Monika Ravik[1]

Using "Knowing That" and "Knowing How" to Inform Learning of Peripheral Vein Cannulation in Nursing Education

[1] University of South-Eastern Norway, Porsgrunn, Norway, E-mail: monika.ravik@usn.no

Abstract:
Background: Peripheral vein cannulation is one of the most common invasive practical nursing skills performed by registered nurses. However, many registered nurses lack competence in this practical skill. Learning peripheral vein cannulation associated with successful placement and maintenance is not well understood.
Framework: Ryle's ways of knowing, "knowing that" and "knowing how", can be used during peripheral vein cannulation learning to guide development and competence in this practical skill.
Aim: The aim of the article was to provide an overview of Ryle's ways of knowing and to make recommendations for best practices for nurse teachers and nurses teaching students peripheral vein cannulation.
Conclusion: Ryle's ways of knowing can assist nursing students in their learning and development of peripheral vein cannulation.

Keywords: vein cannulation, learning, knowledge, Ryle's ways of knowing
DOI: 10.1515/ijnes-2018-0078
Received: November 10, 2018; **Revised:** October 18, 2019; **Accepted:** October 31, 2019

Introduction

Competence in peripheral vein cannulation (PVC) in nursing is emphasized as important to ensure effective treatment and patient safety (Hunter, Vandenhouten, Raynak, Owens, & Thompson, 2018; Marshburn, Engelke, & Swanson, 2009). Learning PVC is a key component in nursing education, in both academic and clinical settings (Alexandrou et al., 2012; Ewertsson, Bagga-Gupta, Allvin, & Blomberg, 2017; McWilliams & Malecha, 2017; National Curriculum Regulations for Nursing Programs, 2008). However, many newly qualified nurses lack competence in PVC (Hunter et al., 2018; Marshburn et al., 2009), and consequently fail and make mistakes in many of their attempts at PVC. In the nursing literature, the practical skill of PVC is identified as one of the most difficult invasive skills to learn and perform (Ewertsson et al., 2017; Hunter et al., 2018; Marshburn et al., 2009; McWilliams & Malecha, 2017). Given the risk of patient harm associated with a lack of competence in PVC, e. g. phlebitis and bloodstream infection (Carr et al., 2016; Hadaway, 2012), the effectiveness of much PVC teaching has to be questioned. A notable gap in this debate is how Ryle's (1949) ways of knowing could improve PVC learning in nursing education.

Background

The literature has described practical nursing skills in technical terms as manual, motor or psychomotor development, involving neuromuscular coordination and manual dexterity (Gomez & Gomez, 1987; Oermann, 1990). Bjørk and Kirkevold (2000) criticized such definitions for being too technical and simplistic, arguing that practical nursing skills were complex actions. They developed a more sophisticated understanding of practical nursing skills involving several elements. In addition to technical aspects, they included theoretical and practical knowledge, caring intentions adjusted to both patient and environment, and ethical and moral considerations necessary to perform practical skills proficiently (Bjørk & Kirkevold, 2000). Such complexity shows that practical nursing skills encompass psychomotor, cognitive and affective domains of learning (Murray, Grant, Howarth, & Leigh, 2008).

PVC is an invasive practical skill where the skin and blood are penetrated to enable intravenous therapy to be administered with direct insertion into the patient's vein (Cappelen Damm Var Healthcare, 2019). PVC

Monika Ravik is the corresponding author.

is one of the most frequently performed invasive skills by nurses working in hospitals globally, with up to 70–90 percent of hospitalized patients requiring medication administered via a vein cannula (Carr et al., 2016; Hunter et al., 2018). However, many registered nurses lack competence in PVC (Hunter et al., 2018; Marshburn et al., 2009). Concern has been expressed about the risk of patient harm associated with the lack of PVC skills among registered nurses (Binner et al., 2011; Carr et al., 2016; Milutinović, Simin, & Zec, 2015; Missen, McKenna, Beauchamp, & Larkins, 2016; Zamanzadeh, Jasemi, Valizadeh, Keogh, & Taleghani, 2015). For example, vein inflammation, phlebitis, is a common complication of PVC (Carr et al., 2016; Hadaway, 2012; Meeder, van der Steen, Rozendaal, & van Zanten, 2016; Milutinović et al., 2015; Niël-Weise, Stijnen, & van den Broek, 2010), diagnosed by clinical symptoms such as pain and signs of local infection (Carr et al., 2016). Several factors have been associated with the development of phlebitis, such as mechanical factors caused by the use of inadequate equipment and lack of skill of the inserter (Milutinović et al., 2015), and infection factors caused by catheter contamination (Hadaway, 2012). Phlebitis caused by such catheter-related infections risks progressing into a bloodstream infection (Hadaway, 2012), which can result in an extended hospital stay (Carr et al., 2016; Norwegian Institute of Public Health, 2014).

Having a skilled nurse to insert PVC is important to reduce complications of PVC (Da Silva, Priebe, & Dias, 2010; Keleekai et al., 2016). Learning PVC in nursing education is very important to safeguard patient safety. In the academic setting, simulation-based learning is the main approach to acquisition of the skill of PVC. Simulation aims to prepare students for tasks such as PVC that they will meet in the clinical setting (Bruce, Levett-Jones, & Courtney-Pratt, 2019; Downing et al., 2016; Hayden, Smiley, Alexander, Kardong-Edgren, & Jeffries, 2014). A simulation setting is a safe learning environment, allowing students to learn practical skills prior to skill performance on patients (Bland & Tobbell, 2016; Bruce et al., 2019; Hayden et al., 2014; McWilliams & Malecha, 2017). In the clinical setting, it is expected that practical skills previously learned in simulation will be transferred and further developed through practice on patients (Ewertsson et al., 2017). However, students tend to have challenges in learning PVC in simulation (Ravik, Havnes, & Bjørk, 2015, 2017a), and transferring the learning of PVC from simulation to the clinical setting (Ravik et al., 2015; Ravik, Havnes, & Bjørk, 2017b), as well as developing PVC competence during a clinical placement period (Ravik et al., 2017b). Even experienced nurses have expressed a lack of competence in PVC (Lyons & Kasker, 2012).

Creation of the best possible learning environment in PVC is important in providing students with the necessary skills. Dieckmann, Friis, Lippert, and Østergaard (2012) revealed several barriers to students' learning related to nurse teachers. Being unfamiliar with their role as nurse teachers, providing insufficient simulator briefing, and presenting irrelevant theory are examples revealed in the study. Previous studies have also documented that it cannot be taken for granted that nurse teachers have the proficiency needed to properly organize skill teaching (Husebø, Dieckmann, Rystedt, Søreide, & Friberg, 2013; Rystedt & Sjöblom, 2012) and the nurse teacher's pedagogical proficiency is seldom a separate focus in studies on nurse teachers' competencies for providing high-quality nursing education (Zlatanovic, Havnes, & Mausethagen, 2017). Even though nursing education has placed a high value on students' learning in the clinical setting (Ewertsson et al., 2017; McInnes, Peters, Hardy, & Halcomb, 2015), it cannot be taken for granted that nursing students have maximum learning opportunities in PVC during their clinical placement (Ravik et al., 2017b). This illustrates that for skill learning to be successful, nurse teachers' and nurses' pedagogical competence is just as important as theoretical and practical knowledge in practical skills. We should never become tired of encouraging quality education and the issue of how to organize and ensure quality in student learning. The WHO (2016) has advocated that educators should be competent and efficient in helping students to learn.

It is suggested that PVC learning in nursing education could be maximized when educational methods include the inspiration of pedagogical perspectives on learning (Clapper, 2015). In studies by Ravik et al. (2017a, 2017b), both theoretical and practical knowledge were relevant to students' PVC learning and successful cannula insertion. These two forms of knowledge can be considered as equivalent to what Ryle (1949) termed as "knowing that" (theoretical knowledge) and "knowing how" (practical knowledge).

The aim of this article was to describe and discuss methods nurse teachers could use to improve the quality of PVC learning in the simulation setting, based on Ryle's (1949) ways of knowing: "knowing that" and "knowing how". A further aim was to discuss whether and how the two learning approaches are applicable in the clinical setting. This article will provide an overview of Ryle's (1949) ways of knowing, and their application to learning PVC in nursing education.

Ryle's ways of knowing

"Knowing that" is the theoretical and factual knowledge that underpins an action. For example, "knowing that" related to PVC is the theoretical and factual knowledge of for example anatomy, physiology and pathology, and

the purpose and consequences of the skill performance (Cappelen Damm Var Healthcare, 2019). "Knowing how" is how the actual action should be performed or accomplished (Ryle, 1949), such as how PVC should be performed in a way that ensures the best possible outcome for patients. In explaining "knowing how", Ryle (1949) emphasized that "knowing that" is a form of knowledge that is a prerequisite for "knowing how", the specific action, and he argued that there is no dualistic distinction between the two forms of knowledge, but that theoretical knowledge, "knowing that", is an integral part of practical knowledge, "knowing how".

Ryle (1949) explained two different approaches to practical knowledge, "knowing how". One approach is to perform an action based on habits, which means that the action is built on routines. The other way is to perform an action based on "intelligent practice", meaning that a given action is grounded in thinking and reflecting through internal and/or external voice. The internal voice of reflection is inner speech or self-knowledge, a way of representing what and how the learner is thinking (Ryle, 1949). The external voice of reflection is a reflection in others' talk. The act of questioning and discussing encourages learners to engage in reflection, and sharing reflections increases the learning for each individual learner (Ryle, 1949). Ryle (1949) stated that reflection is not simply thinking in action, as it involves a reanalysis of the action and the knowing implicit in the action. In this way, reflection is about conscious thought, a speculative process in an action, meaning to go beyond habitual practice and being aware of one's own action, leading to new understanding and action. Ryle (1949) argued that thinking and reflecting connected the two forms of knowledge, "knowing that" and "knowing how", in a given action. This illustrates a cognitive approach underlying learning and understanding, involving performing an action correctly, but also making necessary adjustments during the performance of a practical skill. Ryle (1949) proposed that acting in an "intelligent practice" was an embodied disposition, meaning that a kind of knowledge was situated and subjective, but also that theoretical and practical knowing appeared simultaneously. The purpose of "intelligent practice" is to learn and to be able to change and improve an action, thus achieving progression (Ryle, 1949). In this way, knowledgeable doers are considered to be always still learning.

"Knowing that" and "knowing how" when learning PVC in the simulation setting

"Knowing that"

Ryle (1949) argued that "knowing that" is a prerequisite for engaging in "intelligent practice". This means that some factual knowledge about the practical skill of interest, such as PVC, should be acquired before learning and performing "knowing how", to enable "knowing how" to have a firm basis. The research literature, however, shows that many nursing students lack "knowing that" in PVC (Ravik et al., 2017a, 2017b). For example, in two qualitative studies by Ravik et al. (2017a, 2017b), the authors revealed that second-year nursing students had very poor "knowing that" in how to insert a venous cannula properly into the vein. Consequently, the vein was missed and the students had to terminate their attempt at PVC. Such a shortfall in knowledge has consequences for students engaged in what Ryle (1949) defined as "intelligent practice". Benner (1984) argued that without "knowing that", nursing students lack the factual knowledge necessary to ask and reflect on the right questions, which is emphasized as an important component in the development of clinical nursing skills such as PVC.

A qualitative study by Günay and Kilinc (2018) gives a possible explanation of why the acquisition of "knowing that" in nursing education may be challenging. The nursing students in this study were at all levels of their education, but had the common experience that the theoretical part of their course was very intensive, with a great deal of information to relate to. This intensive focus on "knowing that" can also be understood as a concern in learning practical skills in nursing. In addition to PVC, students have to learn many other practical nursing skills, often in a short period of time (Flo, Flaathen, & Fagerström, 2013; Hilton & Barrett, 2009). Consequently, students could experience being cognitively overloaded with information (Günay and Kilinc 2018). Students could easily be criticized for skipping "knowing that" in skill acquisition, including PVC. However, being cognitively overloaded is challenging, and can lead to a lack of motivation in learning (Raaheim, 2011).

Generally, immediately prior to the simulation-based practical skill learning, many nursing educational institutions provide the students with a theoretical review by a nurse teacher related to the skill to be learned, such as PVC (Moulton, Lucas, Monaghan, & Swobada, 2017). Transmission of "knowing that" related to PVC could be a useful starting point for the learner to become familiar with elements of the skill. Instruction focused learning is, however, described as a teacher-centered approach to learning, providing a low level of learner autonomy, and is assumed to encourage passive learning (Tun, Alinier, Tang, & Kneebone, 2015). In order to facilitate students' ability to acquire "knowing that", a useful practice could be student-centered collaboration in small groups arranged by a nurse teacher before the theoretical review of the skill given by the nurse teacher. In this way, students in cooperation with each other would be encouraged to familiarize themselves with a basic "knowing that" concerning the skill to be learned, e. g. PVC. Topping (2005) argued that cooperation by students

in small groups was beneficial in helping each other to build skill understanding. Cooperation with fellow students revealed their own lack of "knowing that", and helped students to maximize their own and fellow students' acquisition of "knowing that" (Bengtsson & Ohlsson, 2010), showing that student collaboration plays an important role in meaningful learning. In this way, the teacher is facilitating learning through construction of "knowing that" rather than merely communicating "knowing that", as well as encouraging students to take responsibility for their own learning process and learning needs, and to have an autonomous and active role in learning and creation of knowledge (Jeffries, 2005; Tun et al., 2015). This could be expected to provide the students with a better starting point for both understanding and engaging in the "knowing that" presented by the nurse teacher about PVC; they would thus have a basic "knowing that" prior to the actual simulation activity, and therefore better engage in "knowing how" including "intelligent practice" during simulation.

"Knowing how"

To guide instruction in PVC, nurse teachers use guidelines (Haraldseid et al., 2017; Ravik et al., 2017a). Research shows that a common practice is that timely guidelines to describe "knowing how" form the basis of simulation-based skill learning, including PVC (Haraldseid et al., 2017; Ravik et al., 2017a; Zarifsanaiey, Amini, & Saadat, 2016). Timely guidelines appear to be a starting point for a mechanical "knowing how" more than they are a basis for reflection in action (Ravik et al., 2017a). The fact that learners are aware of their own stepwise performance in PVC does not necessarily means that they are capable of translating their awareness into learning and action. Consequently, the performance of PVC becomes a theoretical exercise of knowledge presentation, where the skill is performed with a minimum of effort. The learning of PVC is thus in line with what Ryle (1949) would have referred to as a practice based on habits, meaning that "knowing how" is mechanical and based on routines. Both Ryle (1949) and Benner (1984) argued that only doing an action mechanically does not enhance the learning of "knowing how", but instead leads to repetition of an action that remains at a beginner level.

When skills are learned and performed only mechanically, the complexity of a practical skill performance is not taken into consideration, and the direction of learning shifts from knowing the skill in a complex way (Bjørk & Kirkevold, 2000). By contrast, students who were encouraged by nurse teachers to engage in reflection had the opportunity to "go behind" the actual doing and be critical of their actions, as well as having the ability to expand their attention and understanding, both towards themselves and others (Jarnulf, Skytt, Mårtensson, & Engström, 2019; Ravik et al., 2017b). For example, students in the study by Jarnulf et al. (2019) progressed in taking responsibility for nursing interventions because they were able to engage in reflection together with their nurse teachers.

Reflection is not an unknown phenomenon in practical skill learning in nursing education (Ewertsson et al. 2015; Havnes, Christiansen, Bjørk, & Hessevaagbakke, 2016; Husebø et al., 2013; Reierson, Haukedal, Hedeman, & Bjørk, 2017), and is often defined in the nursing literature as critical thinking (Sullivan, 2012). In many nursing educational institutions, both in academic and clinical settings, reflection takes place both before and after an action, so-called briefing and debriefing. Nurse teachers/nurses and students are thus able to reflect together on different elements of the practical skill performance (Edwards, 2017; Husebø et al., 2013; Jarnulf et al., 2019; Phillips, Duke, & Weerasuriya, 2017; Reierson et al., 2017). Ryle (1949), however, argued that reflection before or after an action was an inadequate way to think about learning, and was not defined as "intelligent practice". An action cannot be considered with the mind and then executed with the body (Ryle, 1949). On the contrary, reflection should take place parallel with the skill learning, meaning that mind is revealed in the doings of learners, so called reflection in action, to be defined as "intelligent practice" (Ryle, 1949). Although reflective thinking and conscious thought in action are important for learning to occur, there is limited information in the literature on how these approaches could be used in practical skill learning in nursing education. Failure to engage in reflective processes in action can lead to negative outcomes in students' learning and skills development (Ravik et al., 2017a, 2017b).

"Intelligent practice"

Artificial body parts, such as latex arms, function as an alternative to patients' arms (Hayden et al., 2014; Ravik et al., 2017a). Using such a training modality, students are allowed to learn and perform PVC without fear of harming patients. Additionally, students are permitted to make mistakes, repeat and take the time they need when learning PVC (Bland & Tobbell, 2016; Bruce et al., 2019; Hayden et al., 2014; Johannesson, Silén, Kvist, & Hult, 2013; McWilliams & Malecha, 2017). Using artificial body parts also allows students to safely engage in "intelligent practice" during PVC learning. However, studies have shown that nurse teachers imparted knowledge to students through one-way communication in the simulation setting. Consequently, the focus was on

the educator's knowledge, a teacher-centered approach in learning, making the students passive receivers of information with a low level of learning autonomy (; Ravik et al., 2017a; Tun et al., 2015).

When artificial body parts are used during PVC learning, the "knowing how" could enable students to use the "knowing that" needed to engage in "intelligent practice". This can be done by nurse teachers incorporating the use of study questions on PVC during "knowing how", parallel to using the guidelines, and not as a separate part before or after learning the skill, thus giving students the opportunity to properly engage in reflection, i. e. "intelligent practice". In this way, students could be helped by nurse teachers and each other to discuss and question various steps of PVC, working together to a common objective. In this way, students can make changes that facilitate learning and skill performance, as well as becoming aware of challenging parts of "knowing how", which could be used as a basis for the "intelligent practice". For example, Ravik et al. (2017a) found in their research that it was particularly challenging for students to learn and perform the step of PVC that involved how to advance the cannula slightly to ensure entry into the vein lumen after the first flashback of blood into the chamber of the stylet. In "intelligent practice" using artificial body parts, students could together and with their nurse teacher reflect, and construct and develop meaning and understanding of this particularly challenging part of PVC, being shaped by it and becoming part of it. In such an approach to learning, nurse teachers are urging students to reflect, look back and be critical, whilst encouraging and guiding them rather than telling them what to do. Students thus reshape what they are doing while they are doing it. Such an approach to learning shows that reflection can be used as a basis for directing learning in PVC.

The use of artificial body parts could also give students the opportunity to engage together and with a nurse teacher in an "intelligent practice" that is based on recontextualization, meaning that students "imagine and problematize how the skill should be performed in another context", such as a clinical setting (Bjørk, Christiansen, Havnes, & Hessevaagbakke, 2015, p. 134). Research shows that simulation-based equipment does not fully imitate clinical reality and consequently challenges students to transfer learning to the clinical setting (Haraldseid, Friberg, & Aase, 2015; Longworth, 2013; Ravik et al., 2015). Marton (2006), however, suggested that learning was primarily created from differences, with sameness having a secondary role. In general, students have no experience with PVC before they learn the skill through simulation (Ravik et al., 2017a). Consequently, they lack previous experience with PVC to relate to the learning situation. Nurse teachers in the simulation setting who are aware of and identify gaps or differences between the two learning environments try to make the students aware of elements of the PVC where they should reflect and engage in "intelligent practice". In this way, nurse teachers act as an intermediary between the student and the learning objective, helping students to approach the learning objective in a strategic way (Ryle, 1949).

By comparing and contrasting elements of a PVC in the real world of practice with what they are doing in the simulated setting, "intelligent practice" could allow students to form a cognitive bridge between the two learning environments, since they are engaged in complex learning (Husebø, Friberg, Søreide, & Rystedt, 2011). If recontextualization is encouraged by nurse teachers in the simulation setting, students might become more confident to transfer these challenging steps to the clinical setting. An "intelligent practice" that is based on recontextualization and reinterpretation could thus lead to a deeper level of learning and understanding because students are encouraged to engage in a higher cognitive approach to deal with differences and challenges likely to appear in the clinical setting. Additionally, students will experience that the knowledge is of importance, and consequently their motivation for learning will increase (Bengtsson & Ohlsson, 2010). This demonstrates that a reflecting nurse teacher helps students to take more responsibility for their learning, to experience their autonomous role in learning, and to develop their capacity for cognition. Consequently, the use and development of higher order cognitive reasoning and abstract thinking abilities, a deep level of learning, should be one implication of the design of a PVC learning environment (Zarifsanaiey et al., 2016).

When the students masters both engaging in "intelligent practice" and correctly performing PVC on a latex arm, I propose that the next step in learning PVC should be to learn to perform the skill on patients in the clinical setting, i. e. to transfer PVC "knowing that" and "knowing how" from the simulation to the clinical setting.

"Knowing that" and "knowing how" when learning PVC in the clinical setting

"Knowing that"

The students in the study by Bengtsson and Ohlsson (2010) thought it was important to apply "knowing that" in practice. The descriptions in the literature of challenges for students in transferring "knowing that" from the simulation setting to the clinical setting may be seen in light of the fact that many nursing students lack the "knowing that" necessary to be transferred from one learning environment to another (Ravik et al., 2017a, 2017b). Nurses are the most important source of support for student learning in clinical practice (McIntosh,

Gidman, & Smith, 2014). There is, however, criticism in the literature that nurses are not helping students enough to apply "knowing that" in the clinical setting (Jarnulf et al., 2019; Tuomikoski, Ruotsalainen, Mikkonen, Miettunen, & Kääriäinen, 2018). Nurses mainly ask students lower level questions that do not encourage and assist the development of reflective thinking, "intelligent practice" (Jarnulf et al., 2019; Phillips et al., 2017; Tofade et al., 2013). For example in the study by Phillips et al. (2017), around 73 % of questions from nurses to students were from the lower cognitive level of "knowing that", requiring only simple recall of information. One explanation could be that many nurses have inadequate teaching skills when supervising students during their clinical placement (Phillips et al., 2017; Tuomikoski et al., 2018). However, when many students have a gap in their "knowing that", nurses have to focus on teaching theoretical knowledge to provide students with a sound base on which to build their next stage of understanding and development, rather than requesting "knowing that" in a stage of higher cognitive application. This illustrates that focusing on simple questions is not necessarily incorrect or inadequate in student learning of PVC, but is important to help students to acquire the "knowing that" necessary for further learning and understanding. When students answer questions from nurses regarding "knowing that", nurses have the opportunity to assess students' level of "knowing that", and make the students aware of what they lack, as well as helping students to close knowledge gaps (Chin & Osborne, 2008).

"Knowing how"

Nursing students are novice practitioners with no or little experience in what they are expected to perform, and have difficulty in handling the entire "knowing how" in a given situation (Benner, 1984). The novices have to use and rely on "knowing that" such as rules or guidelines on how to act in certain situations, such as PVC (Benner, 1984). Nurses mentoring students in PVC should, however, facilitate reflective discussions to improve student learning (Jarnulf et al., 2019; Tuomikoski et al., 2018). Although Ryle (1949) emphasized that reflection should occur in action, there are implications for students to engage in "intelligent practice" when they are learning and performing PVC on patients, as will be evident in the following discussion.

"Intelligent practice"

For students engaged in "intelligent practice", the situation will be different when they learn to perform PVC on patients in the clinical setting rather on artificial body parts in the simulation setting. Reflecting with a nurse using external voice in action when performing PVC on patients, i. e. reflecting "over the head of the patient", could cause insecurity for many patients who do not understand the verbal exchange between students and nurses (Marcus, 2014). Such an emotional experience for a patient could lead to difficulty in e. g. paying attention to threat-related information (Mathews & MacLeod, 2005). When patients react emotionally, "intelligent practice" is suggested to be unethical.

Ryle (1949) argued that reflecting both with and without speech during an action is a time-consuming process for learners. There are physical aspects of the invasive practical skill of PVC that could limit the possibility to use this prolonged time to engage in "intelligent practice". For example, there is a limit to how long a tourniquet could be tightened on a human arm when inserting the cannula, before the tourniquet has to be released because of the risk of complications such as hemoconcentration due to venous pressure (Buowari, 2013). There may also be disease-related conditions that will imply a very short time for the tourniquet, such as veins easily rupturing due to the effect of medical treatment such as the steroid hormone cortisone (Norwegian Directory of Medicines, 2010).

From the perspective of registered nurses, a preceptor role is challenging to undertake alongside their daily activity (Fillingsnes & Thylén, 2012; Jarnulf et al., 2019). Jarnulf et al. (2019) argued that being a mentor was an additional task to providing patient care. Patient care had to be prioritized over mentoring students; consequently, mentors sometimes lacked the time and resources to effectively facilitate students' learning. In this way, it is easy to understand that clinical conditions could make it challenging for nurses to let students spend extra time on engaging in "intelligent practice" when they are learning PVC on a patient's arm.

Emotional and time-related problems in student learning of PVC on patients' arms indicate that nurses should take a critical view of inviting students to engage in "intelligent practice". This suggests that Ryle's (1949) "intelligent practice" cannot be used uncritically, but must be considered against any consequences of the thinking and reflective process during the action. Limits in the possibilities for students, defined as novice practitioners, to engage in "intelligent practice" without spending additional time and be a risk of providing emotional challenges for patients when learning and performing the skill on a patient, may explain why reflection in action is only directly observable in what Benner (1984) defined as an expert level of competence. The

mind and body are integrated, meaning that mind is shown in the skill performance, doing and thinking are complementary (Ryle, 1949).

Conclusion

Although PVC is stated to be a central learning objective in nursing education, less is known about nursing students' learning of PVC. Ryle's ways of knowing, "knowing that" and "knowing how" could be applicable to the learning of PVC in nursing education, but should not be used uncritically. This is where the knowledge and skills of the nurse teacher come into play, to foster reflection, discussion and questioning during simulation-based PVC learning. A key feature for learning PVC is the precise designing of "intelligent practice", to enable students to be engaged in critical thinking processes with increasing creativity, rather than repeating mechanical actions. Only learning to perform PVC based on habits runs the risk that reflective processes are lacking. In that case, it will be challenging for students to develop an "intelligent practice" that has become embodied and tacit knowledge of what needs to be done, including how and when, and involving a great deal of flexibility in skill performance. Efforts must be made to immerse students in "intelligent practice" to enable them to generate clear ideas on how they can specifically incorporate the lessons learned from simulation into their "knowing how" on patients in the clinical setting.

Emotional and time-related challenges in student learning of PVC on patients' may restrict students to engage in "intelligent practice" in the clinical setting. If students learn from nurse teachers in a simulation setting how they can engage in "intelligent practice", they might be expected to be capable of conducting inner reflections when they perform PVC on patients in a clinical setting. In this way, the PVC performance will reveal a habitual action, but still contain an inner reflection, which for the student is important both to perform the skill accurately and to adjust the performance to the individual patient's needs. Nurse teachers who adopt such an "intelligent practice" to simulation-based PVC learning could have a considerable impact on students' development of PVC competence, both in the simulation and clinical setting. This is in line with Beach (1999), who argued that learning should take place in the learning context and then be transferred to and developed in an applied context.

References

Alexandrou, E., Ramjan, L., Murphy, J., Hunt, L., Betihavas, V., & Frost, S. A. (2012). Training of undergraduate clinicians in vascular access: An integrative review. *JAVA*, *17*(3), 146–158. doi: 10.1016/j.java.2012.07.001

Beach, K. (1999). Consequential transitions: A sociocultural expedition beyond transfer in education. *Review of Research in Education*, *24*, 101–139. doi:10.3102/0091732X024001101

Bengtsson, M., & Ohlsson, B. (2010). The nursing and medical students motivation to attain knowledge. *Nurse Education Today*, *30*, 150–156. doi: 10.1016/j.nedt.2009.07.005

Benner, P. (1984). *From novice to expert. Excellence and power in clinical nursing practice*. Menlo Park, CA: Addison-Wesley Publishing Company.

Binner, M., Ross, D. & Browner, I. (2011). Chemotherapy-induced peripheral neuropathy: Assessment of oncology nurses' knowledge and practice. *Oncology Nursing Forum*, *38*(4), 448–454. doi: 10.1188/11.ONF.448-454

Bjørk, I. T., Christiansen, B., Havnes, A., & Hessevaagbakke, E. (2015). Exploring the black box of practical skill learning in the clinical skills center. *Journal of Nursing Education and Practice*, *5*(11), 131–138. doi: 10.5430/jnep.v5n11p131

Bjørk, I. T., & Kirkevold, M. (2000). From simplicity to complexity: Developing a model of practical skill performance in nursing. *Journal of Clinical Nursing*, *9*, 620–631.

Bland, A. J., & Tobbell, J. (2016). Towards an understanding of the attributes of simulation that enable learning in undergraduate nurse education: A grounded theory study. *Nurse Education Today*, *44*, 8–13. doi: 10.1016/j.nedt.2016.05.011

Bruce, R., Levett-Jones, T., & Courtney-Pratt, H. (2019). Transfer of learning from university-based simulation experiences to nursing students' future clinical practice: An exploratory study. *Clinical Simulation in Nursing*, *35*, 17–24. doi: 10.1016/j.ecns.2019.06.003

Buowari, O. Y. (2013). Complications of venepuncture. *Advances in Bioscience and Biotechnology*, *4*(1), 126–128. doi: /10.4236/abb.2013.41A018

Cappelen Damm VAR Healthcare. (2019). Praktiske prosedyrer i sykepleien [Practical skills in nursing]. Retrieved from https://www.varhealthcare.no/

Carr, P. J., Rippey, J. C. R., Cooke, M. L., Bharat, C., Murray, K., Higgins, N. S., ... Rickard, C. M. (2016). Development of a clinical prediction rule to improve peripheral intravenous cannulae first attempt success in the emergency department and reduce post insertion failure rates: The Vascular Access Decisions in the Emergency Room (VADER) study protocol. *BMJ Open*, *6*(6), e009196. doi: 10.1136/bmjopen-2015-009196

Chin, C., & Osborne, J. (2008). Students' questions: A potential resource for teaching and learning science. *Studies in Science Education*, *44*, 1–39.

Clapper, T. C. (2015). Theory to practice in simulation: An overview. *Simulation & Gaming*, *46*(2), 131–136. doi:10.1177/1046878115599615

Da Silva, G., Priebe, S., & Dias, F. (2010). Benefits of establishing an intravenous team and the standardisation of peripheral intravenous catheters. *Journal of Infusion Nursing*, *33*(3), 156–160.

Dieckmann, P., Friis, S. M., Lippert, A., & Østergaard, D. (2012). Goals, success factors, and barriers for simulation-based learning: A qualitative interview study in health care. *Simulation & Gaming*, *43*(5), 627–647. doi: 10.1177/1046878112439649
Edwards, S. (2017). Reflecting differently. New dimensions: Reflecting-before-action and reflection-beyond-action. *International Practice Development Journal*, *7*(1). doi:10.19043/ipdj.71.002
Ewertsson, M., Allvin, R., Holmström, I. K., & Blomberg, K. (2015). Walking the bridge: Nursing students' learning in clinical skill laboratories. *Nurse Education in Practice*, *15*, 277– 283. doi: 10.1016/j.nepr.2015.03.006
Ewertsson, M., Bagga-Gupta, S., Allvin, R., & Blomberg, K. (2017). Tension in learning professional identities – nursing students' narratives and participation in practical skills during their clinical practice: An ethnographic study. *BMC Nursing*, *16*(48), 3–8. doi: 10.1186/s12912-017-0238-y
Fillingsnes, A-B., & Thylén, I. (2012). Praksissykepleieres pedagogiske utfordringer i klinisk veiledning av sykepleierstudenter [Nurse preceptors' educational challenges in clinical tutoring of nurse students]. *Nordisk Sygeplejeforskning*, *4*(2), 249–262.
Flo, J., Flaathen, E. K., & Fagerström, L. (2013). Simulation as a learning method in nursing education - A case study of students' learning experiences during use of computer-driven patient simulators in preclinical studies. *Journal of Nursing Education and Practice*, *3*(8), 138–148. doi: 10.5430/jnep.v3n8p138
Gomez, G. E., & Gomez, E. A. (1987). Learning of psychomotor skills: Laboratory versus patient care setting. *Journal of Nursing Education*, *26*(1), 20–24.
Günay, U., & Kilinc, G. (2018). The transfer of theoretical knowledge to clinical practice by nursing students and the difficulties they experience: A qualitative study. *Nurse Education Today*, *65*, 81–86. doi: 10.1016/j.nedt.2018.02.031
Hadaway, L. (2012). Short peripheral intravenous catheters and infections. *The Art and Science of Infusion Nursing*, *35*(4), 230–240. doi: 10.1097/NAN.0b013e31825af099
Haraldseid, C. & Aase, K. (2017). Variability among groups of nursing students' utilization of a technological learning tool for clinical skills training: An observational study. *Journal of Nursing Education and Practice*, *7*(7), 66–76. doi:10.5430/jnep.v7n7p66
Haraldseid, C., Friberg, F., & Aase, K. (2015). Nursing students' perceptions of factors influencing their learning environment in a clinical skills laboratory: A qualitative study. *Nurse Education Today*, *35*, e1–e6. doi: 10.1016/j.nedt.2015.03.015
Havnes, A., Christiansen, B., Bjørk, I. T., & Hessevaagbakke, E. (2016). Peer learning in higher education: Patterns of talk and interaction in skills centre simulation. *Learning,Culture and Social Interaction*, *8*, 75–87. doi: 10.1016/j.lcsi.2015.12.004
Hayden, J. K., Smiley, R. A., Alexander, M., Kardong-Edgren, S., & Jeffries, P. R. (2014). The NCSBN National Simulation Study: A longitudinal, randomized, controlled study replacing clinical hours with simulation in prelicensure nursing education. *Journal of Nursing Regulation*, *5*(2), 1–64. supplement.
Hilton, P., & Barrett, D. (2009). An investigation into students' performance of invasive and non-invasive procedures on each other in classroom settings. *Nurse Education in Practice*, *9*, 45–52. doi: 10.1016/j.nepr.2008.03.005
Hunter, M. R., Vandenhouten, C., Raynak, A., Owens, A. K., & Thompson, J. (2018). Addressing the silence. A need for peripheral intravenous education in North America. *JAVA*, *23*(3), 157–165. doi: 10.1016/j.java.2018.06.001
Husebø, S. E., Dieckmann, P., Rystedt, H., Søreide, E., & Friberg, F. (2013). The relationship between facilitators' questions and the level of reflection in postsimulation debriefing. *Simulation Healthcare*, *8*, 135–142. doi: 10.1097/SIH.0b013e31827cbb5c
Husebø, S. E., Friberg, F., Søreide, E., & Rystedt, H. (2011). Instructional problems in briefings: How to prepare nursing students for simulation-based cardiopulmonary resuscitation training. *Clinical Simulation in Nursing*, *8*(7), e307–e318. doi: 10.1016/j.ecns.2010.12.002
Jarnulf, T., Skytt, B., Mårtensson, G., & Engström, M. (2019). District nurses experiences of precepting district nurse students at the postgraduate level. *Nurse Education in Practice*, *37*, 75–80. doi: 10.1016/j.nepr.2019.05.004
Jeffries, P. R. (2005). A framework for designing, implementing, and evaluating simulations used as teaching strategies in nursing. *Nursing Education Perspectives*, *26*(2), 96–103.
Johannesson, E., Silén, C., Kvist, J., & Hult, H. (2013). Students' experiences of learning manual clinical skills through simulation. *Advances in Health Sciences Education*, *18*, 99–114. doi: 10.1007/s10459-012-9358-z
Keleekai, N. L., Schuster, C. A., Murray, C. L., King, M. A., Stahl, B. R., Labrozzi, L. J., ... Glover, K. R. (2016). Improving nurses' peripheral intravenous catheter insertion knowledge, confidence, and skills using a simulation-based blended learning program. *Simulation Healthcare*, *11*, 376–384.
Longworth, M. K. (2013). An exploration of the perceived factors that affect the learning and transfer of skills taught to student midwifes. *Midwifery*, *29*, 831–837. doi:10.1016/j.midw.2012.07.013
Lopreiato, J. O. (Ed), Downing, D, Gammon, W, Lioce, L, Sittner, B, Slot, V, & Spain, A. E. (Associate Eds.), and the Terminology & Concepts Working Group. (2016). *Healthcare Simulation Dictionary*. Retrieved from http://www.ssih.org/dictionary
Lyons, M. G., & Kasker, J. (2012). Outcomes of a continuing education course on intravenous catheter insertion for experienced registered nurses. *Journal of Continuing Education in Nursing*, *43*, 177–181.
Marcus, C. (2014). Strategies for improving the quality of verbal patient and family education: A review of the literature and creation of the EDUCATE model. *Health Psychology & Behavioural Medicine*, *2*(1), 482–495. doi:10.1080/21642850.2014.900450
Marshburn, D. M., Engelke, M. K., & Swanson, M. S. (2009). Relationships of new nurses' performance-based clinical competence. *The Journal of Continuing Education in Nursing*, *40*(9), 426–432. doi: 10.3928/00220124-20090824-02
Marton, F. (2006). Sameness and difference in transfer. *The Journal of the Learning Sciences*, *15*(4), 499–535.
Mathews, A., & MacLeod, C. (2005). Cognitive vulnerability to emotional disorders. *Annual Review of Clinical Psychology*, *1*, 167–195.
McInnes, S., Peters, K., Hardy, J., & Halcomb, E. (2015). Clinical placements in Australian general practice: (Part 1) the experiences of pre-registration nursing students. *Nurse Education in Practice*, *15*, 437–442. doi: 10.1016/j.nepr.2015.04.003
McIntosh, A., Gidman, J., & Smith, D. (2014). Mentors' perceptions and experiences of supporting student nurses in practice. *International Journal of Nursing Practice*, *20*(4), 360–365.
McWilliams, L. A., & Malecha, A. (2017). Comparing intravenous insertion instructional methods with haptic simulators. *Nursing Research and Practice*, *2017*, 1–11. Article ID4685157. doi: 10.1155/2017/4685157

Meeder, A. M., van der Steen, M. S., Rozendaal, A., & van Zanten, A. R. H. (2016). Phlebitis as a consequence of peripheral intravenous administration of cisatracurium besylate in critically ill patients. *BMJ Case Report*, 1–3. doi: 10.1136/bcr-2016-216448

Milutinović, D., Simin, D., & Zec, D. (2015). Risk factor for phlebitis: A questionnaire study for nurses' perception. *Revista Latino-Americana de Enfermagem*, *23*(4), 677–684. doi: 10.1590/0104-1169.0192.2603

Missen, K., McKenna, L., Beauchamp, A., & Larkins, J.-A. (2016). Qualified nurses' rate new nursing graduates as lacking skills in key clinical areas. *Journal of Clinical Nursing*, *25*, 2134–2143. doi: 10.1111/jocn.13316

Moulton, M. C., Lucas, L., Monaghan, G., & Swobada, S. M. (2017). A CLEAR approach for the novice simulation facilitator. *Teaching and Learning in Nursing*, *12*, 136–141. doi: 10.1016/j.teln.2016.11.003

Murray, C., Grant, M. J., Howarth, M. L., & Leigh, J. (2008). The use of simulation as a teaching and learning approach to support practice learning. *Nurse Education in Practice*, *8*, 5–8. doi: 10.1016/j.nepr.2007.08.001

National Curriculum Regulations for Nursing Programs [Forskrift til rammeplan for sykepleierutdanning]. Oslo: Norwegian Ministry of Education and Research. 25 January 2008; No. 128. Retrieved from https://lovdata.no/dokument/SF/forskrift/2008- 01-25-128

Niël-Weise, B. S., Stijnen, T., & van den Broek, P. J. (2010). Should in-line filters be used in peripheral intravenous catheters to prevent infusion-related phlebitis? A systematic review of randomized controlled trials. *Anesthesia & Analgesia*, *110*, 1624–1629. doi: 10.1213/ANE.0b013e3181da8342

Norwegian Directory of Medicines [Felleskatalogen]. 2010. Retrieved from https://www.felleskatalogen.no/medisin/norsk-helsenett

Norwegian Institute of Public Health/Folkehelseinstituttet Infeksjoner i Norge – Folkehelserapporten. (2014). [Infections in Norway – public health report 2014]. Retrieved from http://www.fhi.no/artikler/?id=110547

Oermann, M. H. (1990). Psychomotor skill development. *The Journal of Continuing Education in Nursing*, *21*(5), 202–204.

Phillips, N. M., Duke, M. M. & Weerasuriya, R. (2017). Questioning skills of clinical facilitators supporting undergraduate nursing students. *Journal of Clinical Nursing*, *26*, 4344–4352. doi: 10.1111/jocn.13761

Raaheim, A. (2011). *Læring og undervisning* [Learning and teaching]. Bergen: Fagbokforlaget.

Ravik, M., Havnes, A., & Bjørk, I. T. (2015). Exploring nursing students' transfer of peripheral venous cannulation from skills centre to the clinical setting. *Journal of Nursing Education and Practice*, *5*(3), 59–70. doi: 10.5430/jnep.v5n3p59

Ravik, M., Havnes, A., & Bjørk, I. T. (2017a). Defining and comparing learning actions in two simulation modalities: Students training on a latex arm and each other's arms. *Journal of Clinical Nursing*, *26*(23–24), 4255–4266. doi: 10.1111/jocn.13748

Ravik, M., Havnes, A., & Bjørk, I. T. (2017b). Conditions affecting the performance of peripheral vein cannulation during hospital placement: A case study. *Nursing Research and Practice*, *2017*, 1–10. doi: 10.1155/2017/9748492. Article ID 9748492

Reierson, I. Å., Haukedal, T. A., Hedeman, H., & Bjørk, I. T. (2017). Structured debriefing:What difference does it make? *Nurse Education in Practice*, *25*, 104–110. doi: 10.1016/j.nepr.2017.04.013

Ryle, G. (1949). *The concept of mind*. New York: Barnes and Noble.

Rystedt, H., & Sjöblom, B. (2012). Realism, authenticity, and learning in healthcare simulations: Rules of relevance and irrelevance as interactive achievements. *Instructional Science*, *40*, 785–798. doi: 10.1007/s11251-012-9213-x

Sullivan, E. A. (2012). Critical thinking in clinical nurse education: Application of Paul's model of critical thinking. *Nurse Education in Practice*, *12*, 322–327. doi: 10.1016/j.nepr.2012.03.005

Tofade, T., Elsner, J. & Haines, S.T. (2013). Best practice strategies for effective use of questions as a teaching tool. *American Journal of Pharmaceutical Education*, *77*(7), Article 155, 1–9.

Topping, K. J. (2005). Trends in peer learning. *Educational Psychology: An International Journal of Experimental Educational Psychology*, *25*(6), 631–645. doi: 10.1080/01443410500345172

Tun, J. K., Alinier, G., Tang, J., & Kneebone, R. L. (2015). Redefining simulation fidelity for healthcare education. *Simulation & Gaming*, *46*(2), 159–174. doi: 10.1177/1046878115576103

Tuomikoski, A-M., Ruotsalainen, H., Mikkonen, K., Miettunen, J., & Kääriäinen, M. (2018). The competence of nurse mentors in mentoring students in clinical practice - A cross-sectional study. *Nurse Education Today*, *71*, 78–83. doi: 10.1016/j.nedt.2018.09.008

WHO. (2016). *Nurse educator core competencies*. Retrieved from http://who.int/hrh/nursing_midwifery/nurse_educator050416.pdf

Zamanzadeh, V., Jasemi, M., Valizadeh, L., Keogh, B., & Taleghani, F. (2015). Lack of preparation: Iranian nurses' experiences during transition from college to clinical practice. *Journal of Professional Nursing*, *31*(4), 365–373. doi: 10.1016/j.profnurs.2015.01.005

Zarifsanaiey, N., Amini, M., & Saadat, F. (2016). A comparison of educational strategies for the acquisition of nursing student's performance and critical thinking: Simulation-based training vs. integrated training (simulation and critical thinking strategies). *BMC Medical Education*, *16*(294), 1–7. doi: 10.1186/s12909-016-0812-0

Zlatanovic, T., Havnes, A., & Mausethagen, S. (2017). A research review of nurse teachers'competencies. *Vocations and Learning*, *10*, 201–233. doi: 10.1007/s12186-016-9169-0