedback and critical reflection to develop the students' knowledge and skills (O'Donnell et al., 2016). Nolan (2004) emphasizes the importance of relationships that promote a sense of security and belonging, as well as purpose that leads to personal achievement.

Incorporating person-centredness in a nursing curricula involves moving beyond mediocracy, emphasizing the value of self-knowledge, combining the science and art of nursing in an optimal way, and utilizing learning methodologies such as problem-based learning, simulation training and reflection (O'Donnell et al., 2016). These ideas are aligned with the goal of striving for clinical excellence in anaesthesia practice and using instruments such as NANTS-no as a means of encouraging critical reflection and self-awareness. Balancing the mechanistic and caring sides of nurse anaesthesia optimally and utilizing simulation training and other student-based methods systematically, may facilitate a more student-centred education. However, in order to put these ideas into practice in nurse anaesthesia education, they need to be founded on pedagogical

principles and theories of learning. Student nurse anaesthetists are already experienced professionals, therefore learning needs to focus on enabling them to extract meaning from their experiences, and emphasize humanistic perspectives that encourage professional and personal growth and development (Merriam, 2018). This is the basis of adult learning theories.

3.1.2 Learning as adults

Learning is broadly defined by Illeris (2018) as: *"any process in living organisms that leads to permanent capacity change and which is not solely due to biological maturation or ageing"*. He further describes it as an integration of an internal and external process, where the internal acquisition of learning is dependent on both the content of what is being learned and the motivation that drives the learning process. This internal process is influenced by interaction with the external social, cultural and material environment in which learning happens (Illeris, 2018). Although adults are known to learn throughout their lives, the systematic study of the way in which they learn and how that differs from children, is a relatively recent discipline (Merriam, 2018).

While andragogy is often regarded as synonymous with adult learning theory, Knowles' assumptions are seen as focusing more on the nature of adult learners rather than on the learning itself (Merriam, 2018). Transformative learning on the other hand, is more concerned with the cognitive process of finding meanings which may then lead to change; a personal, individual transformation in a way of thinking or acting (Calleja, 2014; Merriam, 2018). The aim of NANTS-no is to encourage self-awareness in the individual student that leads to a behavioural transformation, improved non-technical skills and increased patient safety, therefore transformative learning is in line with moving beyond mediocracy and aspiring towards clinical excellence in nurse anaesthesia education (O'Donnell et al., 2016; Wong, 2012).

Transformative learning was first introduced as a concept in 1978 by Jack Mezirow who was influenced by Thomas Kuhn's concept of paradigms, Paulo Freire's work on conscientisation and Jürgen Habermas' domains of learning (Mezirow, 2018). Mezirow defines transformative learning as:

> *"the process by which we transform problematic frames of reference (mindsets, habits of mind, meaning perspectives) – sets of assumption and expectation – to make them more inclusive, discriminating, open, reflective and emotionally able to change" (Mezirow, 2018).*

Mezirow uses the term *frames of reference* in a similar way to Kuhn's paradigm to describe a shared common worldview through which to understand and construe meaning (Calleja, 2014). These frames of reference both shape and set boundaries to the way in which things are perceived and understood and are influenced among other things by previous assumptions and experiences, as well as social and ideological views (Calleja, 2014; Mezirow, 2018). Transformative learning occurs when an existing frame of reference is challenged by what Mezirow calls a *disorienting dilemma.* This triggers a process of critical assessment and reflection which leads to acquiring new knowledge and skills, a new frame of reference (Mezirow, 2018). Immersion in a different context, such as clinical practice in a new and unfamiliar specialty or simulation training, has been seen as the kind of *disorienting dilemma* that can trigger transformative change (Van Schalkwyk et al., 2019). A transformation can either be dramatic and associated with a major life crisis, or be a progressive sequence of insights that lead to changing a point of view (Mezirow, 2018).

Mezirow drew on Freire's critical pedagogy and concept of critical awareness and Habermas' ideas on communicative action to describe the process of self-examination, critical assessment and reflection on the validity of arguments that enables the learner to make sense of meanings (Calleja, 2014; Mezirow, 2018). The social interaction between the student and mentor involving formative feedback and emotional support will also contribute to this process (Calleja, 2014; Mezirow, 2018). Thus, transformative learning involves an active move towards a more critically reflective way of looking at oneself and the world that leads to behavioural change (Van Schalkwyk et al., 2019). However, in order for this to happen, students need to be receptive to and capable of considering other points of view when their own frames of reference are challenged (Van Schalkwyk et al., 2019).

The Freirean approach to person-centred learning advocated by O'Donnell (2016) is founded on participatory learning partnerships which encourage dialogue and critical reflection as a means of empowering students, raising standards, and leading to transformative learning. One of the main aims of using NANTS-no in clinical practice is to encourage cooperation between student nurse anaesthetists and their mentors. Cooperative learning demands an active commitment from the student to take responsibility for their learning, while the mentor or educator is regarded as a facilitator (Kirschner, 2001). Furthermore, it considers teaching and learning to be shared experiences, with the students developing their social and cognitive skills through dialogue and consensus-building (Kirschner, 2001).

The context in which learning takes place also plays a significant role in adult learning by giving it meaning and viability (Kirschner, 2001; Merriam, 2018). Contextual learning is dependent on three factors; the people in the context where the learning takes place, the tools that are used and the activities involved (Merriam, 2018). Therefore, the mentors, clinical supervisors, anaesthesiologists, and other members of the surgical team the students work with in clinical practice, have the capacity either to aid or hinder learning. Instruments such as NANTS-no and the activities involved in clinical practice are intended to promote learning and form a professional identity but may however be challenged by personal, organizational and time constraints (Van Schalkwyk et al., 2019).

The next section presents the ontological, epistemological and methodological assumptions underpinning this research, before the materials and methods used in the studies are described in the following chapter.

3.2 Pragmatism's position as a science of philosophy

Knowledge in healthcare is complex and eclectic, drawing on widely differing philosophical perspectives originating in the natural and social sciences as well as the humanities (Martin & Felix-Bortolotti, 2014; van Dulmen et al., 2017). There are inherent contradictions and tensions between these perspectives, based as they are on different ontological assumptions about the nature of reality. While realism attempts to provide a single universally true view of a world that exists independently of us as individuals

(Polifroni, 1999), the constructivist worldview proposes multiple realities and attempts to gain an understanding of the phenomenon in question (Creswell & Plano Clark, 2018). Traditionally, scientific research has been based on one or other of these worldviews (Johnson & Onwuegbuzie, 2004). However, pragmatism offers a new position by viewing reality as both singular and multiple, in order to find a workable solution to gaining knowledge (Cherryholmes, 1992; Creswell & Plano Clark, 2018; Johnson & Onwuegbuzie, 2004). This pluralistic position acknowledges the existence of multiple ontological perspectives, and therefore seemed an ideal choice as a theoretical underpinning for research that is both rooted in an external reality that exists apart from human experience, but also recognizes that human experiences inform and lead to an understanding of that reality (Morgan, 2014a).

Pragmatism as a philosophical tradition emerged in the United States as a reaction to the historical divide between empiricism and rationalism, and is based on the ideas of Charles Sanders Pierce, William James, and John Dewey among others (Johnson & Onwuegbuzie, 2004; Plowright, 2015). In recent times it has undergone a revival and been refined by so-called neo-pragmatists such as Richard Rorty, Hilary Putnam and Robert Brandom (Johnson & Onwuegbuzie, 2004; Murphy, 1990). Charles Peirce is credited with founding pragmatism in the 1870s, although the term itself was not introduced and popularized in philosophical literature until 1898 by William James (Hookway, 2021; Murphy, 1990).

James presented pragmatism as a *"mediating philosophy"* that provided a means of reconciling an empirical need for facts with humanist values (Hookway, 2021), thus both postpositivist and constructivist approaches to reality are meaningful. Instead of focusing on the ontological and epistemological dichotomy, pragmatism treats the differences as social contexts for inquiry and the knowledge produced as complementary (Creswell & Plano Clark, 2018; Johnson & Onwuegbuzie, 2004; Morgan, 2014a, 2014b). Therefore, adopting a pragmatist position in this research implies an acceptance that a more complete understanding can be achieved by combining a realist approach to assessing reliability in the way non-technical skills are measured, with a

constructivist approach to exploring how the measurement of non-technical skills is experienced, and that the findings may augment each other.

3.2.1 A Pragmatist method of inquiry

The term pragmaticism is derived from the Greek word "pragma" meaning "action", and practical action is the very essence of the pragmatist opposition to Western philosophy (Murphy, 1990). However, an emphasis on practicality has been the root of much of the criticism of pragmatism, as being merely concerned with what works rather than being understood as a philosophical system (Morgan, 2014b).

The basis of pragmatism lies in Peirce's pragmatic maxim from 1878:

> *"Consider what effects, which might conceivably have practical bearings, we conceive the object of our conception to have. Then our conception of these effects is the whole of our conception of the object" (Peirce, 1878)*

This principle assumes a logical and deliberate method of inquiry that looks at defining all the criteria for a concept or belief and anticipated practical consequences, in order to achieve a complete understanding of its meaning (Murphy, 1990; Plowright, 2015). According to Peirce, thought leads to action in order to appease doubt and replace it with settled belief (Murphy, 1990; Peirce, 1877). Once established, belief will lead to a rule for action which can influence or determine behaviour (Murphy, 1990; Peirce, 1878; Plowright, 2015). However, since humans are unable to gain access to all available knowledge, belief is neither absolute nor a static state. This concept of belief and reality is linked to fallibilism; that no belief is certain, and the potential infinity of inquiry will expose all our beliefs to eventual correction in the future (Hookway, 2021; Peirce, 1878).

Put simply, Peirce's pragmatic maxim implies that this research or inquiry is part of a dynamic process in an infinite search for knowledge about student nurse anaesthetists' non-technical skills, while accepting that a full insight is unattainable. Any findings will only be tentative, providing a current picture based on anticipated outcomes of the use of behavioural assessment instruments in nurse anaesthesia education, and may be revised by further inquiry at any time in the future. Therefore, even though findings may

provide meaning, whether or not they provide a true version of reality is beyond our knowledge (Cherryholmes, 1992). James developed this view of truth further by relating truth to what is useful or advantageous in the long run, that is, producing beliefs that prove themselves to be good "for definite, assignable reasons" (Murphy, 1990).

John Dewey who was 20 years younger than Peirce and James and intellectually active right up until the 1950s, extended their work on inquiry. Dewey regarded inquiry as starting with a problem, which could be settled through practical problem-solving, gathering of information and common-sense investigations (Hookway, 2021). By legitimizing the use of everyday practical solutions that are grounded in human experience, pragmatism is therefore strongly connected to the real world in which we live (Johnson et al., 2007; Morgan, 2014b). Any knowledge or belief resulting from this process of inquiry Dewey refers to as "warranted assertability" (Capps, 2019; Dewey, 1939). Dewey (1941) further explains the concept of warranted assertions:

> *"…my whole theory is determined by the attempt to state what conditions and operations of inquiry warrant a «believing», or justify its assertion as true"*

The pragmatic view of *experience* differed radically from and was far richer than the empiricist view of experience as purely sensory, providing material for knowledge (Hookway, 2021; Murphy, 1990). Dewey defined experience as a process by which humans interact with their surroundings (Hookway, 2021; Murphy, 1990), as well as being intrinsically linked to our actions and beliefs and the way in which they affect each other (Dewey, 1922/2002; Morgan, 2014b). In this way, pragmatism argues that human experience is constrained by the nature of the world in which we live, as well as that our knowledge and understanding of this world is connected to, and limited by, how we interpret our experiences (Morgan, 2014a, 2014b). Reality can therefore only be understood through our experiences (Morgan, 2014a), and experiences always occur within a specific context and cannot be separated from this social, historical, political or other context (Cherryholmes, 1992; Dewey, 1922/2002; Morgan, 2014b).

In this research, the PhD candidate's experiences from both the clinical and educational fields will play an important role in shaping the research process. In addition, both the

individual student's former experiences and the context in which he or she experiences learning new skills will give meaning to his or her learning and the anticipated outcome of the research. Although, this experience or knowledge will be unique to the individual student, some also originates from shared experiences and will therefore be common (Morgan, 2014a).

The main philosophical ideas of classical pragmatism have been developed in different directions and disputed in more recent times, however, Morgan (2014b) argues that pragmatism is a coherent philosophy that goes beyond practical problem solving. This section has attempted to demonstrate the ways in which pragmatism's ontological and epistemological assumptions underpin the research in this thesis, while the following section examines how pragmatism can be used as a research paradigm.

3.2.2 Pragmatism as a paradigm for multimethods research

The term paradigm was defined in many different ways by Thomas Kuhn (1962) who popularized the term. In this thesis, a research paradigm is defined as *"a set of beliefs, values and assumptions that a community of researchers has in common regarding the nature and conduct of research"* (Johnson & Onwuegbuzie, 2004). A research paradigm is therefore a conceptual lens through which the world is viewed, influencing epistemological and methodological choices, and determining the methods used to collect, analyze and interpret data (Johnson et al., 2007; Kivunja & Kuyini, 2017).

Using pragmatism as a research paradigm offers an epistemological approach that focuses on the nature of experience; on behaviour or actions, the beliefs that shape them, the social context in which they occur and the consequences of these actions (Kivunja & Kuyini, 2017; Morgan, 2014a). Thus, existing knowledge is extended by reflecting first on a potential research problem, considering different ways of looking at it and possible lines of action, then reflecting on these methods in terms of anticipated consequences before taking action (Morgan, 2014a, 2014b). In this way, the research question or anticipated consequences rather than the philosophical viewpoint, becomes the driving force behind the research (Cherryholmes, 1992; Creswell & Poth, 2018; Hesse-Biber, 2016; Morgan, 2014a).

The purpose of this research is the systematic development of non-technical skills using NANTS-no as a means of promoting clinical excellence and patient safety in nurse anaesthesia education. Thus the process started with exploring what was already known about the subject in light of the PhD candidate's clinical and educational experience (Cherryholmes, 1992). Existing research provided practical examples of how to evaluate the psychometric properties of NANTS-no, however there appeared to be little knowledge about using this kind of instrument in a clinical setting during the education of professionals, or about how these instruments are experienced. Therefore, applying a pragmatic research paradigm involved looking at what was needed to answer the research question, and comparing the practical consequences that would result from using differing approaches to explore the reliability and use of NANTS-no in nurse anaesthesia education (Hesse-Biber, 2016; Morgan, 2014a). Reflecting on different approaches led to the decision to use both quantitative and qualitive methods in the research as the best means of obtaining "warranted assertability".

A research project's methodology provides a systematic structure and is dependent on and closely related to the ontological and epistemological assumptions guiding the research (Guba & Lincoln, 2005). Thus, the decision to use a multimethod strategy is determined by the choice of pragmatism as an appropriate paradigm for this research (Johnson & Onwuegbuzie, 2004). There seems to be some confusion surrounding the definitions of *multimethod* and *mixed method* research as concepts (Anguera et al., 2018; Johnson et al., 2007). Therefore, since Pat Bazeley's definition in Burke Johnson et al.'s article (2007) is regarded as best clarifying multimethods, it applies to the research in this thesis:

> "Multimethod research is when different approaches or methods are used in parallel or sequence but are not integrated until inferences are being made" (Johnson et al., 2007).

Multimethod research combines one or more different types of methods without requiring that these methods be integrated or mixed in individual studies as with mixed research (Anguera et al., 2018; Hesse-Biber, 2016). Instead multiple methods are used

"to address the same research question or different parts of the same research question" (Morse, 2015). Furthermore, multimethod research is not confined to having to use both quantitative and qualitative methods and may involve using multiple types of quantitative or qualitative methods (Anguera et al., 2018; Johnson et al., 2007; Mark, 2016).

A final consideration regarding the choice of pragmatism as a research paradigm is that it also allows for a person-centred approach to methodology. Among other things, person-centred research involves considering the context and being aware of the person in the data, while ensuring the participants' well-being both during data collection and afterwards when disseminating the research (van Dulmen et al., 2017).

4 Materials and methods

This chapter provides a rationale for the multimethod research design, as well as an overview of the methods used in the individual studies to sample participants, collect data and analyze it. Furthermore, it includes ethical considerations regarding the candidate's role in the research. A discussion of the methodological considerations will be presented in chapter 6.

4.1 Multimethod research design

The main aim of this thesis is the systematic development and assessment of non-technical skills using the structured behavioural assessment instrument NANTS-no in nurse anaesthesia education. A sequential multimethod design was chosen where the findings in each study influenced the design of the following one, thereby enhancing the overall result (Creswell & Plano Clark, 2018; Johnson & Onwuegbuzie, 2004; Morgan, 2014a).

The aim of Study I was to evaluate the psychometric properties of NANTS-no when used by nurse anaesthetists involved in clinical supervision to rate non-technical skills after taking part in a workshop, as well as to evaluate the dependability, acceptability and usability of the instrument. In Study II, the aim was to explore whether NANTS-no enabled a systematic development and assessment of student nurse anaesthetists' non-technical skills in clinical practice. The aim of Study III was to explore how student nurse anaesthetists, their mentors and clinical supervisors experienced using NANTS-no in clinical practice.

Figure 4 demonstrates the way in which the concepts, as well as the aim and objectives of the research and the individual studies, are seen as related to one another.

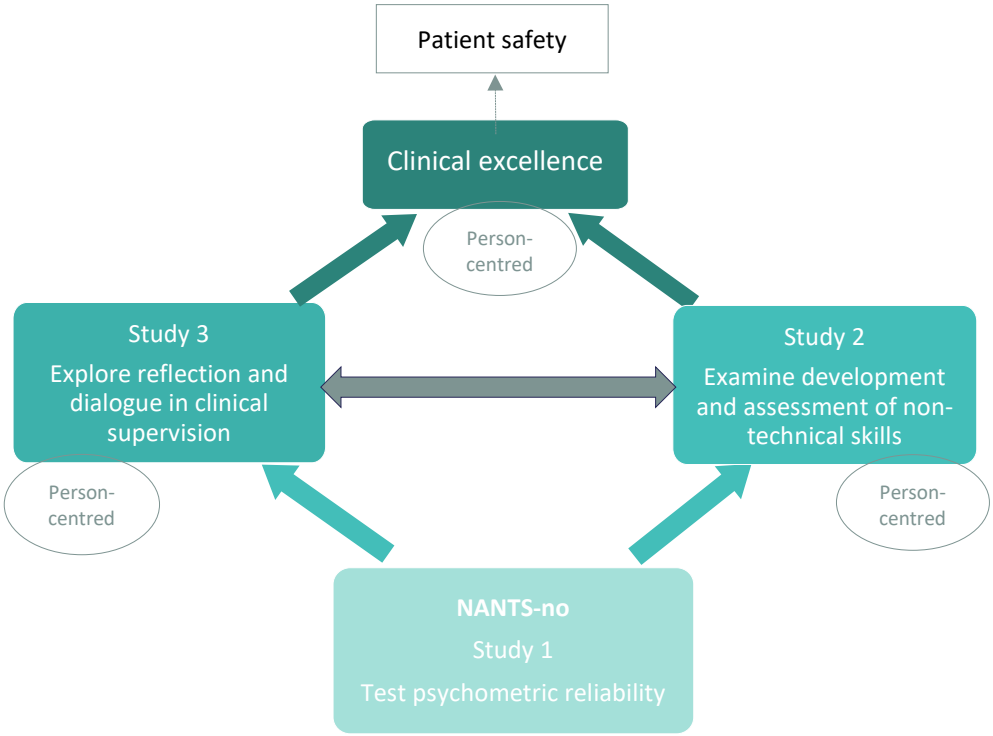

Figure 4: A schematic description of the research design

The design was quantitative-dominant (QUAN → qual) since quantitative methods were used in both Studies I and II and qualitative methods in Study III. An overview of the studies and methods is provided in Table 3.

Table 3: Overview of the research studies

	Design	**Method**	**Data Collection**	**Analysis**
Study I	Explorative	Quantitative	Rating video-recorded simulated scenarios, Questionnaire	Descriptive and summative statistics: Cronbach's alpha, Intra-class correlation, Generalizability coefficient
Study II	Longitudinal cohort study	Quantitative	Rating observed behaviour in clinical practice	Descriptive and summative statistics: Linear mixed-effect models, ANOVA
Study III	Descriptive	Qualitative	Semi-structured interviews with four focus groups	Content analysis Manifest and latent content

4.2 Setting and participants

The research was carried out at a Norwegian university and five hospital trusts comprising a total of nine hospitals, where the student nurse anaesthetists had clinical practice. The master's program in nurse anaesthesia at this University admits 20-25 students every two years. Clinical practice comprises 30 weeks of the program spread over an eighteen-month period, and each student is assigned a place in the operating department at one of the hospitals for the duration of their education. The clinical supervisors who organize clinical practice for the students have shared employment contracts with the hospital trusts and the University. The PhD candidate is responsible for the program in nurse anaesthesia at the University and is also involved in the clinical supervision of student nurse anaesthetists.

Each student nurse anaesthetist is assigned one or two mentors responsible for guiding them on a daily basis in clinical practice. The mentors and clinical supervisors are jointly responsible for assessing the students' clinical competence at the end of each period of practice and ensuring that students attain the expected level to allow them to proceed with their education.

The participants in this research included student nurse anaesthetists, as well as mentors and clinical supervisors involved in clinical supervision at the hospitals. Convenience and purposive sampling strategies were used to recruit the participants and many of them took part in one or more of the studies. A more detailed description of the sampling strategy and materials and methods used in the three studies is given in the following sections.

4.3 Study I

The first study aimed to achieve the first objective of this research, by evaluating the psychometric properties of NANTS-no using a design that had been used in similar studies for testing the reliability of instruments for non-technical skills (Fletcher et al., 2003; Mitchell et al., 2012; Rutherford et al., 2015; Yule et al., 2008). Participants were asked to rate video-recorded simulated scenarios after taking part in a workshop.

4.3.1 Preparatory phase

There was a certain amount of preparatory work as shown below before data could be collected and analyzed.

4.3.1.1 Designing and filming video-recorded simulated scenarios

Video-recorded simulated scenarios were designed and produced for the study. These were inspired by a visit to the Copenhagen Academy for Medical Education and Simulation, where similar video clips demonstrating non-technical skills were used for training purposes. This is a method that has been used in several other similar studies (Fletcher et al., 2003; Jepsen et al., 2016; Lyk-Jensen et al., 2016; Mitchell et al., 2012; Rutherford et al., 2015; Spanager et al., 2013; Yule et al., 2008).

Six scenarios were specially designed by the PhD candidate together with a team of experienced nurse anaesthetists involved in simulation training of non-technical skills. They featured student and qualified nurse anaesthetists in a variety of perioperative situations together with other members of the surgical team. Both routine and critical situations were included, such as preparing a patient for administration of anaesthesia, difficulties during intubation, bone cement implantation syndrome with accompanying fall in oxygen saturation and blood pressure, laryngospasm and allergic reaction to intravenous antibiotics during emergence from anaesthesia. Content validity of the scenarios was evaluated by the nurse anaesthetists who took part in the filming (Polit & Beck, 2012). After reading through the scripts, they provided feedback to improve the authenticity of the situations, resulting in minor alterations.

To ensure that different levels of situation awareness, decision-making, task management, communication and teamwork were displayed while the dialog was a natural as possible, the scenarios were loosely scripted with cues stating what was expected. The various roles were played by qualified nurse anaesthetists and other healthcare professionals using a Laerdal Medical SimMan 3G® patient simulator as the patient. The scenarios were filmed and edited by a University employee working in the communications department and the PhD candidate, and each video clip lasted between four and eight minutes.

4.3.1.2 Producing reference ratings

Prior to the study, the video clips were rated by an expert panel to provide a standard set of ratings which could be used as a means of comparison with the participants' ratings. The panel comprised four experts, all of whom had considerable and relevant clinical experience as well as experience and interest in teaching non-technical skills in both clinical and simulation settings (Keeney et al., 2011). Two of the experts were involved in the development of NANTS-no and testing it in a simulation-based study (Flynn et al., 2017). The third expert had used NANTS-no for educating student nurse anaesthetists at another University, while the fourth member of the panel had considerable experience with teaching critical care nurse students and other professionals about non-technical skills.

The video clips were made available to the expert panel via a Dropbox. The experts were asked to watch each clip and then, immediately afterwards, rate the non-technical skills displayed by the nurse anaesthetist on a specially provided form using the NANTS-no rating scale. A meeting was then held where the experts discussed any disparity in their ratings face-to face in order to reach a consensus (Keeney et al., 2011).

4.3.1.3 Translation of the evaluation questionnaire

An evaluation questionnaire was used to collect background data, evaluate the acceptability and usability of NANTS-no for use in clinical supervision, and evaluate the workshop as a means of learning how to observe and assess non-technical skills. The questionnaire had been used in two previous studies (Mitchell et al., 2013; Rutherford et al., 2015). It was translated to Norwegian by the PhD candidate who has experience working as a professional translator (Polit & Beck, 2012), and adapted for use in this study with the permission of John Rutherford. The translation was checked over by a colleague at the University. Both the original and translated version of the questionnaire are provided in the Appendices (Appendices 2 and 3).

The number of questions was reduced from 33 to 27 as some were deemed not appropriate, and a question about which hospital trust the respondent worked for was included. Many of the questions in the original questionnaire were dichotomous

requiring yes/no answers but allowed the respondent to provide additional comments. To increase the usability of the questionnaire and provide a more nuanced range of responses, the majority of questions were changed to a Likert scale with five alternatives (strongly agree, agree, neutral, disagree, strongly disagree).

The final version of the evaluation questionnaire was uploaded into the Questback system, a net-based feedback platform, and made available to the participants during the study via a link. This allowed them to respond to the questions using a mobile phone, PC or other similar device at the end of the workshop, or at a later date.

4.3.2 Sample

A convenience sample (Polit & Beck, 2012) of all the 69 nurse anaesthetists involved in clinical supervision at four of the hospital trusts were invited to participate via an email sent directly to them at work. The departmental managers ensured that that the invitation was sent to all the appropriate people, and a total of 46 mentors, clinical supervisors and nurse anaesthetists responsible for professional development agreed to take part in the study.

4.3.3 Workshop and data collection

The PhD candidate held a workshop on non-technical skills on seven different occasions at the various hospital trusts or a nearby venue. This was in order to encourage participation and ensure that the groups were of a manageable size to allow discussion and questions. The workshop lasted six hours and was a combination of theory and practical training in observing and rating non-technical skills. Prior to the workshop, the participants were asked to watch a film on the role of human factors during induction of anaesthesia, where poor situation awareness, decision-making, communication and leadership had catastrophic consequences for the patient and her family (*Just a routine operation:* https://www.youtube.com/watch?v=VndU2zap_Rg). They were also asked to familiarize themselves with NANTS-no.

Theory on patient safety, human factors as well as the underlying concepts for developing and assessing non-technical skills formed the first part of the workshop. This

was interspersed with discussions and examples from real-life situations. Participants were encouraged to give examples of both good and poor non-technical skills that they had experienced personally or when supervising a student nurse anaesthetist in clinical practice. The structure of NANTS-no at global, category, element and example level, as well as practical training in using the five-point rating scale formed the remaining part of the workshop. Rater training involved rating non-technical skills observed in video clips, using all five scores on the scale and "N" for "Not observed". The video clips used for rater training were not the same as those produced for the study.

At the end of the workshop, the six video-recorded simulated scenarios were shown. After each video clip, participants were asked to rate the nurse anaesthetist's non-technical skills at element and global level on paper forms using NANTS-no. In addition, participants were asked to spend a few minutes responding to the evaluation questionnaire. Since some decided to complete the questionnaire at a later date, a reminder was sent out by email to increase the response rate. The rating forms and responses to the questionnaire formed the data collected in this study.

4.3.4 Data analysis and reliability testing

The data was analyzed using IBM SPSS Statistics, version 24. The instrument's reliability and dependability were estimated using analyses based on classical test theory and generalizability theory (Brennan, 2010). Acceptability and usability were also assessed as reported in paper 1 but are not included in this overview.

4.3.4.1 Reliability analyses

Psychometric reliability is associated with the consistency of a measure; over time (*test-retest reliability*), over items (*internal consistency*) and over raters (*inter-rater reliability*) (Polit & Beck, 2012). Reliability is also concerned with accuracy. The reliability of the ratings in the study is relative to the proportion of systematic and random variance inherent in the measurements, where systematic variance can be seen as the true difference between the nurse anaesthetists rated in the video clips and random variance as the error component present in the actual ratings (Streiner et al., 2015). NANTS-no's

reliability was evaluated by estimating the instrument's internal consistency, inter-rater reliability and rater accuracy. Test-retest reliability was tested in a previous study, and demonstrated high reliability with an Intra class Correlation Coefficient (ICC) of 0.94 (Flynn et al., 2017).

Internal consistency is the extent to which the NANTS-no elements in the categories are measuring the same concept and was estimated using Cronbach's alpha for each NANTS-no category across all the video clips (Kottner & Streiner, 2010). Inter-rater reliability assesses how similarly the individual raters in the study rated the non-technical skills shown in the six video clips. This was estimated at all levels with two-way mixed, absolute agreement using a mean ICC derived from five pairs of raters randomly selected using a random number generator in Microsoft Excel (Streiner et al., 2015).

Rater accuracy was estimated by comparing participants' ratings to the set of reference ratings using a system of points. Participant ratings that were the same as the reference ratings were assigned 5 points, while a one-point deviation was assigned 4 points, a two-point deviation 3 points and so on. A total score was then calculated for the raters and presented as a percentage of the expert total score for each NANTS-no element across all the video clips. Rater accuracy was also assessed for one scale point difference as a number of elements were rated with two scores (for example, 2-3). The mean absolute deviation (MAD) from the reference ratings was also calculated (Fletcher et al., 2003).

4.3.4.2 Generalizability theory and analyses

Generalizability theory (GT) provides a framework for estimating the various error components and exploring the dependability of the ratings for future generalization (Brennan, 2010). Generalizability theory comprises a generalizability (G) study and a decision (D) study.

The G study estimates the relative importance of the variance components associated with the observed scores or measurements in the so-called *universe of admissible observations* (Brennan, 2001). In this study the video clips (object of measurement), raters and items (NANTS-no categories) could all be sources of variance in the measurements. A G study allows a multi-faceted structure which estimates several

sources of variance in the data set simultaneously, where the facets (object, rater, item) can be crossed or nested in a balanced or unbalanced design (Brennan, 2001; Mushquash & O'Connor, 2006). Facets can be either random or fixed depending on whether their conditions can be exchanged or not. Based on the variance components estimated in the G study, a D study is then used to make predictions about the potential to generalize about a specific set of measurements. The generalizability (G) coefficient represents the difference between the variance in a rater's observed score and the variance in the universe score or measurements (Mushquash & O'Connor, 2006).

A balanced two-facet crossed design G study was carried out with video clips (*n* = 6) x raters (*n* = 46) x NANTS-no categories (*n* = 4). The estimated variance components were then used to estimate an absolute G coefficient for the number of raters needed to reliably rate the video clips in a decision (D) study, where the categories were a fixed component. The generalizability analyses were performed using the MATLAB G1.sps program for SPSS (Mushquash & O'Connor, 2006).

4.4 Study II

Study I tested whether nurse anaesthetists could reliably assess non-technical skills using the instrument in a controlled setting. Study II was designed to explore the use of NANTS-no in clinical practice as a means of developing and assessing non-technical skills in a way that could demonstrate a reliable and measurable progress towards clinical excellence. The aim of this study was therefore to meet the second objective of the research.

A quantitative approach with a longitudinal design was chosen to follow a cohort of student nurse anaesthetists through their clinical education and assess their progress at various time-points. To ensure that the measurements caused as little disruption as possible by creating an artificial situation or providing extra work for the mentors, they were carried out as part of the normal end of semester evaluations.

4.4.1 Sample and preparation

A convenience sample (Polit & Beck, 2012) of all 22 student nurse anaesthetists on the master's program at the University was recruited to take part in the study together with their mentors and clinical supervisors. The students were informed about the study and invited to participate by one of the other researchers in the study who is not involved in the nurse anaesthesia program. It was explained that the measurements would be carried out for all students, but that any data would be destroyed for those who decided not to participate. All 22 student nurse anaesthetists agreed to participate. Two of them left the program during the early part of the study, however, and were therefore excluded. The students were assigned to clinical placements at five different hospital trusts and were encouraged to use the instrument on a regular basis for self-assessment in order to familiarize themselves with NANTS-no.

Prior to clinical practice, the students attended lectures on the role of non-technical skills in providing safe anaesthesia and received training in the use of NANTS-no. The training also focused on the five-point (1-5) rating scale, and it was emphasized that students' non-technical skills were being compared to those of a qualified nurse anaesthetist. It was therefore realistic to expect lower scores at the end of the first semester, as students would lack the necessary proficiency to provide anaesthesia to a patient alone. However, it was anticipated that scores would improve over time. During the study period, calibration training and discussions on the use of NANTS-no were also carried out.

The majority of the mentors and clinical supervisors who had participated in Study I also participated in Study II, and had therefore received training in observing and rating non-technical skills using NANTS-no. They were informed about the study during the workshop in Study I and were recruited via email sent to their workplace. Those who had not taken part in Study I, received help in using the instrument from the clinical supervisors before taking part in the study. They were also recruited via email.

4.4.2 Data collection

The measurements were carried out at three time-points during nurse anaesthesia education. The first assessment took place after nine weeks of clinical practice, the second after 20 weeks and the third after 37 weeks and were made using the NANTS-no five-point rating scale. Assessments were based on the non-technical skills displayed by a student while administering anaesthesia to a patient. Both the student's mentor and clinical supervisor were present in the operating room to assist the student as necessary, while simultaneously observing their behaviour. After safely completing the anaesthesia and handing over the patient, the student nurse anaesthetist, mentor and clinical supervisor each rated the non-technical skills displayed by the student during the anaesthesia, without comparing notes. Participants were asked to rate all 15 NANTS-no elements and provide a global score on a specially provided paper form (Appendix 4). These assessments comprised the data for this study.

4.4.3 Linear mixed-effects models

The data was analyzed using IBM SPSS Statistics, version 26 and Stata Statistical Software, Release 15, and results were considered statistically significant when $p < 0.05$. Since this study involved repeated observations of the same student nurse anaesthetists, linear mixed-effects models were chosen to study the development of the students' non-technical skills over time. Mixed-effects models incorporate both random and fixed effects, as well as estimating different levels of random variation between and within observations clustered at each level (Katz, 2011). They assume that correlation within the cluster is a result of the cluster's shared random effects. A missing data analysis was performed since large amounts of missing data may affect the reliability of the estimations (Katz, 2011), and this resulted in the global scores being excluded from the data as 27% of these were missing.

Not all the participants were assessed three times, therefore models with an unbalanced design were used to analyse the data (Katz, 2011). Seventeen of the students were assessed at all three time-points, while three were assessed at two of the time-points. Fixed effects for time (three time-points), rater (student nurse anaesthetist, mentor,

clinical supervisor) as well as gender and age were included as well as random effects that allowed for dependencies in the data (Katz, 2011).

The amount of variance between groups and within groups explained by the model was analyzed using ANOVA where the given adjusted R^2 could be considered as a minimum estimate (Katz, 2011). R^2 or *coefficient of determination* is the proportion of explained variance in the dependent variable, a statistical measure of how well the outcome is explained by the independent variable(s). To avoid overestimation of the association between one or more independent variables and the outcome, R^2 is adjusted for the number of predictors in the model (Katz, 2011).

4.5 Study III

The decision to use qualitative methods in Study III was based on a desire to meet the third objective in the research and explore the way in which NANTS-no is experienced and used in clinical supervision by student nurse anaesthetists, their mentors and clinical supervisors. A descriptive qualitative design was chosen using two focus groups with student nurse anaesthetists and two focus groups with mentors and clinical supervisors, with each group comprising between five and eight participants (Creswell & Poth, 2018; Kitzinger, 1995; Liamputtong, 2011).

4.5.1 Sampling strategy

A purposeful sampling strategy was used to recruit participants who could provide valuable insights into the research question and ensure maximum variation in perspectives within the sample (Creswell & Poth, 2018; Liamputtong, 2011). Therefore, student nurse anaesthetists were recruited who had clinical placements at different hospital trusts, were at different stages in their education and of different gender. One focus group comprised six newly qualified nurse anaesthetists who were assigned to six different hospitals, and who had taken part as students in Study II. The second focus group comprised six students with placements at five of the hospitals who had only completed one semester. Although they had not taken part in Study II, NANTS-no is implemented in nurse anaesthesia education at the University and these students also

had experience using the instrument. Both groups of students had an equal distribution of male and female participants, and since the members of each group were part of the same student cohort, they all knew each other.

In addition, thirteen nurse anaesthetists involved in clinical supervision at five hospital trusts formed the other two focus groups, with eight participants in one group and five in the other. These two groups included a mixture of mentors and clinical supervisors from the various hospital trusts, so many of the participants were strangers to each other. There was only one male in each group. The majority of the mentors and clinical supervisors had also taken part in Study I and/or Study II. However, those who had not taken part in the previous studies had experienced using NANTS-no in clinical supervision.

Participants were contacted directly by email and sent information about the study. A number of the nurse anaesthetists contacted showed interest in the study but were unable to take part owing to staffing and other constraints. Since the PhD candidate is program coordinator for the master's program in Nurse Anaesthesia at the University, she had access to both the students and the clinical fields which facilitated recruitment. The aim of the sampling strategy was to ensure a wide range of perspectives that highlighted both similar and different experiences using the instrument. The richness of the dialogue in the interviews and the fact that the fourth interview did not provide any new perspectives confirmed the view that four focus groups were sufficient, and data saturation was assumed.

4.5.2 Focus group methodology and data collection

The participants in this study had similar professional backgrounds and the students had also studied together, therefore heterogeneity in the groups was encouraged by including participants of different gender and from different workplaces to gain multiple perspectives (Liamputtong, 2011). In addition, the participants had the shared experience of using NANTS-no in clinical supervision, which was the focus of the study.

The student focus groups were formed from pre-existing cohorts. Discussion flowed easily in both groups and although there were one or two more dominant participants,

they did not prevent others from sharing their experiences or disagreeing with one another. The interaction highlighted both similarities and differences in the students' experiences. The two focus groups with mentors and clinical supervisors were constructed groups, where only a few participants were known to each other. Interaction in the first of these groups was lively with many participants eager to share their experiences, whereas discussion in the second group was more constrained, with some participants needing to be encouraged to contribute to the discussion. Although there was less disagreement between participants in both these groups, they contributed new and subtle nuances to the ways in which NANTS-no was used as a mentoring aid. Humour played an active role in all the focus groups, contributing to easing any social constraints (Liamputtong, 2011).

Since the PhD candidate had no previous experience with focus group interviews, two of the researchers (S.T, P.B-J) assisted with the interviews, acting as assistant moderators and contributing when necessary (Kitzinger, 1995; Liamputtong, 2011). As they were both unfamiliar with the use of NANTS-no in clinical practice they prompted the moderator or asked clarifying questions when something was unclear, thus ensuring richer data. In addition, a pilot interview was conducted with a colleague at the university before the interview with the first focus group, as a means of testing the interview guide and audio-recording device.

4.5.2.1 Data collection

The interviews with the four focus groups were held in a meeting-room at the University to avoid interruptions. As an incentive to taking part and to encourage a relaxed atmosphere, food and tea/coffee was provided and the participants' travel expenses were paid. The interviews lasted between 56 and 84 minutes and were recorded using a university-owned audio recording-device.

A semi-structured interview guide consisting of five open-ended questions was used to conduct the interviews (Appendices 5 and 6). The questions were intended to provide structure to the interview, while allowing discussion. The interview started with an

introductory question before focusing on the ways in which participants used NANTS-no and how it contributed to the mentoring/learning process.

Afterwards the interviews were transcribed verbatim by someone outside the research team who was employed by the University in this capacity. To ensure the transcripts were trustworthy and no valuable data was lost, the PhD candidate read them through several times while listening to the audio files.

4.5.3 Content analysis of the data

Graneheim and Lundman's qualitative content analysis was used to analyse the transcripts using an inductive approach (Graneheim & Lundman, 2004). Qualitative content analysis is a systematic method for analysing and interpreting qualitative data through a process of coding and identifying similarities within and differences between the data (Graneheim & Lundman, 2004; Hsieh & Shannon, 2005). It enables both the analysis of the manifest content of the data and interpretation of the underlying meaning (Graneheim et al., 2017).

Qualitative analysis is a non-linear process and involved the PhD candidate immersing herself in the data. This was done by first reading through the transcripts to gain an initial overview and writing notes in the margin as a means of "open coding" (Creswell & Poth, 2018; Elo & Kyngas, 2008). A flow diagram was then made to describe the current understanding of key concepts and emerging ideas (Hsieh & Shannon, 2005). After that, the data was analyzed in a process called de-contextualization and re-contextualization before being abstracted and interpreted (Lindgren et al., 2020).

4.5.3.1 De-contextualizing the data

The decontextualization process involved breaking down the data in a series of steps; identifying and extracting quotes or so-called meaning units from the transcribed texts, then condensing them by removing unnecessary words without changing the meaning, and finally assigning them codes (Lindgren et al., 2020). This process was carried out manually on a pc with meaning units, condensed meaning units and codes grouped together in tables for each of the interviews.

The initial sorting and grouping of similar codes was then discussed several times with the other researchers to define boundaries, and many changes were made to ensure consistency. The two student interviews were first considered together and then the two interviews with the mentors and clinical supervisors. Finally, all the decontextualized data was considered as a whole and discussed in the light of the initial flowchart that was made. A decision was made to remove the data answering the fifth question in the interview guide about the anaesthetic department as a learning arena, as it was felt this did not contribute to answering the research question. This data will be used in a later study. An example of text that was removed from the analysis is given in Table 4.

Table 4: Example of text removed from the analysis

Meaning unit	*Condensed meaning unit*	*Code*
You just have to accept being part of the production process, but I have never worked in a place that places a greater emphasis on students' learning. From anaesthesiologists, nurse anaesthetists, even to some extent from surgeons and orthopaedic surgeons	You have to accept being part of the production process, but I have never worked in a place where the whole team places a greater emphasis on students' learning.	Production pressure, but emphasis on learning

The final grouping of codes resulted in the re-contextualization of the data in sub-categories and categories that were internally homogeneous and externally heterogeneous, so that the data in each category was mutually exclusive (Graneheim et al., 2017; Graneheim & Lundman, 2004). Three themes and one main theme were then formulated through a process of discussion, abstraction and interpretation (Lindgren et al., 2020). Examples of the analysis process are given in paper 3.

4.6 Ethical considerations

All the studies were carried out in accordance with the Declaration of Helsinki (World Medical Association, 2013). Furthermore, the Norwegian Centre for Research Data was informed of all three studies (project nos. 55538, 56310 and 854411) and approval was obtained from the relevant hospital trusts and the University. No approval was required from the Regional Ethics Committee.

The participants were informed both orally and in writing about the studies, and the concepts of informed consent, voluntary participation, and the right to withdraw without penalty were carefully explained. In addition, requirements regarding confidentiality, data anonymity and the secure handling of data were specified. After appropriate time for consideration, informed consent was obtained from all participants in writing for each of the studies.

In addition, attempts were made to democratize power relations between the PhD candidate and the participants to ensure that they were comfortable taking part and avoid any feelings of coercion or obligation (Karnieli-Miller et al., 2009). This was done by emphasizing differences between the role of the researcher and the PhD candidate's everyday role as a person of authority and by using another researcher (P.B-J) to recruit the students in Study II.

Attempts were also made to ensure a person-centred approach to research by showing sensitivity to the context in which the research was carried out so that the research caused as little disturbance to the people involved (van Dulmen et al., 2017). In Study II, the practical consequences of observing students in a dynamic and complex clinical setting where small distractions can threaten patient safety were weighed. Organizational factors such as production pressure in the operating department and time constraints on the mentors were also taken into consideration. A person-centred approach also involved trying to respect the personhood of the participants during data collection and analysis and when reporting the studies (van Dulmen et al., 2017). The extent to which this was possible was however dependent on the study design (Buetow, 2011).

4.6.1 Role and pre-understandings

Reflexivity and being aware of the researcher's position and pre-understandings and the ways in which they can affect and be utilized in the research are important considerations (Alvesson & Sandberg, 2021; Creswell & Poth, 2018). The idea of *pre-understandings* or prior understandings and a reflexive approach to research comes originally from Gadamer and his hermeneutic philosophy (Maxwell et al., 2020). These understandings (ideas, assumptions, perspectives, beliefs and goals) cannot be separated from us but can be mobilized in a self-critical and open way to inform and enhance the development of knowledge (Alvesson & Sandberg, 2021).

In quantitative research pre-understandings can inform and enhance the design of the study and the way in which data is collected, but do not affect the analysis of the measurements. However, pre-understandings in the form of social relationships may affect measurements particularly in an observation study and cause bias as mentioned in section 4.4.4 (Alvesson & Sandberg, 2021). While in many qualitative approaches, the researcher's position and pre-understandings cannot be separated from an understanding of the phenomenon that is described or interpreted, and transparency is an essential factor. Therefore an open and reflexive approach is encouraged at all stages of the research process (Creswell & Poth, 2018).

An important factor in this research is the PhD candidate's role as clinical supervisor and program coordinator for the master program in nurse anaesthesia, as well as her major involvement in adapting and implementing NANTS-no in nurse anaesthesia education. As discussed in the previous sections, this provided a unique knowledge of and access to the research field. It informed and affected decisions regarding the choice of research problem, the research design and methods, and the sampling strategies used to answer the research problem. It also created a synergistic effect as the research findings had an impact on the nurse anaesthesia program leading to changes in the way non-technical skills are integrated and assessed both at the University and elsewhere in Norway.

Thus, the PhD candidate's role and pre-understandings ensured that she was both interested and invested in this research and its findings (Alvesson & Sandberg, 2021).

Openness about her position and background was therefore important, as well as attempting to ensure credibility by reducing the risk of only finding anticipated answers. Only one of the other researchers had experience with educating nurse anaesthetists and none had any knowledge of developing or assessing non-technical skills in clinical practice. They therefore contributed fresh perspectives to the research which helped the PhD candidate to reflect over assumptions and choices.

5 Summary of results

A summary of the main results from the three studies are presented below, demonstrating how each study provided the premise for the next. A more detailed presentation of the results can be found in the respective papers in part two of the thesis.

5.1 Paper I: Psychometric evaluation of NANTS-no

The study took place over a four-week period in October and November 2017. The 46 participants had an average age of 47 years and 80% were female. They worked at four different hospital trusts and had an average of 12.5 years' experience working as nurse anaesthetists. The majority had previous experience with clinical supervision and almost half had some previous experience using NANTS-no. The response rate to the evaluation questionnaire was 89%.

High reliability and dependability were estimated rating video-recorded simulated scenarios. Internal consistency and inter-rater reliability were both estimated as high in all the NANTS-no categories (Cronbach's $\alpha > 0.9$, ICC > 0.78), and the overall inter-rater reliability was also estimated as high (ICC = 0.8). However, inter-rater reliability varied from moderate to high at NANTS-no element level. The mean rater accuracy was estimated as 82% of the maximum expert panel's element score. The dependability of the ratings was also estimated as high with a generalizability coefficient of 0.83 for one rater rating non-technical skills using NANTS-no, and a coefficient of 0.91 for two raters.

NANTS-no was estimated as having a high degree of acceptability and usability, with the majority of participants stating that the instrument described a nurse anaesthetist's non-technical skills well or very well. NANTS-no was also regarded as useful for aiding student nurse anaesthetists to develop non-technical skills, by promoting critical reflection and providing feedback. Furthermore, it provided a means of assessing student nurse anaesthetists in clinical practice. The workshop was evaluated as providing sufficient training in the use of NANTS-no and the underlying concepts.

However, only 56% of the participants felt they were able to identify non-technical skills in the video clips well or very well.

The findings in this study were based on nurse anaesthetists using NANTS-no to rate non-technical skills in video-recorded simulated scenarios, which is less challenging than rating non-technical skills in a clinical setting. However, the high reliability and dependability demonstrated by the instrument particularly with two raters was encouraging, providing grounds for exploring the use of NANTS-no in a clinical setting. Study II was therefore designed to test NANTS-no as a means of measuring the development of student nurse anaesthetists' non-technical skills in clinical practice.

5.2 Paper II: Systematic development of non-technical skills in clinical practice

A cohort of 20 student nurse anaesthetists was prospectively followed over a twelve-month period between January 2018 and January 2019 and were assessed at three time-points during their nurse anesthesia education. The average age of the students was 31.5 years and 40% were male. They had clinical practice at five different hospital trusts.

The linear mixed-effect models demonstrated a significant association of both time and rater with the overall NANTS-no scores based on an average of the four categories. The overall improvement in the students' non-technical skills was statistically significant both from the first to second, first to third, and second to third time-point. Compared with the mentors' and clinical supervisors' assessments, the students significantly underestimated their non-technical skills ($p < 0.001$). Neither age nor gender influenced the development of non-technical skills.

The average observed scores for the student nurse anaesthetists showed a development of non-technical skills in all four NANTS categories over time, with an average overall NANTS score at the end of the study estimated as >4 by all three raters (Figure 5). A similar improvement was observed in all four NANTS-no categories with mentors and clinical supervisors rating the majority of NANTS-no elements as ≥4.5 at the third time-point.

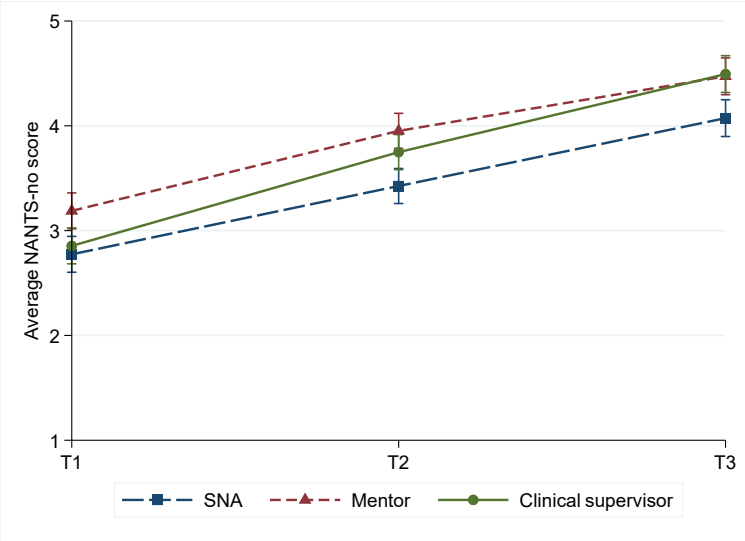

Figure 5: Development of student nurse anaesthetists' non-technical skills by rater over three semesters (as published in paper 2)

The importance of random effects in the data was explored using different models and all demonstrated the same results. The adjusted R^2 indicated that 70% of the expected variation in the scores was explained primarily by the passage of time, with only 7% by differences between the raters. 30% of the variation was due to other unmeasured factors.

The findings in Study II showed that NANTS-no was able to demonstrate a significant improvement over time in student nurse anaesthetists' non-technical skills in clinical practice. It therefore appeared to provide a reliable framework for making summative assessments in clinical practice. However, since the instrument also has a formative purpose, Study III was designed to describe how NANTS-no was experienced and used in clinical supervision.

5.3 Paper III: Experiences using NANTS-no in clinical practice

Semi-structured interviews were held with four focus groups over a period of eighteen months between April 2019 and September 2020. Qualitative content analysis identified six categories representing the manifest content: *Raising awareness of non-technical skills, Internalizing the skills, Structured mentoring, Reliable evaluation, Implementation* and *Feasibility*. In addition, three themes were identified: *Promotion of excellent non-*

technical skills, Promotion of cooperative learning and *Promotion of organizational acceptance*, and one main theme emerged representing the latent content: *Forging a path towards clinical excellence.*

Promotion of excellent non-technical skills: Using NANTS-no was described as raising awareness of the importance of non-technical skills and providing a vocabulary for these skills. It was also seen as providing a standard of excellence for ensuring the professional suitability of future colleagues by helping to shape the student's professional identity. *Promotion of excellent non-technical skills* also involved internalizing the skills through a process of critical reflection and dialogue. NANTS-no contributed to this process by aiding self-awareness, aligning the students' view of their clinical progress with their mentor's observations, and acting as a catalyst for behavioural change. Changing behaviour was seen as challenging, requiring motivation and willingness to make the necessary effort.

Promotion of cooperative learning: NANTS-no was seen as providing a common language that facilitated a more systematic approach to mentoring and contributed to a shared understanding of the students' clinical progress. The concrete examples in NANTS-no enabled mentors to provide structured feedback and use the available time for mentoring more efficiently. Using the instrument facilitated a more professional definition of roles and a change in the way mentoring was carried out. *Promotion of cooperative learning* was also seen as the way in which using NANTS-no contributed to a more reliable and objective assessment of the students' skills, providing a measurable progress. Assessments were less subjective as they were based on objective criteria rather than individual mentors' gut feelings or personal chemistry, although scores could be influenced by bonds formed through working together on a daily basis. NANTS-no was regarded as particularly useful for elucidating why a student was in danger of failing clinical practice.

Promotion of organizational acceptance: Although mentors and students were generally positive to using NANTS-no, promoting acceptance of the instrument in the anaesthesia departments was described as an ongoing process with certain challenges. The instrument was described as well-organized and comprehensive, despite a certain

amount of overlap in some categories and elements. While the students found it required little effort to use, the mentors found the large amounts of text overwhelming at first. A lack of familiarity impeded implementation of the instrument at both individual and departmental level, and acceptance was regarded as a maturation process that would take time. Scoring was seen as problematic, as the mentors were afraid of making false judgements, while the students were afraid of setting too high a score, often rating themselves lower than their mentors. Comparing a student's non-technical skills with those of a qualified nurse anaesthetist was also considered challenging. A final impediment was the terminology of the rating scale, which the mentors in particular found negative and demotivating.

The findings in this study provided an insight into how NANTS-no was experienced and used in clinical practice. They also demonstrated how NANTS-no appears to act as a catalyst for change and increased professionalization of the learning and mentoring process by promoting the ideal of clinical excellence in nurse anaesthesia.

6 Discussion

In this chapter the central findings are summarized and then discussed in light of the research's aim and objectives. This chapter also includes a discussion of the methodological aspects of the research as a whole and the individual studies.

6.1 Using NANTS-no in nurse anaesthesia education

The aim of this research was the systematic development and assessment of non-technical skills using NANTS-no as a means of promoting clinical excellence and patient safety in nurse anaesthesia education. The process of inquiry in this research appears to demonstrate with "warranted assertability" that using NANTS-no in nurse anaesthesia education promotes a systematic development and assessment of non-technical skills and a professionalization of clinical supervision.

The findings show that nurse anaesthetists involved in clinical supervision were able to reliably assess non-technical skills in video-recorded simulated scenarios using NANTS-no after participating in a workshop. The instrument also met requirements for dependability in high-stakes summative assessments when two nurse anaesthetists involved in clinical supervision assessed non-technical skills in video clips. NANTS-no was perceived as an acceptable and usable instrument for developing and assessing student nurse anaesthetists' non-technical skills in clinical practice. Evaluating the instrument's psychometric properties was the first objective of the research.

In addition, NANTS-no demonstrated a systematic development and assessment of student nurse anaesthetists' non-technical skills in clinical practice. This was the second objective of the research. The students achieved a final score close to excellence at the end of their education when compared with a qualified nurse anaesthetist.

The instrument's acceptability and usability in clinical supervision was described as high by the participants in Study I. A more nuanced understanding of this aspect emerged in Study III. Although the participants were positive to using NANTS-no and it facilitated a more professional partnership in the mentoring/learning process, there were challenges

with implementing the instrument. Exploring the experiences of student nurse anaesthetists, their mentors and clinical supervisors with using NANTS-no in clinical practice was the third objective of the research. A discussion of these central findings and the extent to which they contribute to promoting clinical excellence and ultimately also patient safety, is discussed in the following sections.

6.1.1 Reliable assessment of non-technical skills

Reliability is a major factor in ensuring objectivity and impartiality when using instruments to perform high-stakes assessments that will potentially have a determining effect on future professional practice (Higham et al., 2019). Not only must the instrument demonstrate high psychometric reliability, but the assessments must be standardized to ensure consistency, and the assessors trained in observing and assessing non-technical skills (Collins & Callahan, 2014; Elisha et al., 2020; Wong, 2012). A move from institutionally derived assessment instruments to reliable and standardized assessment of clinical performance is one of the challenges in nurse anaesthesia education that needs to be addressed, to meet increasing demands for accountability (Elisha et al., 2020).

One of the objectives of this research was to evaluate the psychometric properties of NANTS-no in a way that enabled comparison with other similar tools to ensure that it met psychometric requirements. Table 5 presents an overview of the reliability estimated for NANTS-no and other structured behavioural assessment instruments for non-technical skills, tested by participants rating video-recorded simulated scenarios after taking part in a training workshop (Fletcher et al., 2003; Mitchell et al., 2012; Rutherford et al., 2015; Yule et al., 2008). The Danish studies that tested the reliability of ANTSdk, N-ANTS and NOTSSdk also used video-recorded simulated scenarios but had pretest-posttest designs with fewer participants (Jepsen et al., 2016; Lyk-Jensen et al., 2016; Spanager et al., 2013). This overview is not intended as a meta-analysis but rather as a rough comparison of reliability measurements.

Table 5: A comparison of the reliability of instruments for assessing non-technical skills

Instrument	Internal consistency *(categories)*	Inter-rater reliability/ agreement *(categories)*		Mean Rater accuracy	Generalizability *(One rater)*	Participants
	Cronbach's α	ICC	R_{wg}	%	G-coefficient	N
ANTS[1]	>0.79		>0.56	>88*		50
ANTSdk[2]	0.97	>0.98		>78		19
NANTS-no	>0.90	>0.78		>83*	0.83	46
N-ANTS[3]	0.99	0.79				22
ANTS-AP[4]	>0.69	>0.54				48
NOTSS[5]	0.98	>0.95	>0.51	>63		44
NOTSSdk[6]	0.98	0.98			>0.8	15
SPLINTS[7]			>0.72	>91		34

ICC (average measures) **± one scale point difference*

[1](Fletcher et al., 2003) [2](Jepsen et al., 2016) [3](Lyk-Jensen et al., 2016) [4](Rutherford et al., 2015) [5](Yule et al., 2008) [6](Spanager et al., 2013) [7](Mitchell et al., 2012)

NANTS-no compares favourably with other similar instruments with regard to reliability. Study I was one of two studies that estimated the dependability of ratings, however while Spanager et al. (2013) needed three trained raters to reliably rate general surgeons' non-technical skills with a G coefficient >0.9, two raters were sufficient in Study I. Although all these instruments broadly assess similar domains of non-technical skills and are customized to suit a specific professional field there is little research testing their usability in clinical settings (Higham et al., 2019; Spanager, Konge, et al., 2015). There is also discussion about the need for instruments customized to suit specific fields rather than a generic tool which could be used in any healthcare context (Higham et al., 2019; Wisborg & Manser, 2014). However, the fact that the behavioural markers are adapted to reflect the context in which nurse anaesthetists work and could be used as objective criteria on which to base the assessment, was seen as a positive factor by the participants in this research. One criticism of non-technical skills instruments used in anaesthesia is that communication with the patient, which is an essential aspect of patient-centred anaesthesia care, is not explicitly included (Boet et al., 2018). This is potentially an area that should be addressed in any future development of NANTS-no if the aim is clinical excellence.

Behavioural assessment instruments often appear deceptively simple to use (Flin & Patey, 2011; Johnson & Aggarwal, 2019). However, observing and assessing non-technical skills requires thorough training (Hull et al., 2013; Klampfer et al., 2001). Although only 56% of the participants in Study I felt they were able to identify the non-technical skills displayed in the video clips well, the high level of dependability estimated with one (G coefficient = 0.83) and two raters (G coefficient = 0.91) suggests that the six-hour training course was in fact sufficient. Other studies also found shorter training courses sufficient to demonstrate reliability (Mitchell et al., 2012; Rutherford et al., 2015). Moreover, 83% of the participants stated that they had received sufficient training about NANTS-no. This was also confirmed in Study II by the fact that only 7% of variation in scores was explained by differences between the raters. However, there appeared to be misunderstandings about the use of "N" for "not observed" behaviour in Study I and this was confirmed in the interviews. While these findings are positive it is nevertheless important to recognize that rater-based assessments of behaviour are not infallible, and various psychometric weaknesses such as leniency, categorization or bias can threaten dependability (Gingerich et al., 2011).

Another aspect of performing reliable assessments is ensuring standardization, both with regard to the method of assessment and the criteria that are being assessed. Although there is consensus that non-technical skills contribute to patient safety, no standard definition currently exists for non-technical skills and the various domains they encompass (Johnson & Aggarwal, 2019). There is a need for benchmarks to determine which aspects of competence are being measured, what constitutes adequate performance, and to ensure assessors are trained and experienced in evaluating the same criteria. These are crucial factors in summative assessments, and it is arguable whether the current instruments for non-technical skills meet all these requirements (Boet et al., 2018; Higham et al., 2019; Jepsen et al., 2015; Johnson & Aggarwal, 2019).

In the focus groups it emerged that the mentors were concerned among other things about making false judgements and rating a student's non-technical skills too low, whereas the students were afraid of overestimating their performance and scoring too high. This supported the findings in Study II, where the students significantly

underestimated their non-technical skills (p <0,001) compared with the mentors' and clinical supervisors' assessments. The mentors showed a tendency towards leniency and bias presumably due to working on a daily basis with the students and scored them higher at the first two assessments than the clinical supervisors. This kind of leniency has been noted in other literature (Helminen et al., 2016; Schierenbeck & Murphy, 2018). Study II provided a snapshot of a student's proficiency on a single day instead of an evaluation of skills for the whole period (Jepsen et al., 2015), and stress and anxiety may have affected the student's performance during the assessment. However, this study demonstrated a systematic development of non-technical skills, which will be discussed further in the next section.

6.1.2 Developing clinical excellence

Promoting clinical excellence in nurse anaesthesia education through a systematic development and assessment of non-technical skills to ensure that patients receive excellent and safe anaesthesia care, was the focus of this research. The link between excellent non-technical skills, professionalism, clinical excellence and patient safety (Jones et al., 2018) has been established earlier in this thesis. The student nurse anaesthetists in Study II clearly demonstrated a development of non-technical skills throughout their nurse anaesthesia education, achieving a final average score of 4.5 from both mentors and clinical supervisors at the final assessment. On the NANTS-no rating scale 4 indicates good non-technical skills, while 5 is equivalent to excellent non-technical skills when compared with a qualified nurse anaesthetist. Therefore, if the aim is clinical excellence and NANTS-no is to be used for summative assessments in nurse anaesthesia education, it would seem appropriate to suggest that a global NANTS-no score of ≥4 should be a minimum requirement in order to qualify as a nurse anaesthetist.

The mentors described NANTS-no as useful for determining professional suitability in students and guaranteeing high standards and quality in future colleagues. Ensuring that student nurse anaesthetists meet guideline expectations for clinical performance has been an important concern in education, to avoid a waste of individual and institutional resources and demonstrate accountability (Collins & Callahan, 2014; Helminen et al.,

2016). Professional expertise is multi-faceted, encompassing more than just academic excellence and technical proficiency (Smith et al., 2011), and poor and unsafe clinical performance is often caused by poor non-technical skills (Jones et al., 2018). However, communicating a lack of proficiency in non-technical skills to students has often been challenging, as these tacit qualities have not been clearly defined until relatively recently (Flynn et al., 2017; Lyk-Jensen et al., 2014). The objective criteria in the NANTS-no taxonomy can be used for determining where students lack proficiency and providing feedback, or as potential grounds for dismissal from the program, and this was regarded as a major benefit. In particular, poor situation awareness and decision-making were identified by mentors as threatening patient safety and potentially leading to dismissal, as seen in other research (Tower et al., 2019).

Clinical excellence involves striving continually to perfect one's practice and a commitment to aiming beyond mediocracy by actively engaging in new and challenging situations in order to learn from them (Larsson, 2017; O'Donnell et al., 2016; Smith et al., 2011). The focus groups described NANTS-no as providing a standard for excellence against which both students and qualified nurse anaesthetists could measure their own skills, as well as aiding student nurse anaesthetists in developing a professional identity. The high level of complexity and responsibility in the role of nurse anaesthetist requires a continuous commitment to personal and professional development, in order to further excellent and patient-centred anaesthesia practice (Herion et al., 2019; McCormack & McCance, 2016; Smith & Greaves, 2010; Solymos et al., 2020). However, although NANTS-no was originally intended as a framework for encouraging professional development and life-long learning in qualified nurse anaesthetists, using it in this way is dependent on the workplace culture and having a shared vision of attaining excellent practice (McCance et al., 2013).

Developing a professional identity involves demonstrating values such as personal integrity, respect and accountability and behaviour that are at the top of the amended version of Miller's pyramid of learning and assessment (Cruess et al., 2016; Miller, 1990). These values and attitudes are prerequisites for providing patient-centred care and are integral to the nursing role (McCormack & McCance, 2010). It is therefore assumed that

they are already part of the students' professional identity as experienced nurses, although these values are regarded as dynamic and under continual development (Aagaard, Sorensen, et al., 2017). The examples of professional behaviour associated with best practice in the various NANTS-no skill categories and elements, aided the students in developing a new professional identity as a nurse anaesthetist in line with the IFNA standards (Herion et al., 2019). In addition, raising awareness of the importance of excellent non-technical skills may potentially improve patient safety.

Using NANTS-no to develop clinical excellence also led to a professionalization of clinical supervision by clearly defining roles and enabling assessments that were based on objective criteria and influenced to a lesser extent by personality conflicts or bias. Furthermore, it made mentors more aware of their own professional behaviour and non-technical skills and changed the way in which some mentors supervised their students, in line with other research (Jølstad et al., 2017). Similar improvements in the quality of student supervision were also seen using SPLINTS-no, a non-technical skills instrument for scrub practitioners (Sirevåg et al., 2021). The pursuit of clinical excellence and professionalism requires an investment in excellence at all levels in education (Smith & Greaves, 2010; Solymos et al., 2020; Wong, 2012). First and foremost, educating for excellence demands excellent teachers who engage their students and communicate knowledge and skills in an effective manner to maximize learning and encourage self-reflection and professional growth (Wong, 2012). Further discussion of the mentoring and learning process is presented in the next section.

6.1.3 Transformative and person-centred learning

Study III provided interesting insights into how using NANTS-no resulted in transformative learning and a professional partnership between the student nurse anaesthetists and their mentors, based on critical reflection, self-awareness and dialog. An important factor was the relationship between the mentor and student nurse anaesthetist providing a safe but challenging environment for learning, built on mutual trust and power-sharing that facilitates personal achievement (McCance et al., 2011; Nolan et al., 2004). Since the operating room is a learning context characterized by a

high level of production pressure and dynamic and complex situations in a highly technological environment, where the patient undergoing surgery is the focus (Aagaard, Laursen, et al., 2017), this relationship is crucial to enable learning and ensure patient safety.

Transformative learning occurs when previous assumptions and experiences are challenged by, for example, being immersed in a new context (Mezirow, 2018; Van Schalkwyk et al., 2019). Despite being experienced nurses, clinical practice in the anaesthetic department is a completely new context for student nurse anaesthetists, and can be experienced as extremely stressful and challenging (Phillips, 2010). Using NANTS-no both alone and together with their mentors, appeared to trigger processes of critical self-reflection in the student nurse anaesthetists, where previous assumptions were questioned and re-assessed as the first step towards transformative learning (Mezirow, 2018). By measuring their own behaviour against the behavioural markers in the instrument to determine their strengths and weaknesses, they used NANTS-no to match their image of themselves against their mentors' feedback. NANTS-no therefore facilitated greater self-awareness in the students, which triggered changes in behaviour, contributing to personal and professional development and clinical excellence. This is in line with other literature describing transformative learning in healthcare professionals (Van Schalkwyk et al., 2019).

Being judged on behavioural skills was regarded as something new and uncomfortable but could also be motivational. The student nurse anaesthetists described various ways in which they actively used the examples in NANTS-no to improve their non-technical skills, by for example taking the lead in an acute situation, showing more assertiveness, or supporting other team-members. Speaking up when the patient's life is at risk and learning from excellent performance are highlighted as important strategies for improving patient safety (Jones et al., 2018; Preckel et al., 2020). Increasing clinical assessment and decision-making skills and aiding graduates in articulating and justifying their decisions is also in line with what is expected from a master's candidate (Madi et al., 2019).

Using NANTS-no in clinical supervision also meant that mentors could utilize mentoring time more effectively for reflection and dialogue, by basing formative feedback on the examples of good and poor practice. Sirevåg et al. (2021) also found supervision of scrub practitioners more manageable using the SPLINTS taxonomy to structure feedback. Instruments for individual non-technical skills are primarily intended for structuring learning and providing formative assessments (Flin & Maran, 2015; Jepsen et al., 2015). However, there is currently little research into how the users actually experience using these instruments as formative tools.

In Study III the participants regarded using NANTS-no in a formative way as promoting cooperative learning. By encouraging dialog about the students' strengths and weaknesses based on the examples in NANTS-no, a shared understanding of the student's proficiency and what needed to be addressed emerged (Kirschner, 2001). The students wanted constructive and specific feedback from their mentors, while giving negative feedback was seen by the mentors as easier when it was based on NANTS-no, as it was not regarded as personal criticism. This kind of cooperative learning based on mutual trust was described by one student as a professional partnership, thus encompassing the ideas of person-centred education (McCance et al., 2011; O'Donnell et al., 2016). However, issues regarding usability and implementation of the instrument are presented in the next section.

6.1.4 Usability and implementation challenges

NANTS-no demonstrated high reliability in summative assessments in clinical practice. In addition, both the student nurse anaesthetists, their mentors and clinical supervisors were generally positive towards using NANTS-no as a formative and summative instrument. There were however challenges with regard to both usability and implementation of the instrument in the anaesthetic departments.

The usability and acceptability of the instrument was evaluated in Study I, and a high percentage of mentors and clinical supervisors stated that NANTS-no was useful for aiding students to develop non-technical skills (100%) and promoting critical reflection (98%). Furthermore, it was useful for aiding mentors to provide feedback (98%) and

evaluate student nurse anaesthetists in clinical practice (93%). These findings were similar to two other studies that used the same questionnaire (Mitchell et al., 2012; Rutherford et al., 2015). Although the students generally found NANTS-no easy to use, many of the mentors and clinical supervisors in the focus groups found the amount of text in the instrument overwhelming at first and commented on a certain amount of overlap in the categories and elements that hindered familiarization. It took time and effort to familiarize themselves with NANTS-no, but regular use increased their proficiency. Some for example carried it in their pocket and spent quiet moments reading through the different elements. Lack of familiarity was also described as an implementational impediment with other instruments (Flin & Patey, 2011). In-depth analysis of usability of new instruments is therefore recommended (Higham et al., 2019).

The idea of assessing non-technical skills in healthcare professionals is a relatively new concept, particularly in Norway where traditionally clinical assessments have focused more on technical proficiency (Flynn et al., 2017). Therefore, rating social and interpersonal skills was seen as both strange and unfamiliar by the nurse anaesthetists in this research. Other healthcare professionals have also found this challenging (Flin et al., 2010). The five-point rating scale was regarded as the greatest impediment to the feasibility of NANTS-no. The demotivating, negatively-loaded language in the rating-scale in addition to comparing the students with qualified nurse anaesthetists, made scoring non-technical skills challenging for the mentors. Since the feasibility of an instrument is a crucial factor for effective implementation, this is something that needs to be addressed to ensure the further acceptance of NANTS-no as a means of promoting clinical excellence and patient safety (Johnson & Aggarwal, 2019).

A further consideration is whether student nurse anaesthetists, with only a few weeks clinical experience, should be compared in summative assessments with qualified nurse anaesthetists. NANTS-no was adapted from ANTS, which was originally intended to be used for assessment of non-technical skills once a basic degree of technical proficiency had been achieved (Flin & Patey, 2011). Although NANTS-no has shown a high level of

reliability in nurse anaesthesia education, this deviation from its original purpose raises certain concerns. Despite research showing no correlation between non-technical and technical skills, they do appear to be intertwined and training them separately has therefore little value (Gjeraa et al., 2016). All the focus groups discussed whether or not it would be better to use the rating-scale to assess students according to their expected level at a given period, rather than compared to a qualified nurse anaesthetist. They concluded however that they would then lose one of the most important benefits with NANTS-no. Being able to measure progress throughout nurse anaesthesia education was seen as advantageous by all the participants.

The long-term purpose of this research is the systematic integration of non-technical skills in nurse anaesthesia education and the implementation of NANTS-no as a framework for facilitating this in clinical practice. However, the focus groups highlighted challenges regarding implementation of the instrument, since not all the nurse anaesthetists working in the anaesthetic departments were familiar with NANTS-no. There has been an increasing amount of interest for using NANTS-no in nurse anaesthesia education in Norway since it was first introduced, but the need for an implementation strategy appears to have been underestimated. Difficulties implementing these assessment instruments is not new, and much has been written for example about the varying success of strategies used for implementing ANTS (Flin & Maran, 2015; Flin & Patey, 2011; Flin et al., 2010). The Expert Recommendations for Implementing Change (ERIC) suggest a selection of strategies for implementing new ideas and clinical interventions (Kirchner et al., 2020). In particular, identifying barriers and facilitators, identifying champions and training and educating stakeholders might be relevant strategies for improving the implementation of NANTS-no (Kirchner et al., 2020).

Identifying barriers and facilitators and assessing the readiness of the anaesthetic departments for implementation is a particularly useful strategy before implementation, but can also be applied throughout the process (Kirchner et al., 2020). Although it is the educational institution that is responsible for deciding which

instruments should be used in clinical supervision and assessments, ensuring they are used correctly or even at all requires the cooperation of all stakeholders. Therefore, carrying out an assessment of potential barriers and practical challenges to implementation in the context for which it was intended, would have been beneficial. Production pressure and time constraints on mentors, for example, is an aspect of feasibility that needs to be investigated further.

Increasing facilitation by conducting educational meetings and identifying key persons who can aid implementation in the workplace are other useful strategies (Kirchner et al., 2020). The nurse anaesthetists involved in clinical supervision took part in the workshop in Study I, and the PhD candidate also had information meetings with departmental managers at the various hospital trusts prior to starting this research. In addition, a few calibration meetings with those involved in clinical supervision were held at some of the hospitals, but not all. Regular educational meetings with all the staff to increase knowledge and raise awareness of the concepts behind non-technical skills as well as providing regular calibration training for those involved in clinical supervision could be a useful strategy to aid the implementation of NANTS-no (Flin et al., 2010). Using clinical supervisors and mentors to champion implementation of the instrument in the departments may also be helpful. Training and educating stakeholders is therefore an ongoing process that needs to be prioritized in the future.

This concludes the discussion of the research findings. To summarize, NANTS-no appears to be a reliable instrument for developing and assessing non-technical skills in clinical practice in nurse anaesthesia education, but a strategy is required to ensure full implementation of the instrument in anaesthesia departments. Since a systematic focus on non-technical skills is regarded as essential to achieving clinical excellence and increasing patient safety, NANTS-no may also contribute to promoting these two aims. The next section is a discussion of methodological considerations.

6.2 Methodological considerations

The first part of this discussion comprises considerations when carrying out multimethods research and is loosely based on Greene's framework of methodology (2008) and the work of Onwuegbuzie and Johnson on validity in mixed research (2006). Although this research has used a multimethod approach and is therefore not subject to the same stringent requirements regarding integration (Anguera et al., 2018; Hesse-Biber, 2016), it is nevertheless a useful framework for considering methodological aspects. The second part is a discussion of the strengths and limitations of the individual studies.

6.2.1 A pragmatic approach to multimethods research

The philosophical assumptions adopted in a research project have methodological implications and it is important to understand what these assumptions mean for the research (Greene, 2008; Hesse-Biber, 2016). Therefore, clearly stating the philosophical position strengthens this research, but also places a responsibility to ensure it is actually founded on and guided by these assumptions (Creswell & Plano Clark, 2018). Some of the criticisms levelled against those who choose pragmatism are a lack of reflexivity and using the position as a means of side-stepping methodological conflicts (Greene, 2008; Hesse-Biber, 2016). The pragmatism of Peirce, James and Dewey endorses a practical approach grounded in human experience, where different philosophies can peacefully coexist and provide workable solutions (Johnson & Onwuegbuzie, 2004; Johnson et al., 2007). A pragmatist position therefore allowed the combination of quantitative and qualitative methods in this research, providing insights impossible to achieve with a single method and facilitating a more complete understanding of using NANTS-no in clinical practice.

The pragmatist method of inquiry involving a process of reflection on anticipated consequences and action, is a "bottom-up" approach driven by the research question or main aim of the research (Cherryholmes, 1992; Johnson et al., 2007; Morgan, 2014a). Methodological decisions in the research have therefore been concerned with the impact of selecting one research method rather than another, and attempting to

strengthen the whole process through reflexivity, as this ensures authenticity in the research process (Hesse-Biber, 2016; Morgan, 2014a). Pragmatism also endorses the ideas of fallibilism and warranted assertability, thus it is important to recognize that any findings in this research cannot be regarded as certain or absolute (Johnson & Onwuegbuzie, 2004). Instead, the reliability of NANTS-no when used in clinical practice should be seen as warranted assertions about the instrument based on the context of the research.

Although there is an increasing amount of multimethod or mixed method research today, there are still a number of controversies surrounding the mixing and misappropriation of methods and designs, as well as doubt as to its actual value (Creswell & Plano Clark, 2018). The sequential multimethods design was chosen as best suited to meet the purpose of the research, with the findings from each study influencing the design of the following one. In mixed research where the prioritized method is quantitative (QUAN → qual), the qualitative study is used to explain or explore the quantitative results (Creswell & Plano Clark, 2018). However, in this research the qualitive study was designed to describe experiences using the instrument rather than explain outliers or surprising results in the first two studies. This may be regarded as a limitation, although the qualitative study did in fact provide some insight into issues regarding rating non-technical skills.

The purpose of using multiple methods was to seek enhancement through complementarity, where the findings together provide a deeper and broader insight into the research question (Greene, 2016; Johnson & Onwuegbuzie, 2004). Each of the studies aimed at addressing one of the objectives related to a common overall research goal using a different method, and therefore it can be argued that it meets the requirements for multimethods research (Anguera et al., 2018). Utilizing both quantitative and qualitive methods has strengthened the research by both testing that the instrument measures what it is intended to measure, but also gaining an insight into how the users experience using it.

In this way the strengths of different methods were combined, but to accomplish this in a way that strengthens the research requires an understanding of the different strengths

of each method (Creswell & Plano Clark, 2018; Johnson et al., 2007). It also involves minimizing any weaknesses by assessing how the strengths of one method can compensate for the weaknesses of another (Onwuegbuzie & Johnson, 2006). For example, the quantitative methods allowed controlled designs to measure non-technical skills objectively, minimizing the researcher's impact, but interesting phenomena relating to the context outside the research objective may have been excluded. The qualitative approach on the other hand involved the PhD candidate immersing herself in the data to study the experiences of the participants subjectively and in depth. However, the findings may not apply to other settings and may have been more easily influenced by personal biases (Johnson & Onwuegbuzie, 2004; Morgan, 2014a). The qualitative study was designed to strengthen the research by highlighting experiences that were not addressed in the quantitative studies.

A further consideration is the question of integration and inferences drawn from the research. In mixed research, integration can occur at different stages, but typically occurs during data analysis (Collins, 2016; Creswell & Plano Clark, 2018; Greene, 2008; Johnson et al., 2007). Since each method was used to gain insight into a different objective, integration is not required (Anguera et al., 2018). However, any inferences drawn from the different methods used in this research though mutually illuminating, should also be able to demonstrate that they are based on the concepts associated with the chosen research paradigm (Collins, 2016). Thus, the inferences discussed in the previous section are regarded as strengthening the research, by providing a more complete picture of using NANTS-no in nurse anaesthesia education through the complementarity of quantitative and qualitative perspectives applied to the various objectives.

A final consideration is the way in which the researcher's and the various stakeholders' interests influence the research, and the extent to which the participants personhood and wellbeing was considered (Collins, 2016; van Dulmen et al., 2017). Stakeholders include the University and healthcare trusts where the research was conducted, and the people who participated in the various studies. Since the role of the PhD candidate is so closely involved with nurse anaesthesia education and the instrument that is the focus

of this research, it is important to consider how this impacted on the research. An intimate knowledge of the field can be regarded both as a strength and potential source of bias, as discussed earlier. In addition, ethical issues, such as ensuring that power relations between the researcher and participants were balanced (Karnieli-Miller et al., 2009), and the values and interests of participants and stakeholders taken into account, were important considerations (Collins, 2016; Greene, 2008). Attempts have been made throughout to ensure these factors were considered at every stage of the process, by among other things listening to concerns and keeping stakeholders informed of the progress of the research. An open declaration of the PhD candidate's interests and role attempts to ensure transparency (Alvesson & Sandberg, 2021), and is an important aspect when assessing the validity of the research.

6.2.2 Validity and rigour in multimethods research

The validity of multimethods and mixed research is an important issue (Johnson et al., 2007; Onwuegbuzie & Johnson, 2006). Attempts to draw meta-inferences that can be generalized for example to nurse anaesthesia education in Norway, can be threatened by issues regarding the integration of the sample (Collins, 2016; Onwuegbuzie & Johnson, 2006). Although a few of the same participants took part in all three studies and some took part in two of the studies, the qualitative study also included student nurse anaesthetists from another cohort which could affect inference quality (Onwuegbuzie & Johnson, 2006). Another threat to inference quality is the lack of randomization in the two quantitative studies (Onwuegbuzie & Johnson, 2006).

Weakness minimization is also an aspect of the legitimation process and has been discussed in the previous section. A further aspect is the extent to which the sequential order of the studies has influenced the ability to draw inferences (Onwuegbuzie & Johnson, 2006). In this research, reversing the sequential order of the studies would have produced different results. Therefore the sequence may be considered as a threat to validity (Collins, 2016).

A final aspect is the extent to which the insider view and the observer view are utilized and presented in the research (Onwuegbuzie & Johnson, 2006). This may be particularly

challenging when the researcher is inexperienced. One strategy for reducing this threat is having the findings, interpretations and inferences reviewed by other disinterested and more experienced researchers as well as by those involved in the research team. Another strategy is to ensure that the language and terminology that belong to the different paradigms is employed in an authentic manner to demonstrate different viewpoints (Collins, 2016). Attempts were made to utilize these strategies and ensure a balance between the two viewpoints and validity in the research.

In quantitative studies internal and external validity need to be considered and control used to eliminate various threats (Polit & Beck, 2012). While ensuring trustworthiness and integrity to authentically capture the lived experiences of the participants, is a major concern in qualitative research, and involves considering aspects such as credibility, transferability, dependability and confirmability (Lincoln & Guba, 1985; Onwuegbuzie & Johnson, 2006). The following sections discuss the strengths and limitations of the three individual studies.

6.2.3 Strengths and limitations of Study I

This study was a type of replication study which used a tried and tested method of evaluating psychometric properties reliability in instruments for non-technical skills, enabling comparisons of reliability and enhancing external validity (Polit & Beck, 2012). Since a minimum of 50 participants is recommended for reliability studies (Cicchetti, 2001), efforts were made to recruit all the nurse anaesthetists involved in clinical supervision. Although the sample in this study was less than 50, it was representative of the group for whose use the instrument was intended in nurse anaesthesia education, thereby enhancing external validity (Polit & Beck, 2012). However, selection bias may be a threat to internal validity (Polit & Beck, 2012). Boet et al. (2018) commented on the risk of bias in many of the studies involving non-technical skills instruments used in anaesthesia, owing either to doubtful quality or too few studies confirming validity and reliability. Although, NANTS-no's reliability has been tested in different areas, the PhD candidate has been responsible for all the research, so this may be a threat to validity.

A training course on non-technical skills over two full days is regarded as the "gold standard" (Hull et al., 2013; Klampfer et al., 2001). Following these recommendations is challenging owing to staffing requirements, cost implications and effectivity demands, as the majority of other studies have also experienced (Higham et al., 2019; Lyk-Jensen et al., 2016; Rutherford et al., 2015; Spanager et al., 2013). However, measures such as establishing a good dialogue with the hospital trusts, limiting the workshop to one full day and being flexible with regard to time and venue increased participation levels. It is also recommended that training courses are held by a multidisciplinary team of clinicians and psychologists/human factors experts (Flin & Maran, 2015; Hull et al., 2013). Owing to time constraints and availability this was not possible. The PhD candidate does however have both clinical expertise and considerable experience with teaching non-technical skills.

Rating non-technical skills in video clips is generally regarded as easier than in clinical practice (Flin & Maran, 2015). However, the participants were not given the opportunity to rewind the clip, so the scripted scenarios were over as quickly as any real-life situation. This study had a relatively small number of video clips compared to other studies and they were also generally longer, which may have led to rater fatigue (Lyk-Jensen et al., 2016). This could have been alleviated by using shorter clips, allowing more time for rating or spreading rating sessions over two days. However, such changes would have been difficult to implement owing to organisational constraints and may also have affected the data quality.

The expert panel lacked a psychologist or expert in human factors which may be seen as a limitation. However, having knowledge of and experience in the field, inclination and time to participate as well as effective communication skills, are possibly the most important qualifications for members of an expert panel (Keeney et al., 2011). Although a classical Delphi approach was not used to achieve consensus and members may have been influenced by each other, using face-to-face discussions is a recognized method (Keeney et al., 2011). A larger expert panel may have strengthened the study, although there are no fixed guidelines regarding size and composition.

Back-translation is generally considered obligatory when translating a questionnaire to another language, and the fact that this was not carried out may be seen as a limitation (Polit & Beck, 2012). Although the PhD candidate is bilingual this is not a sufficient qualification, however her knowledge of the field, linguistic abilities and experience as a translator may be regarded as strengths (Polit & Beck, 2012). Moreover, the purpose and content of the questionnaire were very simple.

The psychometric properties were evaluated using both standard test theory and generalizability theory since although reliability coefficients provide a measurement comprising a true score and measurement error, they do not provide information about the relative contribution of the multiple potential sources of error (Streiner et al., 2015). This therefore strengthens the dependability of the findings (Brennan, 2010). Ideally Cronbach's alpha should lie between 0.6 and 0.9 in order to demonstrate average to good internal consistency between the elements in a category (Streiner et al., 2015). Therefore, the high Cronbach's alpha in this study may imply redundancy in some of the NANTS-no elements or category diversity in the scale (Streiner et al., 2015). Since the large number of raters (46) in relation to the number of NANTS-no elements (15) could affect the estimated ICC, attempts were made to mitigate this problem by estimating inter-rater reliability based on a mean derived from five randomly selected pairs (Streiner et al., 2015). This seemed appropriate since NANTS-no is intended for use in clinical practice with one or two raters. Rater accuracy was assessed for one scale point difference as previous studies have shown boundary difficulties when assigning scores (Fletcher et al., 2003). *Absolute* G coefficients were used in the generalizability analyses as they are more stringent than *relative* G coefficients and therefore useful when the objective is to generalize the dependability of raters' measurements (Mushquash & O'Connor, 2006). Therefore, the results can be regarded as strengthening the instrument's reliability (Brennan, 2010).

6.2.4 Strengths and limitations of Study II

This study had a relatively simple design which enabled it to be carried out without too many difficulties or disruptions to the student's education or demands for effectivity.

Ideally only mentors who had taken part in Study I which tested if they could reliably assess non-technical skills, should have been included in Study II. The study may also have been strengthened by using only a small number of mentors and clinical supervisors to assess the SNAs at all three time-points as this would have exerted more control (Polit & Beck, 2012). However, owing to staffing issues both measures proved impossible to carry out. Thus, the study reflects the real-life challenges facing clinical assessment in the operating department, while simultaneously demonstrating the instrument's reliability in clinical practice.

The sample size was small and recruited as a convenience sample, rather than through randomization after conducting a power analysis (Polit & Beck, 2012). Selection bias is therefore a threat to internal validity, although the homogeneity of the sample may have eliminated some variability (Onwuegbuzie & Johnson, 2006). The study could have been strengthened by increasing the sample size or comparison with a control group of students from the same or another University (Polit & Beck, 2012). However, since each student was assessed three times on 15 NANTS-no elements by three raters, the number of individual measurements was large and provided a robust set of data for the linear mixed effects models.

Another threat to internal validity is maturation which may have been a confounding factor in this study, as it can be assumed that the student nurse anaesthetists would have demonstrated a certain development owing to the passage of time (Polit & Beck, 2012). Attempts to reduce this threat by having three time-points rather than two may have been beneficial as pretest-posttest designs are particularly at risk. The data was gathered using the same instrument throughout the study, and since the instrument had demonstrated reliability, this enhanced internal validity (Polit & Beck, 2012).

A potential threat to external validity and whether inferences can be generalized is observational bias (Onwuegbuzie & Johnson, 2006). This was particularly the case in Study II since the mentors worked with the students on a daily basis, and this may have influenced their rating of the students' non-technical skills. In addition, as in any observational study of behaviour, the Hawthorne effect may be a confounding factor (Polit & Beck, 2012). Attempts were made to reduce this threat by having three different

assessors for each of the measurements. A possible threat to the study's objectivity was the PhD candidate's role as one of the clinical supervisors. All these factors do not however appear to have affected the robustness of the data. External validity was enhanced in the study by describing the context and selecting settings and participants that were representative for nurse anaesthesia education (Polit & Beck, 2012).

The use of linear mixed effect models which can accommodate unequal numbers of observations per cluster resulting from randomly missing data or, for example, participants dropping out, strengthened the data analysis as three of the participants were not assessed at all three time-points (Katz, 2011). Using standard analysis methods that do not take dependencies such as each student being rated at three time-points by three raters into account, can lead to outcomes being overlooked or overestimated (Katz, 2011). A final consideration is that mixed-effects models can also accommodate different variance by raters which was an advantage in this study (Katz, 2011).

6.2.5 Strengths and limitations of Study III

There is currently only one other qualitative study exploring user's experiences with instruments for developing and assessing non-technical skills (Sirevåg et al., 2021). This study therefore provided important insights, particularly as it included both student and mentor perspectives, unlike Sirevåg's study. The PhD candidate's role and understanding of the clinical context strengthened the credibility of the study by enabling recruitment of participants to the focus groups that could provide a rich variety of perspectives. However, her role as a figure of authority may threaten credibility and dependability. As stated earlier, attempts were made to democratize power relations to avoid feelings of obligation or coercion (Karnieli-Miller et al., 2009).

One of the most unique aspects of focus groups is the interaction between the participants that enable participants to explore and clarify their ideas and experiences more readily than individual in-depth interviews (Liamputtong, 2011; Webb & Kevern, 2001). This interaction provided valuable insight into participants' attitudes, priorities and understanding, and explored differences between the ways in which they reflected

on and influenced each other's views as well as identifying group processes and norms (Kitzinger, 1994).

Group composition is an important factor in focus group methodology where issues such as homogeneity/heterogeneity, shared experiences and whether or not participants are known to one another can affect interaction in the group (Liamputtong, 2011). The groups were homogenous in some respects as participants had similar professional backgrounds or student cohorts which facilitated discussion, however, the fact that they had different workplaces provoked a wider range of perspectives (Liamputtong, 2011). Opinions vary on whether or not group participants should know each other (Liamputtong, 2011). When participants already know each other as in the two student groups, group norms can often be already established, placing constraints on interaction by silencing dissenting voices or creating situations where one participant dominates. In constructed groups as with the clinical supervisors and mentors, it may be easier to express honest opinions without fear of repercussions (Kitzinger, 1995; Liamputtong, 2011). However, the interaction in all the groups yielded rich data through shared and contradictory viewpoints and generated a new and deeper understanding of the subject.

Enabling active participation in the discussion and exploiting humour and laughter to ease social constraints and encourage interaction is a major part of the moderator's role (Kitzinger, 1994; Kitzinger, 1995; Liamputtong, 2011). A moderator should among other things be flexible, open-minded and have good listening and observation skills as well as being sensitive and non-judgmental with regard to participants' needs (Liamputtong, 2011). This can be a challenging task particularly when the researcher is inexperienced as was the case in this study, and can affect the quality of the data collected (Liamputtong, 2011). In addition, the PhD candidate's role in adapting NANTS-no, involvement in nurse anaesthesia education at the University may have acted as a bias when carrying out the interviews. Attempts were made to counterbalance these issues by two of the other researchers taking an active role as assistant moderators during the interviews (Graneheim & Lundman, 2004). Since they are not involved in the clinical side of the nurse anaesthesia program, they had a more open and questioning approach to

both data collection and analysis that counterbalanced the PhD candidate's pre-understandings and increased trustworthiness (Graneheim et al., 2017).

A possible threat to trustworthiness may be that the interviews were transcribed by someone outside the research team, thus potentially affecting the analysis and interpretation of the data. To counterbalance this and ensure nothing was lost, the transcripts were read through while listening to the audio files. This was also a means of becoming immersed in the data and forming an impression of the interaction between the participants (Creswell & Poth, 2018). Providing detailed descriptions of the analysis process as well as the various researchers' roles ensures transparency. Epistemological assumptions as well as the research question will influence the degree of interpretation and level of abstraction in the data analysis, and not all methods of qualitative content analysis include an abstraction process and interpretation of underlying thems (Elo & Kyngas, 2008). Since this study was concerned with experiences using something concrete, the findings had a relatively low level of abstraction and degree of interpretation (Lindgren et al., 2020).

Research credibility is increased by reporting group interaction where disagreement and discussion led to clarification and modification of differing opinions that enhanced the data, and sequences in the discussion which illustrated how consensus was achieved (Kitzinger, 1995; Webb & Kevern, 2001). Using representative examples of the participants' views illustrates and strengthens the confirmability of the findings (Graneheim & Lundman, 2004). However, the fact that participants were not invited to read through and confirm the findings may be regarded as a limitation.

7 Conclusion and recommendations

The aim of this research was to promote clinical excellence and patient safety in nurse anaesthesia education by first testing the psychometric properties of NANTS-no, then examining whether it could be used in clinical practice to reliably develop and assess student nurse anaesthetists' non-technical skills. The final objective was to explore how the students, mentors and clinical supervisors experienced using the instrument in clinical supervision.

NANTS-no demonstrated high reliability and dependability in assessing non-technical skills both in a controlled setting and in clinical practice. It provided a standard for excellence in anaesthesia care, as well as a standardized and more objective means of assessment that demonstrated a measurable progress during nurse anaesthesia education. The student nurse anaesthetists achieved an average score of 4.5 from the mentors and clinical supervisors at the end of their education which is close to excellence. It would therefore seem appropriate to suggest that achieving an average score of 4 should be a minimum requirement to determine professional suitability and ensure that qualified nurse anaesthetists provide safe anaesthesia care.

Using NANTS-no as a formative instrument appeared to promote a professionalization of clinical supervision that encouraged critical reflection and self-awareness in the students. This led to transformative learning and behavioural change. It also contributed to changing the way in which the mentors supervised their students, promoting a professional partnership based on dialog and person-centred relationships.

Although the students, mentors and clinical supervisors were generally positive towards using NANTS-no in clinical supervision, there were challenges with implementing the instrument in the anaesthetic departments. Assessing non-technical skills is still a relatively new concept and the language used in the rating scale was regarded as demotivating, particularly when rating non-technical skills during the first semester. Furthermore, not all the nurse anaesthetists in the anaesthetic departments were familiar with the instrument. There is therefore a need to develop strategies for increasing implementation.

To conclude, using the structured behavioural assessment instrument, NANTS-no, as a means of systematically developing and assessing non-technical skills in nurse anaesthesia education, appears to contribute towards promoting both clinical excellence and patient safety in anaesthesia care.

7.1 Recommendations for further research

The following are recommended areas for further research:

- Further testing of the reliability of NANTS-no in simulation and clinical settings to confirm the findings in this research
- Explore the usability of NANTS-no as an instrument in professional development for qualified nurse anaesthetists
- Further development of NANTS-no to incorporate communication with the patient
- Implementation research to explore the feasibility of NANTS-no in anaesthetic departments
- Evaluation of modifications to the NANTS-no rating scale
- Explore the effect of using NANTS-no to develop non-technical skills on patient safety outcomes

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Paper 1

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Psychometric Testing of a Structured Assessment Instrument for Non-technical Skills (NANTS-no) for Use in Clinical Supervision of Student Nurse Anesthetists

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Background: This study evaluated psychometric properties of a structured behavioral assessment instrument, Nurse Anaesthetists' Non-Technical Skills—Norway (NANTS-no). It estimated whether reliable assessments of nontechnical skills (NTS) could be made after taking part in a workshop. An additional objective was to evaluate the instrument's acceptability and usability. **Methods:** An explorative design was used. Nurse anesthetists (n = 46) involved in clinical supervision attended a 6-hour workshop on NTS, then rated NTS in video-recorded simulated scenarios and completed a questionnaire. **Results:** High reliability and dependability were estimated in this setting. Participants regarded the instrument as useful for clinical supervision of student nurse anesthetists (SNAs). **Conclusions:** Findings suggest that NANTS-no may be reliable for performing clinical assessments of SNAs and encouraging critical reflection. However, further research is needed to explore its use in clinical settings.

Keywords: nontechnical skills; nurse anesthetist/anesthetist; psychometric testing; patient safety; education; NANTS-no

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Clinical supervision is an essential part of anesthesia nursing education. It strives to bridge the gap between theory and practice and promote professional and personal development, by facilitating the learning of clinical skills and developing critical and reflective thinking (Jokelainen, Turunen, Tossavainen, Jamookeeah, & Coco, 2011). However, the majority of Norwegian nurse anesthetists involved in clinical supervision currently lack any formal training in this area. A recent report on the quality of clinical practice (The Norwegian Association of Higher Education Institutions, 2016) called for closer cooperation between educational and healthcare institutions, as well as a more formalized training for clinical supervisors to raise standards.

The International Federation of Nurse Anesthetists (IFNA, 2016) promotes high standards of competence and behavior to ensure quality in anesthesia. Developing, training, and assessing nontechnical skills (NTS) is generally regarded as essential for providing safe anesthesia and ensuring excellent care (Fletcher et al., 2003; Flin & Mitchell, 2009; Glavin, 2009). However, there is a need for a common taxonomy and robust and reliable instruments in anesthesia nursing education for observing and assessing these skills. The Nurse Anaesthetists' Non-Technical Skills—Norway (NANTS-no) structured behavioral assessment instrument is intended for developing and assessing NTS in student and postgraduate nurse anesthetists in Norway, and was tested in a simulation setting (Flynn, Sandaker, & Ballangrud, 2017). In this article, the instrument's psychometric properties were further tested, prior to using the instrument in clinical settings. The purpose of the study was to:

- Explore whether experienced nurse anesthetists involved in clinical supervision can reliably and accurately assess NTS in simulated video-recorded scenarios using NANTS-no, after participating in a 6-hour workshop.
- Estimate whether each individual mentor is able to provide a reliable assessment of NTS in video-recorded simulated scenarios.
- Explore whether NANTS-no is perceived as an acceptable and usable instrument for developing and assessing student nurse anesthetists' (SNAs) NTS in clinical practice.

BACKGROUND AND CONCEPTUAL FRAMEWORK

Clinical supervision is a generic term for the process of providing support and guidance to SNAs or other professionals, with the aim of enabling learning and development of professional skills in a safe environment (Lyth, 2000). Proctor (1991) described clinical supervision as having normative, formative, and restorative elements, where the *normative* focuses on the setting, the *formative* on education and development, and the *restorative* on providing support. The term *mentor* appears to have a variety of meanings in clinical practice literature, encompassing both ad hoc arrangements and more formalized monitoring and assessment (Fowler & Cutcliffe, 2011; Jokelainen et al., 2011). In this article, mentor is used to describe the experienced postgraduate nurse anesthetists whose role involves supervising, teaching, and assessing SNAs throughout their clinical training.

Mentorship places responsibility on both the mentor and the SNA to enable an individual learning process and empower development of a new professional identity and competence (Jokelainen et al., 2011). Although there are standardized means of testing theoretical knowledge, there is currently a lack of validated and reliable instruments for forming and assessing nurse anesthetists in clinical practice in Norway, and few internationally (Collins & Callahan, 2014; Lyk-Jensen et al., 2016; Sevdalis, Hull, & Birnbach,

2012). A major challenge facing mentors is simultaneously ensuring patient safety, while guiding SNAs through complex, dynamic, and critical situations in a highly technical environment. A recent study highlighted the way in which management attitudes and increasing demands for efficient production limit professional development among nurse anesthetists (Averlid, 2017). These same factors are among those reported by both students and mentors as constraints on the mentoring role and a threat to patient safety (Jølstad, Røsnæs, Lyberg, & Severinsson, 2017; Rylance, Barrett, Sixsmith, & Ward, 2017).

The IFNA "Code of Ethics and Standards of Practice, Monitoring and Education" for nurse anesthetists utilizes the Canadian Medical Education Directions for Specialists (CanMEDs) Competency Framework (IFNA, 2016). The CanMEDs framework has been recently adopted by the Norwegian Association of Nurse Anesthetists in an attempt to ensure high standards of safety and quality in clinical practice and the education of nurse anesthetists. The seven competencies described in the framework (Figure 1) incorporate NTS such as communication and situation awareness, task management, leadership, and teamwork, as well as promoting the professional identity of the nurse anesthetist (Herion, Egger, Greif, & Violato, 2019). The decision to adopt this framework for Norwegian nurse anesthetists is in line with an international movement in healthcare education and clinical practice aimed at moving beyond competence, with excellence as an aspirational goal (O'Donnell, Cook, & Black, 2016; Smith, Glavin, & Greaves, 2011; Wong, 2012). Since the role of NTS in developing standards of clinical excellence and improving patient safety

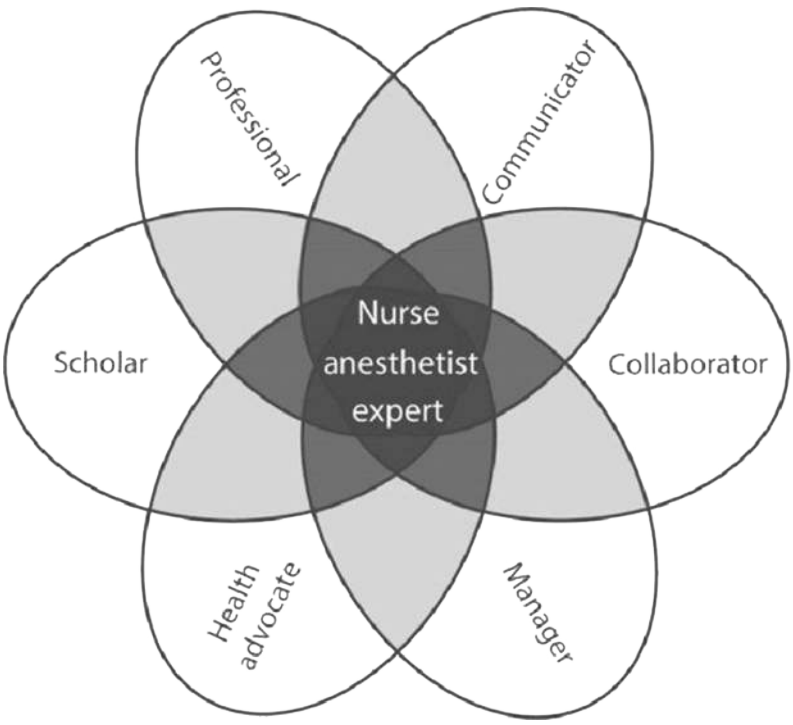

Figure 1. Adapted by IFNA from the CanMEDS Physician Competency Diagram with permission from The Royal College of Physicians and Surgeons of Canada. Copyright©2009

is the focus of this article, the CanMEDs framework seemed an appropriate conceptual framework for the measurement of NTS.

There is a general acceptance that a high number of adverse events in healthcare are a result of human factors and could have been prevented (Jha, Prasopa-Plaizier, Larizgoitia, & Bates, 2010). Surgery and anesthesia are particularly high-risk areas (Kennerly et al., 2014), where simple mistakes can have fatal consequences. Measures have been implemented at all levels to improve patient safety in the operating theatre (Haugen et al., 2019; Sevdalis et al., 2012; Tan, Pena, Altree, & Maddern, 2014), and there is a growing bank of research on the role of NTS that focuses on the individual professional's behavior. Flin et al. (2008) define NTS as "cognitive, social and personal resource skills that complement technical skill, and contribute to safe and efficient task performance." Ensuring nurse anesthetists have well-developed NTS, such as heightened situation awareness, optimal decision-making, and task management, and open and effective communication is a prerequisite for excellent practice and providing high standards of safe anesthesia care (Gaba, Howard, & Small, 1995; Herion et al., 2019; Larsson & Holmstrom, 2013; Rutherford, Flin, & Mitchell, 2012).

In response to international focus on the role of human factors in adverse events, a number of behavioral assessment instruments have been developed to structure the development, training, and assessment of NTS in healthcare professionals (Higham et al., 2019). There are currently instruments for assessing NTS in an operating theatre setting for anesthesiologists (Fletcher et al., 2003), nurse anesthetists (Lyk-Jensen, Jepsen, Spanager, Dieckmann, & Ostergaard, 2014), anesthetic practitioners (Rutherford, Flin, Irwin, & McFadyen, 2015), surgeons (Spanager et al., 2013; Yule, Flin, Paterson-Brown, Maran, & Rowley, 2006), and scrub nurses (Mitchell et al., 2013). NANTS-no was adapted for Norwegian nurse anesthetists in 2014 (Flynn et al., 2017) from Anaesthetists' Non-Technical Skills (ANTS) for anesthesiologists (Fletcher et al., 2003). The structure and sequence of the categories and the decision to change the rating scale from four to five points, was influenced by the Danish instrument for nurse anesthetists (Lyk-Jensen et al., 2014). ANTS was chosen as the basis for NANTS-no as it had already been translated to Norwegian and seemed most appropriate, requiring only relatively minor changes to the language and practice examples to make it acceptable. It had also already been validated in 2014, unlike the Danish instrument (Fletcher et al., 2003; Lyk-Jensen et al., 2016).

NANTS-no has a hierarchical structure of 4 categories and 15 elements (Table 1), with behavioral examples of good and poor practice for each element. In addition, the instrument has a five-point numerical rating scale (1–5), where behavior that places the patient's life at risk is rated as 1, marginal behavior as 2, acceptable behavior as 3, good behavior as 4, and excellent behavior as 5. The numerical rating scale is used to rate each element and category, and to provide a global score. Where behavior is not observed for an element, N is used.

All these behavioral rating instruments have a similar taxonomy and rating scales, and are designed to facilitate objective observations and ratings of the skills and behavior relevant for the individual professional (Flin & Maran, 2015; Higham et al., 2019). The purpose of NANTS-no and other similar instruments is primarily formative enabling mentors to provide structured and objective feedback (Jepsen, Østergaard, & Dieckmann, 2015). A further aim is to encourage self-awareness and critical thinking, allowing healthcare professionals to reflect on and assess how their behavior affects their performance and highlighting issues that need addressing. Assessment is important both to ensure quality and validity in education, encourage learning, and demonstrate accountability to stakeholders.

Traditionally, assessment in anesthesia nursing education has focused more on testing theoretical knowledge and technical proficiency (Wong, 2012). In order to be able to make systematic summative assessments of NTS in clinical practice, the instruments must be sufficiently reliable and robust (Higham et al., 2019). Regular use and repeated training are recommended before using these instruments to make assessments in clinical settings (Flin & Maran, 2015).

The need for separate instruments that reflect the healthcare setting in which they are to be used has been discussed (Flin & Patey, 2011; Higham et al., 2019; Jepsen et al., 2015; Wisborg & Manser, 2014). Since a generic instrument for assessing NTS in healthcare does not currently exist, there is a persuasive argument for a separate instrument that reflects organizational and cultural differences in nurse anesthesia education and clinical practice. Nurse anesthetists in Norway have an independent professional responsibility when providing anesthesia, as well as working in close collaboration with anesthesiologists (Averlid, 2017; Nilsson & Jaensson, 2016; Ringvold et al., 2018), and NANTS-no was adapted to reflect this setting. Although NANTS-no appeared to display high reliability (ICC = 0.91) when used in a simulation setting, there is need for further research to see whether it may also be suitable for use in clinical settings.

TABLE 1. The NANTS-no Framework

Categories	Category Score	Elements	Element Score
Situation awareness		Gathering information	
		Recognizing and understanding	
		Anticipating and thinking ahead	
Decision-making		Identifying possible options	
		Assessing risks and selecting options	
		Reevaluating	
Task management		Planning and preparing	
		Prioritizing	
		Identifying and utilizing resources	
		Maintaining standards and levels of quality	
Team working		Exchanging information	
		Assessing roles and capabilities	
		Coordinating activities	
		Displaying authority and assertiveness	
		Supporting other team members	

METHODS

The development of NANTS-no has been described in an earlier article (Flynn et al., 2017). The current study used an explorative design to examine the instrument's psychometric properties prior to use in clinical settings. Participants used the NANTS-no five-point rating scale to rate NTS in video-recorded simulated scenarios. These ratings together with an evaluation questionnaire provided the data for testing the instrument's reliability, generalizability, acceptability, and usability.

Sample

A convenience sample of 69 nurse anesthetists involved in clinical supervision of SNAs in four hospital trusts in Norway, were invited to take part in a 6-hour workshop on NTS in anesthesia nursing. Forty-six nurse anesthetists consented to take part in the study, which took place over a 4-week period in October and November 2017. An additional participant, who attended the workshop, was excluded from the study owing to having been involved in the production of the video-recorded simulated scenarios. All the participants were actively involved in clinical supervision of SNAs, either as mentors (n = 35), clinical supervisors (n = 3), or with responsibility for professional development (n = 8). Background information relating to participants' sex, age, and experience was collected (Table 2).

TABLE 2. Characteristics of the Sample

	%	*N*	Min	Max	Mean (*SD*)
Sex:		46			
Male	19.6				
Female	80.4				
Age in years:		46	31	62	47.3 (8.2)
Number of years as nurse anesthetist:		46	1	30	12.5 (7.4)
Hospital Trust 1	34.8	16			
Hospital Trust 2	23.9	11			
Hospital Trust 3	30.4	14			
Hospital Trust 4	10.9	5			
Previous experience with clinical supervision of SNAs		41			
Yes	73.2				
No	26.8				
Some previous experience with NANTS		41			
Yes	46.3				
No	53.7				

Preparatory Phase

Video Clips. Six short video-recorded simulated scenarios were specially designed and produced for the study, showing nurse anesthetists displaying varying levels of NTS. The scenarios for the video clips were developed by the main researcher (F.M.F) and a team of experienced nurse anesthetists involved in simulation training of NTS. They were evaluated for content validity by the nurse anesthetists who took part in filming the scenarios. Having read the scripts, they provided feedback so changes could be made. The scenarios were loosely scripted to ensure that they demonstrated the desired NTS, while enabling a dialog that was as natural as possible. They featured student and expert nurse anesthetists, as well as other members of the anesthesia and surgical team in a variety of perioperative situations. These included critical and routine situations that can occur during intubation and extubation of anesthetized patients as well as before and during surgery. Each video clip lasted between 4 and 8 minutes. They were filmed using a Laerdal Medical patient simulator, with trained nurse anesthetists and other members of the surgical team playing different roles.

Reference Ratings. A set of reference ratings for the video clips used in the study were produced by a panel of four experts, all with relevant clinical experience and considerable expertise and interest in educating and training NTS (Keeney, Hasson, & McKenna, 2011). Two members of the panel were involved in the development and testing of NANTS-no in a previous study (Flynn et al., 2017), while a third member had experience in using NANTS-no for educating SNAs. The fourth member had considerable expertise in educating and training NTS with critical care nurses and other groups of healthcare professionals. Each member of the panel rated the video clips alone prior to a meeting, where any disparity in the ratings was discussed face-to-face in order to reach a consensus (Keeney et al., 2011).

Evaluation Questionnaire. An evaluation questionnaire based on one used in other studies (Mitchell et al., 2013; Rutherford et al., 2015) was translated to Norwegian with permission from John Rutherford, and then adapted. The translation was carried out by the main researcher who is bilingual in both English and Norwegian, and a colleague. The evaluation questionnaire was used to collect background information, evaluate the workshop, and assess the acceptability and usability of NANTS-no for use in clinical supervision.

Setting

The workshop was held by the main researcher on seven different occasions either at the various hospital trusts or at a nearby venue, in order to encourage participation. Prior to taking part in the workshop, the participants were asked to familiarize themselves with NANTS-no and watch a film on the role of human factors in anesthesia (*Just a routine operation*: https://www.youtube.com/watch?v=VndU2zap_Rg). The workshop comprised theory about patient safety, human factors, and the underlying concepts for developing and assessing NTS, as well as group discussion and rater training. The structure of NANTS-no, its categories, and elements were discussed in detail. Participants were encouraged to give examples of both good and poor NTS, either that they had experienced personally or witnessed while working with SNAs. The rating scale and appropriate use of all the scores (1–5) as well as N (not observed) was also explained. Rater training involved rating three training video clips, after which ratings were discussed, and the participants given feedback. The training video clips were not used for data collection in the study.

At the end of the workshop, each participant individually rated NTS in the six video clips produced for the study using the NANTS-no rating scale. NTS were rated at element and global level. Participants were also asked to complete the evaluation questionnaire.

Psychometric Testing of the Assessment Instrument

Reliability. Reliability of ratings is relative to the proportion of systematic and random variance inherent in the measurements. Systematic variance is the true differences between the nurse anesthetists rated in the video clips and random variance is the error component present in the actual ratings (Streiner, Norman, & Cairney, 2015). Reliability was assessed using analyses based on classical test theory; internal consistency, inter-rater reliability, and rater accuracy.

Internal consistency was estimated for each category across all the videos using Cronbach's alpha. Inter-rater reliability was estimated using a two-way mixed, absolute agreement intraclass correlation coefficient (ICC), where an ICC value > 0.75 represents high reliability, ICC 0.5–0.75 represents moderate reliability, and ICC < 0.5 poor reliability (Portney & Watkins, 2009). As the study had a large number of raters in relation to the number of NANTS-no elements and is intended for use in clinical practice with one or two raters, an ICC based on many raters could be misleading (Streiner et al., 2015). Inter-rater reliability was thus measured at all levels using a mean ICC derived from five randomly selected pairs of raters.

The accuracy of the participants' ratings were compared to the set of reference ratings. A system of points was assigned to reflect how far the participants' ratings deviated from the reference ratings. Participant ratings that were the same as the reference ratings were assigned 5 points. A one-point deviation was assigned 4 points, while a two-point deviation was assigned 3 points, and so on. The raters' total score was then calculated and presented as a percentage of the expert total score for each NANTS-no element across all the video clips. Since some raters had used two scores such as 2–3, rater accuracy was also assessed for one scale point difference from the reference score. The mean absolute deviation (MAD) from the reference ratings was calculated.

Generalizability. Generalizability theory (GT) was used to estimate the various error components and explore the dependability of the ratings for future use (Brennan, 2010). A generalizability (G) study with a balanced two-facet crossed design was carried out with video clips (n = 6) x raters (n = 46) x NANTS-no categories (n = 4). The estimated variance components from the G-study were then used to estimate an absolute generalizability coefficient for the number of raters needed to reliably rate the films in a decision (D) study, where the categories were a fixed component.

Acceptability and Usability. To assess whether NANTS-no was able to measure different types of behavior, the instrument was tested for observability, acceptability, and usability using data from the evaluation questionnaire. The level of observability of NTS in the videos was also assessed by comparing the percentage of "not observed" with the "observed" scores for each video clip.

Data Analysis. Data was analyzed using IBM SPSS Statistics, version 24, and the generalizability analyses were performed using the MATLAB G1.sps program for SPSS (Mushquash & O'Connor, 2006). A random number generator in Microsoft Excel was used for selecting pairs of raters for the inter-rater reliability analysis.

Any NANTS-no ratings that were given as two scores, for example, 2–3, were rounded down to the lower score, while "not observed" was treated as zero. Category scores were

calculated as the mean score of the elements in each category. A missing data analysis was carried out to ensure that it was less than 3%, and any missing data was replaced with zero in the generalizability analyses.

Ethical Considerations

Following notification to the Norwegian Centre for Research Data (project no. 55538) on 8.9.2017 and approval from the hospital trusts, the nurse anesthetists were informed orally and in writing about the study. In accordance with the Declaration of Helsinki (World Medical Association, 2013), the concepts of informed consent, voluntary participation, and the right to withdraw without penalty were carefully explained to the participants. Requirements regarding confidentiality, data anonymity, and secure handling of data were also explained. After appropriate time for consideration, written consent was obtained from all participants.

RESULTS

Forty-six nurse anesthetists involved in clinical supervision of SNAs took part in the workshops. Two participants rated only four out of six clips and a third participant rated five of the clips. Forty-one participants completed the evaluation questionnaire at the end of the workshop. The characteristics of the sample are presented in Table 2.

Reliability

A total Cronbach's $\alpha > 0.9$ was estimated in all categories. The overall inter-rater reliability was estimated as high (ICC = 0.80), and moderate to high for the NANTS-no elements (mean ICC = 0.68–0.91). Inter-rater reliability and Cronbach's α at category level is presented in Table 3.

A mean rater accuracy of 82% of the maximum expert element score was estimated. Mean rater accuracy increased to 89% of the expert score when estimated to one scale point difference. Rater accuracy for global scores was estimated as 81% (MAD = 1.08) and 87% (MAD = 1.19) to one scale point difference. Mean percentages and mean absolute deviation from the total expert score for the individual elements are presented in Table 4.

Generalizability

The G-study estimated an absolute error variance $\sigma^2_{\triangle} = 0.015$, with a higher degree of variance among the raters ($\sigma^2_r = 0.084$) than in the NANTS-no categories ($\sigma^2_c = 0.016$). There was a certain amount of variance in the raters scoring for each video clip ($\sigma^2_{pr} = 0.237$), but only minimal variance in the raters average level in the NANTS-no categories ($\sigma^2_{rc} = 0.007$). The D-study estimated that one rater was sufficient to achieve an absolute generalizability coefficient = 0.83 using NANTS-no (Figure 2).

Observability

Observability of NTS across the scenarios was high, averaging 91% (82.497.8%). However, 18 participants rated over 10% of the scores as "not observed." The distribution of

TABLE 3. Inter-rater Reliability (ICC) for Five Randomly Selected Pairs of Raters and Cronbach's Alpha

	Intraclass Correlation Coefficient (95% CI)					Mean ICC	Cronbach's Alpha
NANTS-no category	**Pair 1**	**Pair 2**	**Pair 3**	**Pair 4**	**Pair 5**		
Situation awareness	0.76 (0.22–0.84)	0.83 (0.19–0.95)	0.80 (0.40–0.93)	0.90 (0.74–0.96)	0.81 (0.48–0.93)	0.82 (0.77–0.87)	.95
Decision-making	0.85 (0.61–0.95)	0.46 (-0.21–0.78)	0.80 (0.44–0.93)	0.92 (0.78–0.97)	0.90 (0.68–0.96)	0.79 (0.62–0.95)	.94
Task management	0.67 (0.25–0.85)	0.79 (0.33–0.92)	0.72 (0.35–0.88)	0.93 (0.85–0.97)	0.81 (0.57–0.92)	0.78 (0.70–0.87)	.91
Team working	0.73 (0.28–0.88)	0.62 (0.14–0.83)	0.80 (0.33–0.92)	0.94 (0.87–0.97)	0.86 (0.70–0.99)	0.79 (0.68–0.90)	.93
Global score	0.81 (−0.64–0.98)	0.79 (−0.13–0.97)	0.87 (0.26–0.98)	0.90 (0.24–0.99)	0.95 (0.65–0.99)	0.86 (0.81–0.92)	
Total inter-rater reliability	0.74 (0.60–0.83)	0.68 (0.27–0.84)	0.78 (0.52–0.88)	0.92 (0.88–0.95)	0.85 (0.77–0.90)	0.80 (0.71–0.88)	

TABLE 4. Rater Accuracy at Element Level

NANTS-no Elements	Mean Percentage of Expert Ratings (MAD)	Mean Percentage Ratings Accurate ±1 Scale Point (MAD)
Gathering information	83 (0.78)	91 (0.86)
Recognizing and understanding	88 (0.74)	95 (0.58)
Anticipating and thinking ahead	87 (0.78)	94 (0.68)
Identifying possible options	86 (0.71)	96 (0.60)
Assessing risks and selecting options	83 (0.96)	89 (1.05)
Reevaluating	86 (0.89)	92 (0.85)
Planning and preparing	86 (0.68)	96 (0.55)
Prioritizing	87 (0.79)	94 (0.68)
Identifying and utilizing resources	83 (0.89)	91 (0.93)
Maintaining standards and levels of quality	77 (1.25)	84 (1.40)
Exchanging information	81 (0.87)	89 (1.02)
Assessing roles and capabilities	80 (0.85)	91 (0.98)
Coordinating activities	76 (1.27)	83 (1.43)
Displaying authority and assertiveness	79 (1.04)	87 (1.18)
Supporting other team members	65 (1.87)	70 (2.03)

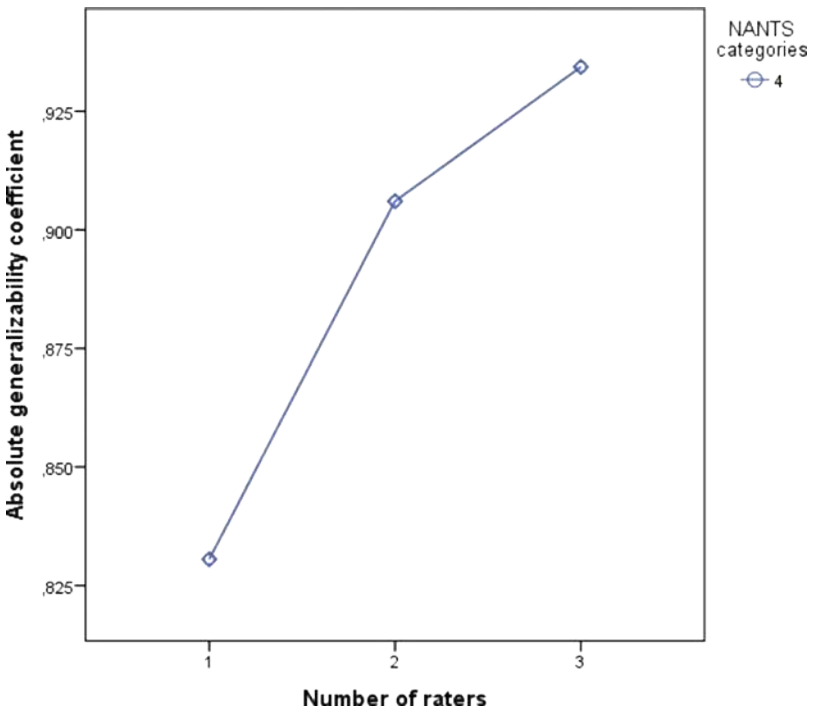

Figure 2. Effect of number of raters on the generalizability coefficient.

TABLE 5. Distribution of "Not Observed" Scores in the Video Clips

Video	*N*	Mean (%)	Std. Deviation (95% CI)
1	46	10.61	13.63 (6.56–14.66)
2	46	12.22	14.90 (7.79–16.64)
3	46	7.30	9.94 (4.35–10.26)
4	46	2.22	4.91 (0.76–3.67)
5	46	16.85	17.39 (11.68–22.01)
6	46	6.52	8.52 (3.99–9.05)
Total	276	9.29	13.03 (7.74–10.83)

Note. One-way ANOVA: F (5, 270) = 7.87, p = <0.005.

"not observed" scores in the video clips is shown in Table 5. Although there was a high level of observability at category level, ranging between 83% and 95%, the following five NANTS-no elements had over 10% of scores recorded as "not observed": *Reevaluating* 15.9%; *Maintaining standards and levels of quality* 14.9%; *Assessing roles and capabilities* 15.9%; *Coordinating activities* 13.8%; and *Supporting other team members* 33%.

Acceptability and Usability

In response to the evaluation questionnaire, 97.5% of participants stated that NANTS-no described the NTS essential for a nurse anesthetist either well or very well. NANTS-no was also described as a useful instrument for aiding SNAs to develop these skills (100%), promoting critical reflection (97.6%), providing feedback (97.6%), and evaluating SNAs in clinical practice (92.7%). Fifty-six percent of the participants responded that they were able to identify the NTS in the videos either well or very well, and 83% stated that they had received sufficient training about NANTS-no and the underlying concepts (95%) during the training session.

DISCUSSION

The NANTS-no structured behavioral assessment instrument aims to facilitate critical reflection, and development and assessment of NTS in clinical practice. The findings in this explorative study suggest that NANTS has sufficiently high reliability and dependability when rating NTS in video clips to encourage testing it in clinical practice. The nurse anesthetists participating in the study also supported this view.

Reliable and Accurate Assessment of NTS

Although overall reliability in the ratings of the video clips was slightly lower than in a previous study that estimated an ICC = 0.91 (Flynn et al., 2017), both inter-rater reliability and internal consistency were higher at category level in this study. An internal consistency $\alpha > 0.90$ may imply that some of the elements are redundant, though such a high alpha is not unusual and may also be a result of factors such as the study setting or category

diversity in the scale (Streiner et al., 2015). The overall reliability of ICC = 0.80 compares favorably with a similar study (Rutherford et al., 2015), though the Danish instruments for anesthesiologists and nurse anesthetists demonstrated higher levels of inter-rater reliability (Jepsen et al., 2016; Lyk-Jensen et al., 2016). Inter-rater agreement levels estimated for Anaesthetists' Non-Technical Skills (ANTS) and Scrub Practitioners' List of Intraoperative Non-Technical Skills (SPLINTS) in similarly designed studies were only reported as acceptable (Fletcher et al., 2003; Mitchell et al., 2013). The high reliability estimated in this setting is therefore encouraging.

The CanMEDs competency framework incorporates NTS in its seven competencies. While there is currently no standard for observing and assessing these skills (Higham et al., 2019), an evidence-based framework for developing behavioral assessment instruments and training instructors and those assessing NTS does exist (Hull et al., 2013; Klampfer et al., 2001). Rater training and familiarity with the structured assessment instrument is seen as essential prior to using these types of instruments in clinical practice (Flin & Maran, 2015). A 2-day training program is recommended for this purpose (Hull et al., 2013; Klampfer et al., 2001). Despite only 6 hours training and over 50% of participants having no previous experience with NANTS, reliability at category level was estimated as >0.75. Inter-rater reliability at element level was more variable (0.68–0.91) and not as high as for N-ANTS-dk (Lyk-Jensen et al., 2016), with the NANTS element *Maintaining standards and levels of quality* showing poorest reliability. In addition, only moderate reliability was estimated for the elements *Assessing risks and selecting options* (0.73*), Assessing roles and capabilities* (0.70), and *Supporting other team members* (0.72). This is still generally higher than in some other studies (Fletcher et al., 2003; Rutherford et al., 2015). *Assessing risks and selecting options* is a cognitive element and may be more difficult to observe (Fletcher et al., 2003), although the cognitive elements in the Situation awareness category were all estimated to have an ICC > 0.8. A possible reason for the lower reliability in the other three elements lies in the fact that more than 10% of the raters had scored these elements as "not observed," with a total of 33% scoring the element *Supporting other team members* as "not observed." Since "not observed" behavior was represented in the data as zero, this inevitably had a negative effect on the analysis.

Rater accuracy reflects the participants' ability to distinguish good from poor behavior (Sevdalis et al., 2012) which is an important factor when supervising SNAs in situations where small mistakes can dramatically affect patient safety. A mean rater accuracy of 82% for elements across all the video clips is comparable with other similar studies (Jepsen et al., 2016; Lyk-Jensen et al., 2016), though ANTS reported higher rater accuracy (Fletcher et al., 2003). Since some of the raters were unable to decide on one score and rated some elements or global scores with, for example, 2–3, it seemed advisable to test rater accuracy to one point difference. This increased the mean rater accuracy. Although time had been spent on calibrating scoring in the workshop, there were presumably difficulties here as in other studies in deciding where to set the boundaries for each score (Fletcher et al., 2003), underlining the need for repeated calibration training. The variation in mean accuracy for the various elements (70%–96%) is presumably also accounted for by the relatively high number of "not observed" scores for some elements, reducing total scores. Participants were encouraged to use the entire scale including "not observed." However, there was an unanticipated higher use of "not observed" scores compared with the expert panel, which may have been a result of misunderstandings regarding when it should be used. Again surprisingly, rater accuracy is highest in the category Situation Awareness, despite cognitive behavioral skills being usually regarded as difficult to observe (Flin et al., 2008).

Dependability of Individual Ratings

Although the ICC > 0.8 estimated in this study is consistent with the required reliability for using NANTS-no as a formative instrument (Hull et al., 2013), reliability testing does not provide information about the variation between the individual participants, and whether each individual participant is able to perform a reliable assessment. Since the aim of this study was to explore whether this structured assessment instrument has a future in formative and summative assessments in anesthesia nursing education, a high generalizability coefficient is of paramount interest.

The G-study estimated that the greatest variance lies between the raters' scores for each video clip, which is unsurprising as each video clip was designed to demonstrate varying levels of NTS. However, only minimal variance was estimated between the elements in each category, and the way the raters scored each category. Although this suggests that the video clips may not have displayed enough variation in the NTS elements and categories in each clip, it may also be a result of difficulties in observing and placing different types of behavior correctly (Graham, Hocking, & Giles, 2010; Rutherford et al., 2015). Lyk-Jensen et al. (2016) suggested that having to rate multiple video clips over a short space of time might prove wearisome (rater fatigue) and thus affect results. To a certain extent, the lack of variance is unsurprising, as poor behavior in one element/category may easily have an impact on behavior in another element/category. For example, poor situation awareness will affect decision-making and prioritizing of tasks, while poor planning may affect team working and situation awareness.

The D-study estimated that one rater could achieve reliable ratings with a generalizability coefficient >0.8, which is acceptable for formative assessments. According to Spanager et al. (2013), a generalizability coefficient >0.9 is recommended for high-stakes assessments for certification purposes. Since there is a need for reliable instruments that can be used for summative assessments to ensure SNAs achieve expected levels of competency as described in the CanMEDs framework, it is encouraging that the D-study estimated that two raters could achieve a generalizability coefficient of 0.91. However, these results were attained rating scripted simulated scenarios. Using a structured assessment instrument to observe behavior of SNAs in clinical settings over longer periods while simultaneously ensuring patient safety, is recognized as far more demanding (Flin, Patey, Glavin, & Maran, 2010).

Acceptability and Usability of NANTS-no

An important factor for the future integration of NANTS-no in anesthesia nursing education is acceptability (Fletcher et al., 2003). Another factor is how easy the instrument is to use. As the aim is to provide a common taxonomy that SNAs, mentors, and other educators can all use to express what is considered excellent anesthesia care, it is positive that NANTS-no is regarded as describing the NTS essential in a nurse anesthetist. The participants also regarded NANTS-no as useful for encouraging SNAs to reflect critically on their performance, as well as aiding mentors in structuring their feedback and providing formative assessments. Objective and specific feedback is particularly necessary when guiding students who are struggling to provide safe anesthesia care (Flin & Maran, 2015). The high percentage of participants that supported this view suggests that NANTS-no would be acceptable as an instrument for this purpose.

Although 56% of the participants stated they were able to identify the NTS in the video clips well or very well, there was a particularly high use of "not observed" scores in the

Team working category. This is surprising as social and interpersonal skills are usually easier to observe than cognitive skills (Flin et al., 2008). The two video clips with the highest mean percentage of "not observed" scores were the two where the expert panel had also used "not observed" for several elements. Even though time was spent on explaining and calibrating the different scores and the use of "not observed," the relative high use of "not observed" for certain elements may have been due to misunderstandings, difficulties in differentiating elements or rater fatigue. Despite this, the overall reliability of the instrument was still estimated as high. A follow-up workshop to clarify these issues would be beneficial prior to using NANTS-no in clinical situations.

Strengths and Limitations

This study has a similar design to several others where participants rated video clips at the end of a workshop. A minimum of 50 participants is recommended for reliability studies (Cicchetti, 2001), but the sample in other similar studies was similar to or smaller than in this study (Lyk-Jensen et al., 2016; Rutherford et al., 2015; Spanager et al., 2013). Despite having slightly less than 50 participants, the sample included all those involved in clinical supervision of the SNAs on which the instrument is to be tested in a follow-up study. Thus, the participants were representative of the group for which the instrument is intended.

It is recommended that training courses for NTS last 2 full days (Hull et al., 2013; Klampfer et al., 2001). Attempts were made to increase both participation and the length of the workshop, but conflicting interests made following recommendations challenging. Other studies also found this impossible to implement due to staffing requirements, cost implications, and effectivity in the operating department (Higham et al., 2019; Lyk-Jensen et al., 2016; Rutherford et al., 2015; Spanager et al., 2013). Another possible limitation was the course not being held by a multidisciplinary team of clinicians and psychologists/human factors experts (Flin & Maran, 2015; Hull et al., 2013), as in some other studies. However, the main researcher who held the course has both clinical expertise and considerable experience with teaching NTS.

It is generally considered to be easier to rate NTS in video clips than in clinical practice (Flin & Maran, 2015). Since the participants were not given any opportunity to rewind the clip, the scripted situations were over as quickly as real-life situations. Other studies have used a larger number than six video clips, thereby providing a greater variety of situations. The video clips in this study were relatively long therefore six was deemed a sufficient number. However, increasing the number or length of the video clips can lead to rater fatigue and affect the results. Rater fatigue could have been lessened by using six shorter video clips, allowing more time for rating or spreading rating sessions over 2 days. However, such changes would either negatively affect the quality of the data or prove difficult to implement owing to organizational constraints.

Although the expert panel did not include a psychologist or expert in human factors, all the members had wide clinical experience as well as experience in teaching, training, or assessing NTS. Knowledge of and experience in the field, inclination and time to participate as well as having effective communication skills, are regarded as the most important qualifications for members of an expert panel (Keeney et al., 2011). Since a classical Delphi approach was not followed to achieve consensus, panel members may have been influenced by each other during the face-to-face discussions. It is also possible that four is rather a small number for an expert panel, though there are no fixed guidelines for size and composition.

The evaluation questionnaire was translated to Norwegian, but a back translation was not deemed necessary since its purpose and content were very simple and the main researcher bilingual.

CONCLUSIONS

This study estimated a high level of reliability and dependability when rating NTS in video clips with the structured behavioral assessment instrument, NANTS-no. The findings suggest that there is a good foundation for further testing NANTS-no in clinical settings as a means of providing feedback and making structured assessments of SNAs. The findings also suggest that it may be useful for encouraging critical reflection in SNAs. Further research is needed to explore its use in clinical supervision.

Relevance to Nursing Practice and Education

This study addressed the need for a formalized training and reliable instruments for use in clinical supervision of SNAs. This research suggests that NANTS-no has high reliability, dependability, and acceptability in the study setting and may be useful as a structured assessment instrument for clinical supervision of SNAs in Norway.

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Paper 2

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Paper 3

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RESEARCH

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Experiences using an instrument for non-technical skills in nurse anaesthesia education: a focus group study

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Abstract

Background: Although there is an increasing amount of research on the use of structured behavioural assessment instruments for non-technical skills in a simulation or clinical setting, there is currently little research into how health-care professionals experience using these instruments. The structured behavioural assessment instrument, Nurse Anaesthetists' Non-Technical Skills-Norway, has recently been introduced to nurse anaesthesia education as a means of developing and assessing non-technical skills in clinical practice. The aim of this study was therefore to explore the experiences of Norwegian student nurse anaesthetists, their mentors and clinical supervisors on using the instrument in clinical practice.

Methods: This study has a qualitative descriptive design. Data was collected through semi-structured interviews with four focus groups comprising twelve student nurse anaesthetists and thirteen mentors and clinical supervisors. The interviews were recorded and then transcribed verbatim. Data was analyzed using qualitative content analysis and an inductive approach.

Results: Six categories were identified that represented the manifest content. One main theme: Forging a path towards clinical excellence was identified representing the latent content, and three themes that described the participants' experiences with using the instrument:

Promotion of excellent non-technical skills: Raising awareness of non-technical skills ensured professional suitability and shaping of a professional identity; internalizing the skills could lead to changes in behaviour.

Promotion of cooperative learning: Mentoring was more structured, based on a common language and understanding and clearly defined roles; measurable progress enabled a more reliable and objective evaluation.

Promotion of organizational acceptance: A lack of familiarity with the instrument, and challenges with scoring and the terminology impeded acceptance.

Conclusion: Increased awareness of non-technical skills when using Nurse Anaesthetists' Non-Technical Skills-Norway contributes to a professionalization of the nurse anaesthetist role and mentoring/learning process in nurse anaesthesia education. Using Nurse Anaesthetists' Non-Technical Skills-Norway promotes the ideal of clinical excellence, not only as an assessment instrument but also by guiding the student's learning process. Despite a high level of commitment to using the instrument there is a need to promote further acceptance in the anaesthetic departments.

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Keywords: Nurse anaesthetist/anesthetist, Non-technical skills, Clinical supervision, Education, Clinical excellence, NANTS-no

Background

Structured behavioural assessment instruments for systematically developing and assessing non-technical skills as a means of enhancing performance and improving patient safety, are still relatively new and used in varying degrees by healthcare professionals [1]. By focusing on human factors, their purpose is to improve individual or team non-technical skills to reduce the risk of errors and adverse events that threaten patient safety [1, 2]. Non-technical skills are described as "cognitive, social and personal resource skills that complement technical skill, and contribute to safe and efficient task performance" [3]. They are regarded as the key to consistently high performance in the best practitioners and are an essential part of being professionally competent [3, 4]. There is increasing interest in the development and assessment of non-technical skills in anaesthesia internationally, but they are currently not systematically incorporated in the nurse anaesthesia curriculum in Norway.

Nurse anaesthesia education, scope of practice and potential for continuing professional development varies widely internationally [5–7]. In Norway, nurse anaesthetists are registered nurses, who have completed either a two-year masters' degree or an eighteen-month post-registration program in nurse anaesthesia. This qualifies them among other things to independently induce and maintain general anaesthesia in patients classified as American Society of Anesthesiologists (ASA) class I or II [6–8]. Nurse anaesthetists work as part of a multidisciplinary surgical team, collaborating closely with anaesthesiologists in particular [8]. During anaesthesia, the nurse anaesthetist is responsible for maintaining homeostasis in the patient, often in acute situations that are both complex and dynamic. This requires high standards of competency and safety as advocated by the International Federation of Nurse Anesthetists (IFNA) [9]. It also demands a level of professionalism that encompasses recognizing and accepting responsibility for maintaining high levels of knowledge, skills, and professional values as well as an active commitment to self-appraisal and continuous professional development [5, 9].

Student nurse anaesthetists (SNAs) learn in clinical practice under the guidance of one or two designated mentors, who are experienced postgraduate nurse anaesthetists that act as role models, facilitating learning by sharing their craft and providing affirmative and formative feedback [10]. A mentor's role involves guiding the SNAs through complex, dynamic and critical situations, while simultaneously ensuring that the patient receives optimal standards of anaesthesia care. The mentor is also responsible for carrying out assessments together with a clinical supervisor to ensure that the SNA has acquired the necessary skills [11]. Clinical supervisors act as a bridge between the educational and healthcare institutions. Their responsibilities include overseeing and organizing clinical practice for all the SNAs at a healthcare trust, teaching and supporting the SNAs and their mentors. Since clinical practice comprises a major part of the training, clinical supervision is an integral part of nurse anaesthesia education. Although some countries have national standards for mentoring, these do not currently exist in Norway, and a large number of nurse anaesthetists involved in clinical supervision lack formal training [12, 13].

The relationship between student and mentor plays an important role in both facilitating the SNA's learning and strengthening professionalism [13, 14]. In order for SNAs to flourish, they need to be treated as equal partners in a relationship where dialogue and critical reflection can enhance learning [13, 15]. This kind of cooperative learning can be defined as "a set of processes which help people interact together in order to accomplish a specific goal or develop an end product which is usually content specific" [16]. While collaborative learning is often used to describe peer or group learning that occurs through social interaction, observation of more knowledgeable others and scaffolding [17], cooperative learning is more closely directed by a teacher or mentor [18]. However, cooperative and collaborative learning share several common assumptions regarding active learning. These include the mentor acting more as a facilitator, learning that is based on the mentor's and student's shared experiences, students taking responsibility for their learning and discussion that aids critical reflection [18].

Traditionally, SNAs' learning in clinical practice has focused on specialized technical skills, however in recent years there has been increasing international awareness of the importance of non-technical skills in providing safe anaesthesia [2]. Facilitating a systematic development of non-technical skills in SNAs is dependent on several factors. The right conditions for learning must be created; a highly challenging but safe environment that stimulates active rather than passive learning [15]. There is also a need for a standardized conceptual model with a common taxonomy for observing, discussing and assessing clinical competencies in SNAs in order to provide

feedback on areas that need addressing [19]. This kind of formative feedback is an integral part of the teaching/learning process and contributes to changing behaviour and developing expert skills [20].

Several educational and healthcare institutions in Norway have adopted the Nurse Anaesthetists' Non-Technical Skills – Norway (NANTS-no) structured behavioural assessment instrument as a means of providing formative feedback, encouraging critical reflection, and developing and assessing SNAs' non-technical skills. NANTS-no is a behavioural marker system that has a hierarchical structure with four categories and fifteen elements (Fig. 1). Each element has behavioural markers with examples of good and poor behaviour. The instrument also has a 5-point behavioural rating scale (1–5) for non-technical skills, where 1 corresponds to behaviour that puts the patient's life at risk and 5 corresponds to excellent behaviour.

NANTS-no was adapted from Anaesthetists Non-Technical Skills (ANTS) in 2014 to reflect the setting in which nurse anaesthetists work in Norway [21] and was originally intended for use by qualified nurse anaesthetists in professional development. However, it has been also tested for use in nurse anaesthesia education in Norway and demonstrated a high level of reliability (ICC = 0.8, Cronbach's alpha > 0.9) and dependability (G coefficient = 0.83) [22, 23]. In addition to ANTS, there are similar instruments for other professions, such as anaesthetic practitioners, surgeons and scrub nurses [1].

NANTS-no has been used in clinical practice over the past few years at the university where this study was held, by both the SNAs and those involved in clinical supervision at the healthcare trusts. It is intended to be used as a means of self-assessment by the students and in evaluations by the mentors and clinical supervisors, where non-technical skills are rated according to the skills expected of a qualified nurse anaesthetist. Moreover, it has a formative purpose to aid feedback in clinical supervision. As part of their education, the SNAs are taught about the importance of non-technical skills and the use of NANTS-no prior to clinical practice.

Although there are a growing number of studies where non-technical skills are assessed in a simulation or clinical setting [1], there is currently little research describing how healthcare professionals experience using structured behavioural assessment instruments in clinical settings [24]. NANTS-no was tested for reliability prior to use in clinical supervision [23], and then used to demonstrate the development and assessment of SNAs' non-technical skills during nurse anaesthesia education [11]. It was therefore considered important to gain an understanding of how mentors, clinical supervisors and SNAs experienced using the instrument. Thus, the purpose of this study was to explore both the instrument's usefulness and

Fig. 1 The NANTS-no structured behavioural assessment instrument

usability in a new area, that of nurse anaesthesia education. Since there is a little research into users' experiences with instruments for non-technical skills, this study may also provide useful information for other fields.

Aim

The aim of the study was to explore the experiences of Norwegian student nurse anaesthetists, their mentors, and clinical supervisors with using NANTS-no in clinical practice during nurse anaesthesia education.

Methods

Design and setting

This study has a descriptive qualitative design [25]. Data was collected through semi-structured interviews with four focus groups [26] and analyzed using qualitative content analysis [27]. Focus group methodology was chosen as a means of gaining rich insight into the participants' experiences using the instrument [28, 29]. It was assumed that interaction within the focus groups would provide richer data than individual interviews, by creating a synergy where shared and contradictory viewpoints would lead to a new and deeper understanding of the research subject [26].

The study was conducted at a Norwegian University, which has a two-year masters' program in nurse anaesthesia (120 ECTS). Clinical practice comprises 45 ECTS of the course, and the University has clinical placements at a number of healthcare trusts in Norway. SNAs are assigned to an anaesthetic department in one of the healthcare trusts for clinical practice and mentored by qualified nurse anaesthetists with experience in the field. The majority of mentors and clinical supervisors attended a six-hour training session prior to the SNAs starting their clinical practice [30].

Participants

A purposeful sampling strategy was used for recruiting participants that had experienced using NANTS-no and ensure maximum variation in the sample [26, 31]. SNAs from two different student cohorts as well as nurse anaesthetists involved in mentoring and clinical supervision of the students were invited to take part in the study. To ensure heterogeneity in the sample and different experiences, the SNAs were recruited at different stages in their education [26]. One cohort had just completed their first period of clinical practice while the other had completed all their clinical training. Purposeful sampling of the nurse anaesthetists involved in clinical supervision ensured variation in workplace, sex, and level of experience [31].

All participants were contacted directly via an email containing information about the study. Twelve SNAs agreed to participate, six from each cohort with an equal number of male and female participants in each group. The SNAs had been on clinical placement at seven different healthcare trusts. Thirteen nurse anaesthetists involved in clinical supervision also agreed to participate, representing five healthcare trusts. Several of those contacted showed interest in the study but were unable to attend owing to staffing and other difficulties. The thirteen participants included a mixture of mentors and clinical supervisors and formed two focus groups with eight participants in one group and five in the other. There was only one male in each group, and the participants had a range of two to thirty years' experience as a nurse anaesthetist.

Sample size was guided by an appraisal of the study's information power [32]. Although Malterud et al. state that their concept for guiding sample size is more ambiguous for focus group interviews, a critical appraisal of the study's aim, sample specificity, use of theory, quality of interview dialogue and analysis strategy to determine information power was seen as a means of strengthening validity. Based on a provisional assessment of these criteria for determining information power and achieving data saturation, four focus groups were presumed adequate [26, 33]. This assessment was confirmed based on the dialogue quality in the interviews, which provided the multiple viewpoints and rich variations in data necessary for content analysis [33, 34]. Since the last focus group provided no new data, saturation was assumed.

Data collection

Data was collected over a period of eighteen months between April 2019 and September 2020. This was in order to gain access to a new cohort of students and a richer data. All the interviews were held in one of the meeting-rooms at the University to avoid interruptions, with the first author acting as moderator. Two of the co-authors took the role of assistant moderator, S.T for three of the interviews and P.B-J for the fourth. Written consent was obtained from all participants at the start of each focus group. The interviews lasted between 56 and 84 min and were recorded using a university-owned audio recording-device.

A semi-structured interview guide with four open-ended questions was prepared in advance. The questions were designed to meet the purpose of the study and explore the usefulness and usability of NANTS-no in clinical practice. The interview started with the moderator asking a general question to start the conversation: "Can you tell me a bit about your experiences using NANTS-no as an assessment instrument in clinical practice?" The follow-up questions were more specific, asking participants to explain how they used NANTS-no, as

Table 1 Illustration of the analysis process from meaning unit to sub-category

Meaning unit	Condensed meaning unit	Code	Sub-category
I realized that this covers much of what we do all the time, what we have done as a nurse anaesthetist the past 30 years, that you always have done…it is just putting it into words	It covers much of what we do as a nurse anaesthetist all the time and have always done. It has just put it into words	Putting into words what a nurse anaesthetist does	Providing a vocabulary for tacit skills
It's about being able to take over the role that is the function of a nurse anaesthetist… when the mentor is there too. Daring to take that responsibility… that's asking a lot of students, it's asking a lot	It's about taking over the role and function of a nurse anaesthetist while the mentor is still there. Daring to take that responsibility, it's asking a lot of students	Daring to take over the role and responsibility	Changing behaviour
Since the examples and numbers make it more concrete and measurable, it makes it easier than just the mentor's gut feeling or view of what a student should be like	Measurable concrete examples and numbers make it easier than a mentor's gut feeling or view of what a student should be like	Measurable evaluation, not the mentor's gut feeling	Objectivity
I think it's a more of a problem for my mentor to give me a low score than for me to give myself a low score	more problematic for mentor to give a low score than for me	Easier for student to give a low score	Scoring barriers

well as in what ways it might be used to enable critical reflection and dialogue in the learning process.

The SNAs in the two student focus groups all knew each other and the discussion flowed easily with participants sharing experiences and disagreeing with one another. This highlighted similarities and differences in their experiences. The two focus groups with mentors and clinical supervisors were more heterogeneous including representatives from several different healthcare trusts. Although some of the participants were unknown to each other, group interaction in the first group was lively with many of the participants eager to share their experiences. Interaction in the second group however was more constrained, with some participants needing to be prompted to contribute to the discussion. It is unclear why this was the case, but it did not noticeably affect the rich description of their experiences. Humour and laughter played a role in all the groups as a means of easing social constraints and underlining shared experiences [26].

Data analysis

The interviews were transcribed verbatim and then analyzed using Graneheim and Lundman's qualitative content analysis [27]. Content analysis is a systematic method for analyzing qualitative data that highlights similarities within and differences between the data. It enables the analysis of both descriptive (manifest) data and interpretative (latent) data that results in categories and/or themes [27].

An inductive approach, which involved immersing oneself in the data was used to search for patterns in the texts and involved a series of steps. First, the transcribed texts were read through several times to gain an initial overview over the data. Any interesting quotes were marked, and notes/comments were made in the margin. The first author also made a flow diagram describing her current understanding of the texts [35]. The next step involved de-contextualizing the data by extracting quotes from the transcribed texts, so-called meaning units, condensing them without altering their meaning, and then assigning them codes [36]. Similar codes were then grouped together into eighteen sub-categories and six categories that represent the manifest content of the interviews. This process was not linear but involved discussion between the authors and movement back and forth between the different parts and the text as a whole. An example of the analysis process is presented in Table 1.

Next followed a process of reflection and discussion on the underlying meaning in the categories to abstract and interpret latent content in the data and go beyond the participants' actual words. This is often a balancing act with regard to the level of abstraction and degree of interpretation [27, 37]. The categories separated themselves into three specific areas; the way in which use of NANTS-no heighted awareness relating to non-technical skills and professional expertise, the way in which it directly contributed to the mentoring and learning process, and implementation and acceptance of the instrument in clinical practice. Three themes with a relatively low level of abstraction and degree of interpretation were then formulated to describe these areas: Promotion of excellent non-technical skills, Promotion of cooperative learning and Promotion of organizational acceptance. A main theme Forging a path towards clinical excellence, with a higher level of abstraction was formulated to encompass the themes and can be interpreted as the latent content or common thread running through the texts [36].

Ethical considerations

Approval from the Norwegian Centre for Research Data (project no. 854411) was granted on 7.12.2018 and was sufficient for this study [38, 39]. The participants were first informed in writing. At the start of each focus group, the concepts of informed consent, voluntary participation and the right to withdraw without penalty were also carefully explained, in accordance with the Declaration of Helsinki [40] and national guidelines [39]. After time for consideration, informed consent was obtained from all the participants. Since the first author was in a position of authority as program coordinator of the master's program in nurse anaesthesia, knew all the participants and contacted them directly, it was important to ensure they did not feel coerced [31, 41]. Her role as a researcher in this context was therefore carefully explained, and one of the co-authors assisted at each interview to strengthen credibility. Participants were also informed about requirements regarding confidentiality, data anonymity and secure handling of data.

Results

NANTS-no was experienced by the participants as a means of promoting excellent non-technical skills and cooperative learning in nurse anaesthesia education. There was however a need for promoting organizational acceptance of the instrument in the working environment. The findings were interpreted as NANTS-no helping to Forge a path towards clinical excellence. A summary of the categories and themes is presented in Fig. 2, and the results are presented for each of the three themes in the text that follows.

In order to demonstrate differences and nuances in the way in which the SNAs, mentors and clinical supervisors experienced using the instrument, quotations are attributed to the relevant participant instead of to the focus group using abbreviations and numbers, for example,

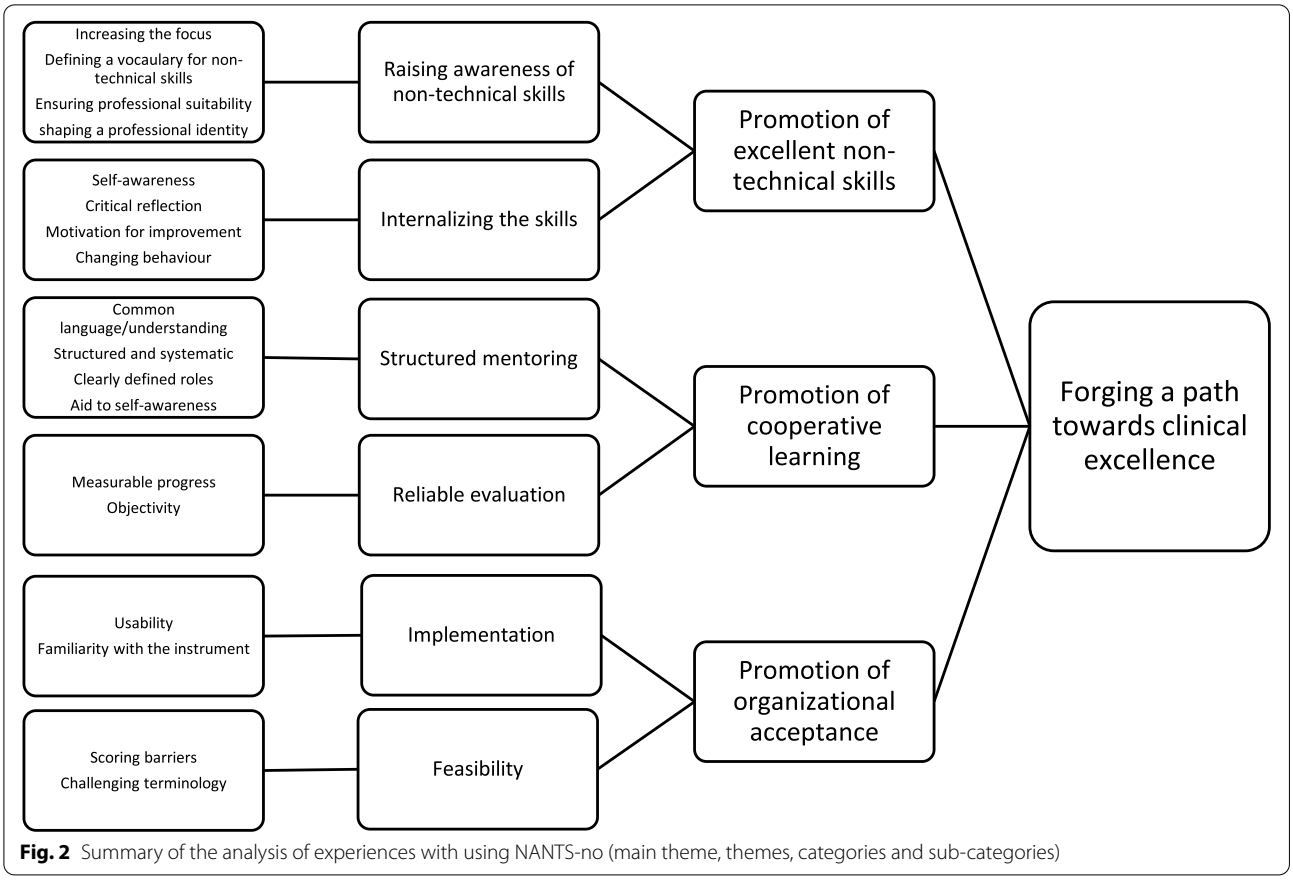

Fig. 2 Summary of the analysis of experiences with using NANTS-no (main theme, themes, categories and sub-categories)

student nurse anaesthetist (SNA1), mentor (M6) and clinical supervisor (CS2).

Promotion of excellent non-technical skills

The participants described using NANTS-no as promoting excellent non-technical skills in student nurse anaesthetists, by raising awareness of the importance of these skills in anaesthesia and helping the students to internalize the skills.

Using NANTS-no was seen as raising awareness by shifting the focus in nurse anaesthesia education to include non-technical skills and providing a vocabulary for these tacit skills. In this way NANTS-no highlighted the skills that were expected of a nurse anaesthetist in their daily work:

> *"I realized that this covers much of what we do all the time, what you have done as a nurse anaesthetist for the past 30 years, what you have always done…it is just putting it into words." (M5)*

Non-technical skills were experienced as being a part of their professional identity and role as a nurse anaesthetist. However, since non-technical skills could also be regarded as something personal, being judged on behaviour could sometimes be an uncomfortable experience. The mentors and clinical supervisors regarded NANTS-no as a means of ensuring professional suitability and that future colleagues had the right skill-set. One mentor commented that there was no room for poor nurse anaesthetists in such a responsible job, while becoming the same kind of nurse anaesthetist as their mentor was not necessarily seen as a goal by the SNAs. By focusing on non-technical skills, NANTS-no was seen as shaping professional behaviour, and providing a standard of excellence for which to strive throughout their career.

The participants regarded the process of SNAs internalizing these skills as one involving self-awareness and critical reflection, which could then motivate towards changes in behaviour. The first step was for SNAs to become aware of their own strengths and weakness. According to the mentors, the level of self-awareness in SNAs varied, and some took longer than others to gain sufficient insight. The SNAs described using NANTS-no to reflect critically on their clinical progress and align their own view with their mentor's observations.

> *"It's about knowing yourself. Whether your behav-*

iour is on target or way off the mark. Whether you see yourself as others see you. That is not a given, you know" (SNA2).

NANTS-no was experienced as aiding self-awareness by opening the way for a process of dialogue and reflection which could act as a catalyst for enabling change in the SNAs. Many SNAs felt that being rated with a low score and given tangible examples of what needed improving was motivational for both personal and professional development. However, not all the SNAs agreed on this. It was also important to receive encouragement and positive feedback about what they were proficient at.

Changing behaviour was regarded by some mentors as potentially challenging, as it required motivation and willingness to make the necessary effort. A positive aspect of NANTS-no was the way it aided the mentors in making students aware of how they could make changes without it being regarded as criticism of their personality. This was because negative feedback was based on the instrument, not the mentor's opinion.

"I really wish we had an instrument like this when I was doing my training. I was a quiet, timid kind of person who didn't dare do much, and my student is just the same. We looked at the team-working category [in NANTS-no], which states you have to take on a role and speak loudly and clearly. So, I wasn't pointing out something negative about her as a person, or her personality. This was something important." (M1)

The SNAs described various ways in which they actively worked on improving their non-technical skills, such as taking the lead in an acute situation, being more assertive or trying to be a supportive team-member. However, at the start of their training they regarded it as important to concentrate on just a few NANTS-no elements, then gradually increase the number when they felt ready.

Promotion of cooperative learning

The participants described using NANTS-no as promoting cooperative learning by enabling both a more structured mentoring process and reliable evaluation of SNAs.

The SNAs experienced NANTS-no as providing a common language for non-technical skills, which made it easier for mentors to follow their progress. Furthermore, it was seen as facilitating a common understanding of what was being observed and assessed.

"We do it together, the assessment. Both of us have the same points that we are assessing – what was your assessment, what was mine, how can we help me to learn these things? So, it's a kind of professional partnership" (SNA12)

By comparing and discussing their assessments, the mentors and SNAs felt they gained a shared understanding of the student's clinical progress. According to one of the focus groups, this resulted in a more structured and systematic approach to mentoring. Using NANTS-no enabled the mentors to give the students structured feedback and use their time more efficiently, while simultaneously ensuring that they observed and assessed the students' non-technical skills.

"I have become very aware of these things myself and use NANTS for all it's worth as a mentor." (M1)
(sounds of agreement)
"That's also what I meant when I said I felt like I have more time. There aren't any more hours in the day, but it makes it easier to use the few available gaps in between." (M3)
"In a more structured way, perhaps?" (M2)
(sounds of agreement)
"Because you are able to identify faster the areas, you actually want to… reflect over." (CS1)

By making the mentors more aware of how they worked together with their students, NANTS-no was seen as changing the way in which they mentored their students. Nevertheless, as one SNA pointed out, whether NANTS-no was used as a mentoring aid was dependent on the mentor. Some mentors still preferred to do things the way they had always done them. The SNAs regarded NANTS-no as contributing to a clearer definition of roles in the mentoring process: "I think it's a good thing that my mentor is my mentor and not my best friend" (SNA12). They differentiated between the mentor's and clinical supervisor's role. Since the supervisor only worked with the students occasionally rather than daily like the mentors, they were regarded as potentially having a different overall view of the students' progress.

In order to understand what was expected of them at a specific level, the SNAs wanted constructive and specific feedback. By providing tangible examples to explain their assessment, the mentors described using NANTS-no to illustrate where the students demonstrated proficiency as well as to point out what needed improving.

"We sat together, me, my mentor and the clinical supervisor, and went through NANTS. They gave me specific feedback about what they thought I needed to work on. So, in that way I think you learn more than when I took my nursing degree, the feedback then could be rather diffuse and general." (SNA5)

This kind of structured feedback was regarded as valuable by the SNAs in aiding them to work systematically on improving their non-technical skills. Although the mentors considered NANTS-no made it easier to give

negative feedback, the SNAs felt it was difficult for a mentor to be honest when a student had very poor skills.

Although assessing behaviour was regarded as new and unfamiliar by the participants, NANTS-no contributed to a reliable evaluation of the SNAs skills by demonstrating a measurable progress and increasing the objectivity of the evaluation. Regular use of the NANTS-no rating scale made the SNAs' progress more visible to both the students and their mentors, although some mentors felt that the actual score was not as important as the direction in which it pointed.

Both the SNAs and mentors discussed whether it would be less confusing to use NANTS-no to assess a student's non-technical skills at the end of each training period in relation to an expected level, rather than as a scale for the whole training. However, using the same scale to measure the SNAs' progress throughout their training was regarded as one of the most valuable aspects of the instrument.

> *"... look we agreed that the scale should maybe be organized to score each period, but if one looks at it as an evaluation instrument for the whole training, it's an advantage to have one scale for the whole thing" (SNA7)*
> *"Yes. I don't think there is any point having one score for ... one dividing it up to rate each period, because you won't get an overall view then" (SNA11)*

The SNAs experienced being evaluated with NANTS-no as less subjective than other clinical evaluations because they were all evaluated on the same objective criteria in a systematic way. This ensured that an evaluation measured their progress more fairly, and was not based on the individual mentor's hang-ups, gut feelings, or on personal chemistry. However, some SNAs felt that rating skills did not necessarily make the evaluation more objective as a score could always be influenced by the mentor's or supervisor's impression of the SNA. The mentors confirmed that they found it difficult to be completely objective when they worked with the student daily, although using NANTS-no encouraged them to reflect over their own behaviour in a more objective way. Nonetheless, they regarded NANTS-no as particularly useful for exemplifying why an SNA failed to pass his or her clinical training.

Promotion of organizational acceptance

The participants described promoting acceptance of NANTS-no as an ongoing process that encompassed the practicalities and feasibility of implementing the instrument in the anaesthesia departments.

Implementation was regarded as dependent on the instrument's perceived usability and nurse anaesthetists' familiarity with it. NANTS-no's schematic format was described as well organized, giving a complete overview of a nurse anaesthetist's non-technical skills. Although the SNAs described NANTS-no as compact and requiring little effort to use, many of the mentors found it overwhelming at first. The full-version contained a large amount of text, but this was regarded as necessary to use it optimally. Various participants commented on overlap in some of the NANTS-no elements and categories that hindered familiarization, although the examples of good and poor behaviour helped to clarify the meaning of the elements. However, the participants were generally positive to using NANTS-no.

A major impediment to implementation was seen as lack of familiarity with the instrument, both on an individual and departmental level. Some participants commented that it was only used on "high days and holidays", and it was like starting afresh each time:

> *"I would really like to use it a bit more, so I've got it under my skin, because I have to go back and look at the elements to see how to score them. I don't always remember them well enough, so it's a bit difficult to use it «bedside» without having the instrument with you... but it's probably a case of practice. If you use it enough, then it will sit properly" (CS4)*

Participants experienced that NANTS-no worked well once they were familiar with the instrument, and using it regularly increased their proficiency. The mentors felt that the SNAs had a higher degree of familiarity, and there was a need for better training in the use of NANTS-no. It was also problematic that the instrument was not properly implemented in the anaesthetic department. Gaining acceptance for NANTS-no was described as a maturation process that would take time.

The feasibility of implementing NANTS-no was challenged by scoring barriers and the instrument's terminology. Rating behaviour and interpersonal skills was regarded as strange and unfamiliar. The mentors regarded it as challenging since providing anaesthesia is a complex process, and an SNA might demonstrate good situational awareness, then miss a small detail that pulled their score down. Using the rating scale to assess whether a student should pass at the end of their training, however, was seen as meaningful. The mentors also expressed concerns about making false judgements and setting too low a score, particularly during the first period of training. It was therefore often easiest to select a score in the middle of the scale.

Although SNAs found using the rating scale became easier over time, it was often difficult to give themselves a high score.

"We find it a bit challenging to put a number on ourselves. At least in my opinion, it's not always so easy. One is maybe a bit too cautious or too daring rating some of the elements." (SNA4)
"It has something to do with the Norwegian spirit of egalitarianism, if you like" (SNA1)

Some mentors agreed that the SNAs rated themselves lower than their mentors. However, one clinical supervisor considered that the SNAs understood the rating scale well and were realistic in their self-assessments. She found it surprising that assessments made by three different people often ended up being very similar.

A further challenge for the mentors was using NANTS-no to compare students to a qualified nurse anaesthetist, particularly during their first clinical training period when they could only expect low scores. They accepted however that the SNAs understood the system and found it less problematic. In addition, the terminology in the rating scale was seen as problematic, as the use of «N—not observed» was unclear while some of the rating descriptors at the lower end of the scale such as «poor» or «marginal» were regarded as both harsh and demotivating. However, this was not mentioned as a problem by the SNAs.

Discussion

The findings in this study provide the first insights into how the structured assessment instrument NANTS-no is experienced, and its usability and usefulness in clinical practice. On a higher level, the study illuminates the way in which using NANTS-no appears to trigger processes and reflections that contribute to the professionalization of both the nurse anaesthetist role and the learning/mentoring process. Although the instrument has not been completely accepted in the challenging environment in which nurse anaesthetists work, there appears to be a high level of commitment to using NANTS-no. These insights may have a transferability value for other healthcare professions interested in integrating a systematic development and assessment of non-technical skills in clinical practice.

Using NANTS-no was described as raising awareness of the importance of non-technical skills. It also provided a tangible and more objective standard of excellence by which SNAs could measure their skills and mentors could determine whether they met expected criteria. The development of non-technical skills is closely interwoven with ideas of professionalism and clinical excellence, which has been an aspirational goal in anaesthesia for the past decade [20, 42]. Aspects of professionalism such as ensuring a high level of knowledge, skills and professional values when delivering patient-centred care, were regarded as prerequisites by the focus groups [5, 9]. Non-technical skills combine these various elements of professional practice into "a coherent performance" [4, 42], ensuring excellence and patient safety.

In the first theme, using NANTS-no to develop excellent non-technical skills was seen as the measure for distinguishing a good nurse anaesthetist from an excellent one. Although the mentors were regarded in general terms as role models, not all the SNAs wanted to model their behaviour on their mentor, as having excellent non-technical skills was not dependent on years of experience. Professionalism includes an active commitment to self-appraisal and continuous professional development [9]. Thus, personal and organizational factors played a significant role, along with the desire to continually improve one's professional practice [42, 43]. Using NANTS-no also aided the participants in differentiating between the nurse anaesthetist's role as a professional and private person. Behavioural skills are often regarded as closely associated with an individual's personality [3], therefore being judged on behaviour could be uncomfortable. However, the participants accepted that the purpose of NANTS-no was changing behaviour and improving skills essential to providing safe anaesthesia care, rather than modifying personality [3].

An important aspect of the mentoring role was seen as determining the SNAs' professional suitability and aiding them in developing a professional identity as nurse anaesthetists. Therefore, having an instrument that could be used as a means of determining the level of non-technical skills and thus professional suitability was considered a crucial aspect, and one that is relevant in many other healthcare professions. The nurse anaesthetist's professional identity is described as both mechanistic and supportive, with the nurse anaesthetist protecting and preserving the patient's integrity and autonomy while monitoring and optimizing physiological functions in a highly technical environment as she "holds the patient's life in her hands" [44–46]. The complexity of the role and level of responsibility require highly developed non-technical skills such as situation awareness, decision-making, communication and teamwork [22].

Promoting excellent non-technical skills also involved the SNAs internalizing these skills, a process where the behaviour and attitudes of mentors and supervisors were incorporated through learning or assimilation and facilitated change. In the past, non-technical skills have often been addressed in an unstructured manner, lacking a taxonomy that articulated and assessed them systematically [19, 21, 22]. By providing a vocabulary for the tacit qualities of professional expertise, NANTS-no enabled discussion of what the nurse anaesthetist role actually comprises, promoting both excellence and patient safety

[42]. A study using a structured assessment instrument for scrub nurses (SPLINTS-no) described heightened awareness as a result of providing a vocabulary for non-technical skills [24]. Articulating their non-technical skills raised the SNAs' awareness of their own strengths and weaknesses, providing them with the means and motivation to change their behaviour and address any problems. However, internalization of non-technical skills depended on self-awareness, and this was seen as varying. Particularly, when a SNA had difficulties developing clinical skills, a lack of self-awareness and inability to use NANTS-no as intended, was seen by the mentors as contributing factors.

In the second theme, the promotion of cooperative learning was seen as encouraging reflection and critical awareness and depends on a culture of mutual trust and respect, where there is shared responsibility for both the process and the outcome [15, 18]. By enabling a clear definition of roles in the mentoring/learning process, using NANTS-no enabled more objective evaluations as personal chemistry between the student and mentor influenced the outcome to a lesser degree. Furthermore, NANTS-no provided objective criteria for discussion which encouraged cooperation and critical reflection through dialogue. Using the instrument to discuss and articulate their strengths and weaknesses with their mentor and supervisor, heightened the SNAs self-awareness while motivating them to behavioural change [18, 20]. This kind of cooperative learning where the SNA is treated as an equal and a colleague, stimulates professional growth [13].

Using NANTS-no also enhanced the mentoring process by demonstrating a measurable progress and enabling the mentors to give structured and constructive feedback with tangible examples of the SNAs proficiency and what needed to be improved. Addressing behavioural skills and elucidating lack of proficiency can be challenging. However, since feedback was based on the instrument rather than criticism of personal characteristics, NANTS-no was seen as contributing to a more objective and professional form of clinical supervision [24].

Although mentoring students and ensuring sufficient time for reflection was regarded as high priority, the operating room was described as a challenging work environment with production pressure and patient safety conflicts [12]. NANTS-no's systematic structure was seen as supporting the mentors in their role and facilitating a more effective use of the time available for reflection and dialogue. Interestingly, using NANTS-no also made the mentors more aware of their own professional behaviour, so that it changed the way some of them supervised their students. An increased awareness of the importance of non-technical skills as well as developing their professional role as a nurse anaesthetist and mentor is in line with the IFNA standards [5, 9]. Mentors using SPLINTS-no when supervising student scrub nurses also experienced increased levels of confidence in their role [24].

Instruments such as NANTS-no can promote cooperative learning and develop expert skills by providing a structure for critical reflection, giving formative feedback, and assessing professional behaviour [11, 19, 42]. As one participant stated, using NANTS-no strengthens the professional partnership between student and mentor. However, the pursuit of professionalism in clinical supervision necessitates a commitment to promoting it at all levels in nurse anaesthesia education [20]. It requires among other things a teaching/learning process that encourages active learning, self-reflection and professional growth [20, 43]. Clinical supervision also needs to be a prioritized role supported by formal training programs that facilitate excellent teaching by expert role models, rather than ad-hoc solutions [12, 13, 20].

In the third theme, use of NANTS-no in clinical practice was to a certain extent impeded by the instrument not being fully accepted in the anaesthetic departments. Although generally positive, many nurse anaesthetists were still unfamiliar with NANTS-no, which meant that SNAs were not supervised in the same way if their mentors were not present. A lack of familiarity with non-technical skills and challenges introducing similar structured assessment instruments has been seen in other healthcare professions [24, 47]. In addition, the terminology and use of the rating scale in NANTS-no were seen as negative factors, particularly as rating behavioural skills was unfamiliar. While the mentors expressed concerns that they might rate a student's skills too low and potentially affect their educational progress, the students were concerned that they might overrate their own skills. This finding was in line with the previous study where the students significantly underrated their non-technical skills [11].

Organizational factors play a major role in ensuring further implementation of this instrument [46]. There is a need for closer cooperation between educational and healthcare institutions to ensure a better understanding of the importance of non-technical skills and promote acceptance and implementation of NANTS-no. To aid this process, educational institutions need to provide sufficient training in observation and assessment of non-technical skills and the use of NANTS-no for clinical staff [30, 47]. Similarly, the anaesthetic departments need to ensure sufficient time for reflection, dialogue, and formative feedback to promote use of NANTS-no and aid SNAs' professional development.

Methodological considerations

Trustworthiness in qualitative empirical research is described as encompassing the concepts of credibility, dependability, confirmability and transferability [48]. It should be apparent in all aspects of the research process to ensure the study's integrity [34]. The first author's role in the master's program in nurse anaesthesia at the University and involvement in clinical supervision, in addition to being partially responsible for adapting NANTS-no for use in nurse anaesthesia education in Norway [22] and implementing it at the University, has an impact on the study's trustworthiness. Her pre-understanding of the context in which the students learn and of the instrument itself, strengthens the study's credibility by enabling the recruitment of heterogeneous focus groups of relevant individuals with varying experience in using the instrument. This ensured rich variations in the data, which is an important aspect in content analysis [34]. However, the fact that the focus groups were all connected to the same university where the instrument was first adapted and tested may be considered a limitation.

The credibility and dependability of the study may be threatened owing to the first author's role as a figure of authority and her involvement in recruiting the participants, collecting and analyzing the data [41]. Attempts were made to democratize power relations by informing the participants about the first author's role as a researcher in this context to avoid feelings of obligation or coercion [41]. In addition, the first author's role in adapting the instrument may have acted as a bias when interviewing the focus groups and analyzing the data. Attempts were made to counterbalance the first author's pre-understandings and any potential bias, by the co-authors assisting in conducting the interviews and carrying out open discussions at all levels while analyzing the data [27]. Since the remaining authors are not in any way involved in the clinical side of the master's program in nurse anaesthesia, this gave them a more open and questioning approach to abstracting and interpreting the data [34].

A possible limitation was the interviews being transcribed by someone outside the research team rather than the researchers. Although this person is regularly employed by the University in this capacity, it may have affected the authors' analysis and interpretation of the data. However, the authors attempted to immerse themselves in the data by reading the transcripts through while simultaneously listening to the audio files to ensure no valuable data was lost, and to form an impression of the interaction between the participants. Reporting group dynamics in the focus groups, differences of opinions, and how opinions were modified through discussion and consensus achieved, strengthens the study's dependability [28, 29].

One aspect of strengthening credibility is reporting the way in which data is analyzed and whether the meaning units, categories and themes provided an answer to the study's aim. Another is striving to prevent incongruence between the degree of interpretation and level of abstraction occurring during data analysis, which could threaten creditability [36]. Being aware of pre-understandings and encouraging a reflexive approach to data collection and analysis strengthens confirmability and the overall trustworthiness of the study. An important aspect of confirmability is that the researchers have taken care to ensure the participants' voices are heard by using representative quotes to illustrate the findings in the study. However, a possible threat to trustworthiness is that the participants were not invited to read the results and confirm that they recognized the findings presented in the study. In order to determine the transferability of the study a thorough description of how participants were selected, data collected, and the analysis process has been provided [27].

Conclusion

This study has provided new insights into how the use of NANTS-no is experienced in clinical practice and highlights challenges with using the instrument in nurse anaesthesia education. By increasing awareness of the importance of excellent non-technical skills, using NANTS-no appears to enhance professionalism in the nurse anaesthetist role and promote the ideal of clinical excellence in nurse anaesthesia. It also appears to promote a professional partnership in the mentoring/learning process by clearly defining roles, providing objective criteria for measuring progress, and encouraging cooperation, critical reflection, and dialogue. Heightened self-awareness can lead to change in behaviour and professional development. In this way NANTS-no appears to be useful not only for assessing non-technical skills in nurse anaesthesia education, but also as a means of learning these skills. This study's findings may therefore be relevant for training other healthcare professionals in non-technical skills. Despite a generally positive attitude towards NANTS-no, ensuring regular use remains challenging, and there is a need to look at improving the terminology and use of the rating scale to promote further acceptance.

Abbreviations

ANTS: Anaesthetists' Non-Technical Skills; ASA: American Society of Anesthesiologists; IFNA: International Federation of Nurse Anesthetists; NANTS-no: Nurse Anaesthetists' Non-Technical Skills-Norway; SNA: Student nurse anaesthetist; SPLINTS-no: Scrub Practitioners' List of Intraoperative Non-Technical Skills-Norway.

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Authors' contributions
F.M.F designed the study, collected, analyzed and interpreted the data and drafted the paper. B.T.V was involved in designing the study, interpreting the data, and revising the paper. P.C.B-J was involved in designing the study, collecting the data, and revising the paper. A.M.L was a major contributor to interpreting the data and revising the paper. S.T was heavily involved in all stages of the process—study design, data collection and interpretation, and revising the paper. The author(s) read and approved the final manuscript.

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Availability of data and materials
The datasets generated and analyzed during the current study are not publicly available due to reasons regarding confidentiality and anonymity but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study has been carried out in accordance with the Declaration of Helsinki and national guidelines for research ethics. All participants provided informed consent. The Norwegian Centre for Research Data assessed the study to ensure it followed regulations regarding person and data protection (project no. 854411). The study was deemed exempt from approval from the Regional Committees for Medical Research Ethics South-East Norway (reference number 464357) in accordance with the Act on Medical and Health Research 2008 [49].

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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Publisher's Note

Appendices

Appendix 1: Nurse Anaesthetists' Non-Technical Skills – Norway (NANTS-no)

Appendix 2: Questionnaire from John Rutherford used in Study I

Appendix 3: Translated questionnaire used in Study I (Norwegian)

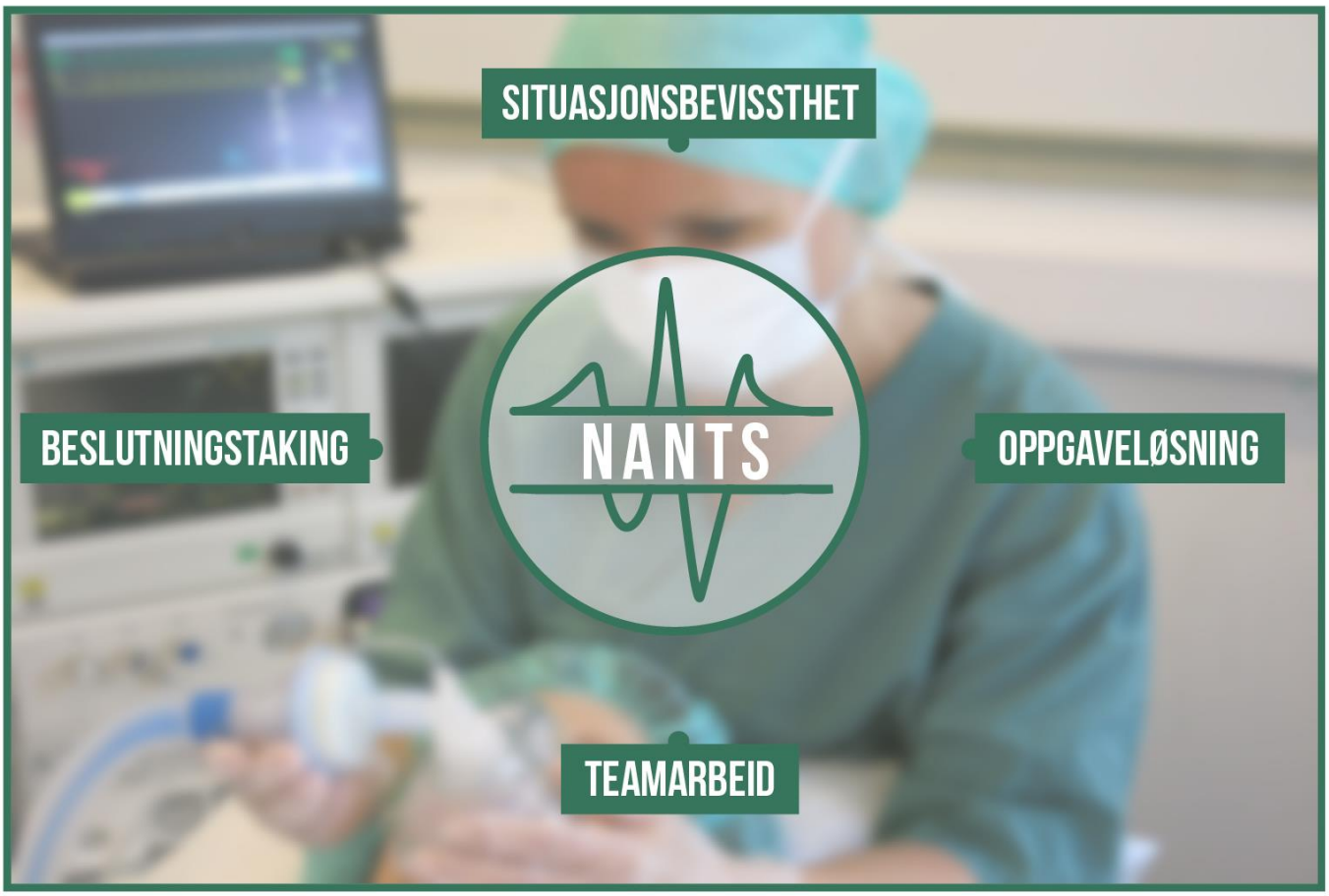
Appendix 4: NANTS-no rating form used in Study II

Appendix 5: Semi-structured interview guide (students) used in Study III (Norwegian)

Appendix 6: Semi-structured interview guide (mentors) used in Study III (Norwegian)

NANTS-no

VURDERING AV ANESTESISYKEPLEIERNES IKKE-TEKNISKE FERDIGHETER



ANTS (Anaesthetists' Non-Technical Skills) er opprinnelig utviklet til bruk for anestesileger. ANTS ble oversatt til norsk ved Høgskolen i Gjøvik I 2009 og tilpasset til bruk for anestesisykepleiere i Norge som NANTS-no (Nurse Anaesthetists´ Non-Technical Skills – Norway) i 2014 av Fiona Flynn, Kjersti Sandaker, Randi Ballangrud og Marie-Louise Hall-Lord.

NANTS-no

Ikke-tekniske ferdigheter beskrives som kognitive, sosiale og interpersonelle ferdigheter som sammen med tekniske ferdigheter bidrar til å håndtere oppgaver på en effektiv og sikker måte.

Flin, O'Connor & Crichton (2008) *Safety at the sharp end: a guide to non-technical skills*

Forskning viser at hoveddelen av anestesirelaterte uønskede hendelser er et resultat av menneskelige faktorer. Tradisjonelt har mye av fokuset både under utdanning og i anestesisykepleierens arbeid vært rettet mot mestring av de tekniske ferdighetene. Men for å fremme pasientens sikkerhet og en høy faglig profesjonsutøvelse i en kompleks og dynamisk hverdag, er anestesisykepleierens ikke-tekniske ferdigheter minst like viktig. Disse *ikke-tekniske ferdighetene* komplementerer de tekniske ferdighetene, og omfatter både kognitive prosesser som situasjonsbevissthet og beslutningstaking og interpersonelle ferdigheter som problemløsning og teamarbeid. I teamarbeidet på operasjonsstua vil gode ikke-tekniske ferdigheter være avgjørende for en sikker og effektiv pasientbehandling.

NANTS-no (Nurse Anaesthetists' Non-Technical Skills - Norway) bygger på ANTS (Anaesthetists' Non-Technical Skills), og er et systematisk rammeverk for vurdering av ikke-tekniske ferdigheter hos anestesisykepleiere i Norge. Det kan brukes ved ferdighetsutvikling og veiledning av studenter og anestesisykepleiere, både under simuleringstrening og i klinisk praksis. NANTS-no har fokus på individet i teamet, og på hvordan den enkeltes bidrag påvirker pasientsituasjonen. Gjennom egen refleksjon og konkrete tilbakemeldinger, kan verktøyet bidra til å utvikle en mer systematisk tilnærming til det daglige rutinearbeidet og håndtering av akutte situasjoner, samt gi anestesisykepleiere et felles språk for å beskrive deres tause kunnskap.

NANTS-no er hierarkisk oppbygd med 4 hovedkategorier og 15 elementer med ulike kjennetegn på god og uhensiktsmessig adferd.

Kategorier	Elementer
Situasjonsbevissthet	▪ Innhente informasjon ▪ Identifisere og forstå ▪ Forutse og være i forkant
Beslutningstaking	▪ Identifisere handlingsalternativer ▪ Vurdere risikofaktorer og velge handlingsalternativ ▪ Revurdere
Oppgaveløsning	▪ Planlegge og forberede ▪ Prioritere ▪ Identifisere og anvende ressurser ▪ Overholde standarder og kvalitet
Teamarbeid	▪ Utveksle informasjon ▪ Vurdere roller og kompetanser ▪ Koordinere aktiviteter ▪ Vise autoritet og gjennomslagskraft ▪ Støtte andre teammedlemmer

SITUASJONSBEVISSTHET

Omfatter ferdigheter angående opprettholdelse av full oppmerksomhet over arbeidssituasjonen ved å integrere relevant informasjon fra omgivelsene; forstå betydningen av innhentet informasjon, og forutse hva som kan hende videre. Kategorien inneholder tre elementer: innhente informasjon; identifisere og forstå; forutse/være i forkant.

Innhente informasjon - samle aktivt inn all relevant informasjon i den enkelte situasjonen gjennom kontinuerlig observasjon og overvåking av omgivelsene.

Kjennetegn på god adferd	Kjennetegn på uhensiktsmessig adferd
✓ Innhenter og dokumenterer relevant pasientinformasjon preoperativt ✓ Observerer pasient, væsker og medikamenter, overvåkningsskjermer og annet medisinskteknisk utstyr kontinuerlig ✓ Søker aktivt informasjon fra teamet for å identifisere eventuelle problemer ✓ Er oppmerksom på det som foregår i operasjonsfeltet ✓ Innhenter informasjon fra flere kilder for å øke påliteligheten	× Er ukonsentrert og reduserer overvåkingsnivået ved forstyrrelser fra omgivelsene × Tilpasser ikke de fysiske omgivelsene for å få bedre oversikt × Er ustrukturert og fragmentert ved innhenting av informasjon × Stiller ikke spørsmål for å orientere seg om situasjonen ved overtakelse av ansvar for pasienten

Identifisere og forstå - tolke innhentet informasjon for å identifisere overensstemmelse mellom nåværende og forventet tilstand, og oppdatere forståelsen av situasjonen.

Kjennetegn på god adferd	Kjennetegn på uhensiktsmessig adferd
✓ Øker graden av overvåkning som respons på pasientens tilstand ✓ Deler informasjon om situasjonens alvorlighetsgrad med andre teammedlemmer ✓ Tilpasser kommunikasjon og adferd i forhold til situasjonen	× Responderer ikke på endringer i pasientens tilstand × Responderer feilaktig i forhold til situasjonen × Deaktiverer alarmer uten å sjekke dem

Forutse og være i forkant - spørre ”hva hvis...?” spørsmål og tenke høyt omkring mulige resultater og konsekvenser av handlinger og tiltak, for å kunne forutsi hva som kan skje i nær framtid.

Kjennetegn på god adferd	Kjennetegn på uhensiktsmessig adferd
✓ Er i forkant av situasjonen ved å gi væske/medikamenter ved behov ✓ Vurderer effekten av handling/tiltak ✓ Tenker forebyggende ved å gjøre nødvendige tiltak for å unngå eller begrense potensielle problemer ✓ Gjenkjenner tegn til utvikling av kritiske situasjoner	× Tenker ikke igjennom potensielle risikomomenter/problemer × Øker ikke overvåkningsnivået i takt med utviklingen av pasientens tilstand × Er uoppmerksom på det som foregår i operasjonsfeltet × Forutser og forstår ikke medikamentenes virkningsmekanisme og interaksjoner

BESLUTNINGSTAKING

Omfatter ferdigheter angående bedømming og valg av handlingsalternativer, både under normale forhold og i tidspressede akuttsituasjoner. Kategorien inneholder tre elementer: identifisere handlingsalternativer; vurdere risikofaktorer og velge handlingsalternativ; revurdere.

Identifisere handlingsalternativer - skaffe oversikt over ulike mulige handlingsalternativer for å kunne ta en beslutning eller løse et problem

Kjennetegn på god adferd	Kjennetegn på uhensiktsmessig adferd
✓ Identifiserer handlingsalternativer basert på faglig vurdering og tidligere erfaringer ✓ Diskuterer ulike handlingsalternativer med kolleger eller pasient ✓ Søker veiledning fra anestesilege når situasjonen krever det	× Tar en forhastet beslutning selv om det er tid til å vurdere alternativer × Spør ikke andre teammedlemmer om forslag til handling når det er aktuelt × Ignorerer forslag fra andre teammedlemmer

Vurdere risikofaktorer og velge handlingsalternativ - avveie fordeler og ulemper ved ulike handlingsalternativer og velge en løsning eller handling basert på dette

Kjennetegn på god adferd	Kjennetegn på uhensiktsmessig adferd
✓ Vurderer risiko/farer ved ulike handlingsalternativer ✓ Avveier handlingsalternativer på bakgrunn av pasientens tilstand ✓ Vurderer kritisk tidsbruk ved ulike handlingsvalg ✓ Iverksetter den valgte handlingen	× Innhenter ikke relevant informasjon om et ukjent medikament/ pasienttilstand × Ser kun et mulig handlingsalternativ eller blir handlingslammet × Konferer ikke med tilgjengelige teammedlemmer om mulige alternativer

Revurdere - reflektere hele tiden over beslutninger som er tatt; revurdere situasjonen i forhold til det valgte handlingsalternativet.

Kjennetegn på god adferd	Kjennetegn på uhensiktsmessig adferd
✓ Revurderer pasientens tilstand etter behandling eller tiltak ✓ Reflekterer over situasjonen dersom beslutningen var å avvente ✓ Fortsetter å vurdere alternative tiltak etter hvert som pasientens tilstand utvikler seg	× Setter ikke av nok tid til at tiltaket kan virke × Inkluderer ikke andre teammedlemmer i revurdering × Revurderer ikke handlingsvalg i lys av ny informasjon

OPPGAVELØSNING:

Omfatter ferdigheter angående organisering av ressurser og iverksetting av nødvendige handlingsstrategier i forhold til avdelingsrutiner og kliniske standarder. Kategorien inneholder fire elementer: planlegge og forberede; prioritere; identifisere og anvende ressurser; overholde standarder og kvalitet.

Planlegge og forberede - utvikle strategier for å håndtere den aktuelle oppgaven og eventualiteter som kan oppstå, revurdere strategiene og iverksette nødvendige tiltak for å komme i mål.

Kjennetegn på god adferd	Kjennetegn på uhensiktsmessig adferd
✓ Avklarer oppgavefordeling med andre medlemmer av teamet ✓ Finner fram nødvendige medikamenter og utstyr på forhånd ✓ Omstiller seg raskt ved endringer i planen ✓ Planlegger postoperativt forløp for pasienten i samarbeid med teamet	× Endrer ikke planen etter å ha fått ny informasjon × Klargjør ikke aktuelle medikamenter og utstyr før i siste øyeblikk × Har ikke egnede akutte/alternative medikamenter og relevant utstyr tilgjengelig

Prioritere - vurdere fortløpende betydning av oppgaver, tiltak, potensielle problemer og opplysninger i forhold til tidsbruk og alvorlighetsgrad; identifisere nøkkelområder og holde fokus uten å la seg bli distrahert av mindre betydningsfulle forhold.

Kjennetegn på god adferd	Kjennetegn på uhensiktsmessig adferd
✓ Diskuterer prioriteringer for gjeldende situasjon med teamet ✓ Anvender en systematisk tilnærming i prioritering av oppgaver (f.eks. ABCDE) ✓ Skiller mellom viktige og mindre viktige oppgaver i kritiske situasjoner	× Lar seg bli distrahert i prioritering av oppgaver × Er ikke oppmerksom på kritiske forhold × Endrer ikke prioritering ved endrede kliniske forhold

Identifisere og anvende ressurser - innhente nødvendige og tilgjengelige ressurser for å gjennomføre oppgaven (for eksempel personale, ekspertise, utstyr). Anvende ressursene med minst mulig avbrudd og stress, og uten å påføre andre medlemmer i teamet unødvendig belastning.

Kjennetegn på god adferd	Kjennetegn på uhensiktsmessig adferd
✓ Identifiserer tilgjengelige ressurser, og ber om ekstra ressurser ved behov ✓ Fordeler oppgaver til relevante teammedlemmer	× Anvender ikke tilgjengelige ressurser × Ber ikke om hjelp ved behov i akuttsituasjoner × Arbeider ikke parallelt med resten av teamet ved oppgaveløsningen

Overholde standarder og kvalitet - sikre trygghet og kvalitet ved å anvende anerkjente anestesiologiske prinsipper, standarder for god praksis og kliniske retningslinjer.

Kjennetegn på god adferd	Kjennetegn på uhensiktsmessig adferd
✓ Kontrollerer at pasienten er klarert i forhold til «Norsk standard for anestesi (f.eks. ASA-klassifikasjon, anestesiform, fasting, allergi, luftveisvurdering) ✓ Følger retningslinjer for hygiene, behandlingsregimer og dokumentasjonskrav ✓ Utfører dobbeltkontroll av medikamenter ✓ Kontrollerer anestesiapparat og annet aktuelt medisinskteknisk utstyr før hver pasientsituasjon	× Bekrefter ikke pasientens identitet og samtykke × Følger ikke vedtatte retningslinjer for kontroll av medikamenter og blodprodukter × Bryter standarder eller retningslinjer som f.eks. minimumsstandard for overvåkning × Følger ikke protokoller eller retningslinjer for håndtering av akuttsituasjoner

TEAMARBEID

Omfatter ferdigheter angående samarbeid i gruppe for å sikre en effektiv og felles gjennomføring av oppgaven. Hovedfokus er på teamet, fremfor oppgaven. Kategorien inneholder fem elementer: utveksle informasjon; vurdere roller og kompetanser; vise autoritet og gjennomslagskraft; koordinere aktiviteter; støtte andre teammedlemmer.

Utveksle informasjon - dele kunnskap og opplysninger som er nødvendige for samarbeid i teamet og gjennomføring av oppgaven.

Kjennetegn på god adferd	Kjennetegn på uhensiktsmessig adferd
✓ Bekrefter felles forståelse av situasjonen med sjekklisten «Trygg kirurgi» ✓ Kommuniserer relevante vurderinger og observasjoner til teammedlemmene ✓ Anvender presis, faglig begrunnet og lett forståelig kommunikasjon ✓ Opprettholder nøyaktig og korrekt dokumentasjon	× Varsler ikke andre teammedlemmer ved endringer i pasienttilstanden × Gir utilfredsstillende overføringsrapport × Inkluderer ikke relevant personell i kommunikasjonen × Utrykker seg ikke klart og konsist

Vurdere roller og kompetanser - vurdere egne og andre teammedlemmers ferdigheter og evne til å håndtere situasjoner; være oppmerksom på faktorer som kan begrense evnen til å handle effektivt og trygt.

Kjennetegn på god adferd	Kjennetegn på uhensiktsmessig adferd
✓ Er bevisst egen rolle og kompetanse i forhold til resten av teamet og ber om hjelp når det er nødvendig ✓ Presenterer seg for nye teammedlemmer ✓ Er bevisst på teammedlemmenes ulike kompetansenivå og erfaringsbakgrunn ✓ Er oppmerksom på egne og andre teammedlemmer som har nedsatt mestringsevne på grunn av stress eller tretthet	× Avklarer ikke rollefordeling/kompetanser × Tar på seg oppgaver utover eget kompetansenivå × Overser hvordan andre teammedlemmer utfører sine oppgaver × Går inn i eksisterende team uten å klargjøre sitt kompetansenivå

Koordinere aktiviteter - samarbeide med andre teammedlemmer for å løse oppgaven; kjenne roller og ansvarsområder til de ulike teammedlemmene, og bidra aktivt til et godt samarbeid.

Kjennetegn på god adferd	Kjennetegn på uhensiktsmessig adferd
✓ Bekrefter roller og ansvar til teammedlemmene («Trygg kirurgi» sjekkliste) ✓ Er fleksibel og tar hensyn til andre faggruppers behov ✓ Viser interesse og engasjement for at teamet skal arbeide sammen mot et felles mål	× Samarbeider ikke med andre faggrupper × Stoler for mye på at teamet er kjent med hvordan oppgaven skal løses, gjør antakelser og tar ting for gitt × Hindrer at teamet klarer å løse oppgaven (ved f.eks. tidsbruk, manglende kompetanse/samarbeidsevne)

Vise autoritet og gjennomslagskraft - vite når og hvordan en aktiv rolle er nødvendig for å sikre en trygg og effektiv oppgaveløsning, tilpasset team og situasjon.

Kjennetegn på god adferd	Kjennetegn på uhensiktsmessig adferd
✓ Viser nødvendig autoritet ved delegering og løsning av oppgaver ✓ Gir klare og tydelige beskjeder til teammedlemmene i akutte situasjoner ✓ Sikrer at de andre teammedlemmene hører etter ved formidling av viktig informasjon	× Konfronterer ikke mer erfarne kollegaer eller andre faggrupper × Viser autoritet når det ikke er belegg for det × Kommuniserer eller argumenterer ikke faglig i forhold til oppgaveløsning × Er utydelig og når ikke frem med relevante faglige argumenter

Støtte andre teammedlemmer - vise forståelse og respekt for andres fagområder, og yte fysisk, kognitiv eller emosjonell hjelp til andre teammedlemmer ved behov.

Kjennetegn på god adferd	Kjennetegn på uhensiktsmessig adferd
✓ Er oppmuntrende og gir støtte til trøtte, sultne og stressede teammedlemmer ✓ Anerkjenner og roser andre teammedlemmers gode innsats ✓ Er i forkant når kollegaer har behov for utstyr eller informasjon	× Etterspør informasjon på et upassende tidspunkt × Er ikke oppmerksom på andres behov for en omfordeling av oppgaver × Svarer nedlatende eller avvisende på andres forespørsler

SCORE – ALTERNATIVER for NANTS-no

Skalaen under kan benyttes for å score ikke-tekniske ferdigheter basert på observert atferd.

Dersom det ikke er relevant at et element er vist i en situasjon, benyttes "ikke observert".

Score	Beskrivelse
5 – Meget bra	Utførelsen viser høy faglig standard og kan brukes som et meget godt eksempel for andre
4 – Bra	Utførelsen var av gjennomgående god standard som ivaretok pasientens sikkerhet og kan brukes som et godt eksempel for andre
3 – Akseptabel	Utførelsen var av akseptabel standard, men kan forbedres
2 – Marginal	Utførelsen gir grunn til bekymring og betydelig forbedring er nødvendig
1 – Dårlig	Utførelsen satte, eller kunne sette, pasientens sikkerhet i fare, omfattende opplæring og støtte er påkrevet
N - Ikke observert	Adferd kunne ikke observeres i denne situasjonen

Takk

Takk til Helle Teglgaard Lyk-Jensen og Doris Østergaard ved Dansk Institut for Medicinsk Simulation (DIMS) som har stilt innholdet i N-ANTS (Nurse Anaesthetists´Non-Technical Skills), utviklet for danske anestesisykepleiere, til disposisjon under arbeidet med NANTS-no.

Background information and evaluation questionnaire

Participant No: …….. V 1.0 - 18.07.2013
School of Psychology, Aberdeen University

1. Are you involved in any training activities at your hospital e.g. supervising juniors/ mentoring programme?
If yes, please give details

2. Do you have any experience of assessing juniors' performance, either formally or informally? If yes, please give details

3. Have you ever received training for giving assessments? If yes, please give details

4. Apart from this study, what sort of knowledge or experience, if any, do you have of the areas of human factors/ non-technical skills?

5. Have you previously been involved with the research in the ANTS-AP project? If yes, please state your involvement, e.g. interviewed, focus group, Delphi study

6. Demographics

Sex: Male / Female

Is English your first language? Yes / No

Number of years as a anaesthetic assistant: _____years

General questions about the system

7. Do you think the ANTS-AP system was useful for structuring your observation of the film scenarios?
Yes / No
If no, what was the problem?

8. Did it seem to address the key non-technical skill behaviours displayed by the anaesthetic assistant?
Yes / No
If no, what behaviours do you think were not addressed?

9. How easy was it to associate observed behaviours with the ANTS-AP elements?
Very difficult / Difficult / Average / Easy / Very easy

Please provide any specific comments about any or all of the elements:

10. How easy was it to associate observed behaviours with the ANTS-AP categories?

Very difficult / Difficult / Average / Easy / Very easy
Please provide any specific comments about any or all of the ANTS-AP categories:

11. Do you think there are any (non-technical) skills elements and/or categories missing from the list?
Yes / No
If yes, what is missing?

12. Do you think there are any (non-technical) skills elements and/or categories in the list which are not necessary?
Yes / No
If yes, which elements and/or categories are unnecessary?

13. Was the wording used for the category and element labels meaningful?
Yes / No
If no, please describe where you thought there were problems

14. Were the descriptions for each category and element clear?
Yes / No
If no, please describe which descriptions were unclear

15. Were the examples of 'good' behaviours helpful for identifying the non-technical skills elements?
Yes / No
Please give any comments (positive or negative) you may have

16. Were the examples of 'poor' behaviours helpful for identifying the non-technical skills elements?
Yes / No
Please give any comments (positive or negative) you may have

Rating scale

17. Please indicate how easy it was to use the rating scale provided:
Very difficult / Difficult / Average / Easy / Very easy
If you have any particular concerns please explain

18. Do you think the rating scale gave you enough flexibility to rate the performance levels seen in the film clips?
Yes No
If no, would you have liked a longer or shorter scale?
longer / shorter

19. Did you use the comments section on the rating form?
Yes No
If yes, please say what sort of information you noted down e.g. feedback on the ANTS-AP system/ explanation of the performance rating you gave

20. Did you have any problems with the design of the rating form?
Yes / No
If yes, please explain

21. Was the amount of background information you were given on non-technical skills too much / just right / too little

22. Were the explanations of the different categories and elements adequate to allow you to understand what the ANTS-AP system is seeking to address?
Yes / No
If no, how do you think the explanations could be improved?

23. Were the film clips useful in helping you to understand how non-technical skills might be demonstrated in real situations in theatre?
Yes / No

24. Overall do you think you received enough training to be able to use the ANTS-AP system?
Yes / No

Film Scenarios

25. Do you think you could see enough in the scenarios to be able to accurately score non-technical skills behaviour?
Yes / No

26. Do you think you could hear enough from the film to be able to score non-technical skills behaviour accurately?
Yes / No

27. Do you think your rating task would have been easier if you had been able to watch the scenario for real in the operating theatre?
Yes / No
Please can you explain why you gave this answer

Role of the ANTS-AP system

28. Do you think the ANTS-AP system would be helpful for senior anaesthetic practitioners giving training to junior anaesthetic practitioners?
Yes / No
Please make any comments:

29. Do you think the ANTS-AP system would be helpful for assessing junior anaesthetic practitioners?
Yes / No
Please make any comments:

30. Do you think the ANTS-AP system would be helpful for anaesthetic practitioners in developing the skills needed to be a good anaesthetic practitioner?
Yes / No

31. Do you think the ANTS-AP system could be used to support in theatre teaching?
Yes / No
If yes, how? If no, why not?

32. In what ways could you see the ANTS-AP system being used in training?

33. Please give any other comments you may have about the ANTS-AP System.

Thank you very much for participating and taking the time to complete this – your opinion is very valuable to the continued development of the ANTS-AP system.

Evalueringsskjema for vurderingsverktøyet NANTS og kurset i bruken av det

Demografiske opplysninger

1) Kjønn?

- ○ Mann
- ○ Kvinne

2) Helseforetak?

- ○ Sykehuset Telemark HF
- ○ Sykehuset i Vestfold HF
- ○ Vestre Viken HF
- ○ Annet

3) Antall år som anestesisykepleier?

4) Har du tidligere erfaring med veiledning og vurdering av anestesisykepleierstudenter i praksis i ditt helseforetak?

- ○ Ja
- ○ Nei

5) Har du fått trening/opplæring i hvordan du skal veilede og vurdere anestesisykepleierstudenter tidligere?

- Ja
- Nei

6) Før du deltok på dette kurset, hadde du hørt om ikke-tekniske ferdigheter?

- Ja
- Nei

7) Har du tidligere kjennskap til vurderingsverktøyet NANTS enten gjennom kompetansehevingsprogrammet for praksisveiledere eller forskning relatert til NANTS (valideringsarbeid eller deltagelse i NANTS simuleringsstudie)?

- Ja
- Nei

NANTS kurs og bruk av vurderingsskjemaet

8) I hvilken grad var innholdet om ikke-tekniske ferdigheter i kurset tilstrekkelig til å gi deg en forståelse av de grunnleggende begrepene?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

9) I hvilken grad fikk du god nok forklaring på de ulike kategoriene og elementene for å kunne forstå hvilken type adferd NANTS rammeverket handler om?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

10) I hvilken grad var filmene nyttige for å forstå hvordan ikke-tekniske ferdigheter kan observeres i virkelige situasjoner på operasjonsstua?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

11) I hvilken grad klarte du å observere tilstrekkelig med adferder i filmene for å kunne skåre ikke-tekniske ferdigheter?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

12) I hvilken grad var lydkvaliteten i filmene god nok for å kunne skåre ikke-tekniske ferdigheter?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

13) I hvilken grad var NANTS et nyttig verktøy for å strukturere dine observasjoner mens du skåret adferden i filmene?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

14) I hvilken grad hadde det vært lettere å skåre adferden dersom det samme scenarioet hadde skjedd i virkeligheten på operasjonsstua?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

15) I hvilken grad var NANTS vurderingsskalaen (1-5) lett å bruke?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

16) I hvilken grad passer NANTS vurderingsskalaen som et skåringsverktøy for å skåre de ikke-tekniske ferdighetene vist i filmene?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

17) I hvilken grad var kommentardelen på vurderingsskjemaet nyttig for å notere underveis?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

18) I hvilken grad vurderer du at kurset har gitt deg tilstrekkelig opplæring for å kunne bruke NANTS i klinisk praksis?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

19) Hvilken kategori av ikke-tekniske ferdigheter er vanskeligst å observere? Vennligst rangerer kategoriene i rekkefølge fra 1-4, hvor 1 er mest vanskelig og 4 er minst vanskelig.

	1	2	3	4
Situasjonsbevissthet	○	○	○	○
Beslutningstaking	○	○	○	○
Oppgaveløsning	○	○	○	○
Teamarbeid	○	○	○	○

Brukervennlighet av NANTS

20) I hvilken grad dekker NANTS de viktigste ikke-tekniske ferdighetene som bør forventes av en anestesisykepleier?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

21) I hvilken grad kan NANTS være nyttig som et verktøy for utvikling av ferdigheter som er vesentlig for å være en god anestesisykepleier?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

22) I hvilken grad kan NANTS brukes til å støtte veiledning av studenter på operasjonsstua?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

23) I hvilken grad kan NANTS være et nyttig verktøy i veiledningssamtaler med anestesisykepleierstudenter?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

24) I hvilken grad kan NANTS brukes til å fremme kritisk refleksjon om egne ferdigheter hos anestesisykepleierstudenter?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

25) I hvilken grad kan NANTS bidra til å skape dialog mellom anestesisykepleierstudent og praksisveileder om studentens progresjon?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

26) I hvilken grad kan NANTS være nyttig som et verktøy for evaluering av anestesisykepleierstudenter i klinisk praksis?

☐ I svært liten grad ☐ I liten grad ☐ I noen grad ☐ I høy grad ☐ I svært høy grad

27) Ønsker du å kommentere kompetansevurderingsverktøyet NANTS eller kurset, vennligst skriv her

Clinical practice:	Stage 1
Student ID:	
Mentor/Supervisor ID:	

Age:	
Gender:	
Hospital:	

NANTS-no

ASSESSMENT OF NURSE ANAESTHETISTS' NON-TECHNICAL SKILLS

Categories	Category assessment (1-5)	Elements	Element assessment (1-5)	Notes on observed behaviour and feedback
Situation awareness		Gathering information		
		Recognizing and understanding		
		Anticipating and thinking ahead		
Decision-making		Identifying possible options		
		Assessing risks and selecting options		
		Re-evaluating		
Task management		Planning and preparing		
		Prioritizing		
		Identifying and utilizing resources		
		Maintaining standards and levels of quality		
Team working		Exchanging information		
		Assessing roles and capabilities		
		Co-ordinating activities		
		Displaying authority and assertiveness		
		Supporting other team members		

1: Poor	2: Marginal	3: Acceptable	4: Good	5: Excellent	N: Not observed

Assessment is based on the level of non-technical skills expected in a qualified nurse anaesthetist

Global assessment (ring the score): **1** **2** **3** **4** **5** **excellence**

Intervjuguide

Forskningsspørsmål: På hvilke måter bidrar NANTS til utvikling av ikke-tekniske ferdigheter, samt veiledning og vurdering av anestesisykepleierstudenter i klinisk praksis?

1. **Undersøke studenters generelle erfaringer med bruken av NANTS som et kompetansevurderingsverktøy under utdanningen.**

Kan dere beskrive / fortelle meg kort hvordan dere erfarte bruk av NANTS som et verktøy i første klinisk praksis?

- Fungerte oppbygging (elementene/eksemplene)?

2. **Undersøke om studenter erfarer at NANTS er nyttig som et verktøy for å utvikle ikke-tekniske ferdigheter i klinisk praksis.**

Kan dere beskrive / fortelle meg litt om hvordan dere brukte NANTS til å utvikle ikke-tekniske ferdigheter?

- Hvor ofte? Hele eller deler av verktøyet?
- Skåringsverktøy?

3. **Undersøke om studenter erfarer at NANTS gir en struktur for å fremme kritisk refleksjon.**

Kan dere beskrive/fortelle meg litt om dere erfarte at NANTS bidro til refleksjon og bevissthet rundt egen klinisk progresjon? På hvilke måter?

- hjelpemiddel til å reflektere kritisk over eget ståsted?
- Hvordan erfarte dere å skåre dere selv?
- Hensiktsmessig med objektiv vurdering av eget ståsted?

4. **Undersøke om studenter erfarer at NANTS bidrar til en læringsprosess basert på dialog og felles ansvar for læring.**

Kan dere beskrive / fortelle meg litt om hvordan NANTS fungerte i veilednings- og læringssituasjoner?

- Bidro NANTS til å skape dialog/felles ansvar for læring?
- nyttig for å diskutere utfordringer med veilederen?
- nyttig for å strukturere veilederens tilbakemeldinger til dere?

5. **Undersøke om læringsmiljøet preger utvikling av studenters ferdigheter og veiledning i klinisk praksis.**

Kan dere beskrive/fortelle meg litt om hvordan dere erfarte læringsmiljøet og på hvilke måter det påvirket utvikling av ferdigheter og veiledningsmuligheter?

Intervjuguide

Forskningsspørsmål: På hvilke måter bidrar NANTS til utvikling av ikke-tekniske ferdigheter, samt veiledning og vurdering av anestesisykepleierstudenter i klinisk praksis?

1. **Undersøke praksisveilederes generelle erfaringer med bruken av NANTS som et kompetansevurderingsverktøy under utdanningen.**

Kan dere beskrive / fortelle meg kort hvordan dere erfarte bruk av NANTS som et verktøy i klinisk praksis?

- Fungerte oppbygging (elementene/eksemplene)?

2. **Undersøke om praksisveiledere erfarer at NANTS er nyttig som et verktøy for å utvikle ikke-tekniske ferdigheter hos studenter i klinisk praksis.**

Kan dere beskrive / fortelle meg litt om hvordan dere brukte NANTS til å utvikle gode ikke-tekniske ferdigheter hos studenter?

- Hvor ofte? Hele eller deler av verktøyet?
- Skåringsverktøy?

3. **Undersøke om praksisveiledere erfarer at NANTS gir en struktur for å fremme kritisk refleksjon hos studenter?**

Kan dere beskrive/fortelle meg litt om dere erfarte at NANTS bidro til refleksjon og bevissthet rundt egen klinisk progresjon hos studenter? På hvilke måter?

- hjelpemiddel til å reflektere kritisk over eget ståsted? Eksempler?
- Nyttig for å diskutere utfordringer med veilederen?

4. **Undersøke om praksisveiledere erfarer at NANTS bidrar til en læringsprosess basert på dialog og felles ansvar for læring?**

Kan dere beskrive / fortelle meg litt om hvordan NANTS fungerte i veilednings- og læringssituasjoner?

- Bidro NANTS til å skape dialog/felles ansvar for læring?
- Nyttig for å strukturere tilbakemeldinger til studenter?
- Hvordan erfarte dere å vurdere/skåre studentene?
- Hensiktsmessig med en objektiv vurdering av ståsted?

5. **Undersøke om læringsmiljøet preger utvikling av studenters ferdigheter og veiledning i klinisk praksis.**

Kan dere beskrive/fortelle meg litt om hvordan dere erfarte læringsmiljøet og på hvilke måter det påvirket utvikling av ferdigheter og veiledningsmuligheter

Errata

The following changes have been made to correct mistakes in the original text:

Page number	Original text	New text
18	section 2.4.1.1	section 2.3.1.1
43	Masters'	master's
75	promote	promoting
79	insigts	insights

In addition, the order of appendices has been changed to include Appendix 1 which is the complete version of NANTS-no (in Norwegian).

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Dissertation for the degree of PhD

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Fiona M. Flynn

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