From the Department of Neurobiology, Care Sciences and Society

Karolinska Institutet, Stockholm, Sweden

STUDENTS' PERCEPTIONS OF INTERPROFESSIONAL LEARNING AND VIRTUAL PATIENTS IN PRIMARY HEALTHCARE

Carrie Tran

Karolinska Institutet

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Students' Perceptions of Interprofessional Learning and Virtual Patients in Primary Healthcare
Thesis for Doctoral Degree (Ph.D.)

By

Carrie Tran

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Principal Supervisor:
Associate Professor Helena Salminen
Karolinska Institutet
Department of Neurobiology, Care Sciences and Society
Division of Family Medicine and Primary Care

Co-supervisor(s):
Ph.D Eva Toth–Pal
Karolinska Institutet
Department of Neurobiology, Care Sciences and Society
Division of Family Medicine and Primary Care

Professor Solvig Ekblad
Karolinska Institutet
Department of Learning, Informatics, Management and Ethics, Cultural Medicine

Professor Uno Fors
Stockholm University
Department of Computer and Systems Sciences

Opponent:
Professor Sari Ponzer
Department of Clinical Science and Education, Södersjukhuset

Examination Board:
Professor Italo Masiello
Linnaeus University
Department of Computer Science and Media Technology

Associate Professor Desirée Wiegleb Edström
Örebro University
School of Medical Sciences

Professor Max Scheja
Stockholm University
Department of Education

Popular science summary of the thesis

Imagine you have a father or know an elderly person who recently came home from the hospital after a surgery for a hip fracture, and had multi-comorbidity. Perhaps he does not live alone, but rather with his wife, who has early symptoms of dementia. His health condition was getting worse since he came home from the hospital, and he was not able to get to the primary healthcare centre. His wife was concerned about him but could not help him. What makes this aged person's health condition worsen and who can help him and how?

This is a common case that might occur in primary healthcare.

Studies have shown that when different healthcare professions collaborate, this results in increased patient safety and more efficient healthcare. Students need to be prepared working in teams in their future work life.

The overall aim of this thesis was to find new ways to facilitate students' interprofessional learning in primary healthcare. In the first study we explored how students from four different healthcare professions (nursing, medicine, occupational therapist, and physiotherapist students) perceived prerequisites for interprofessional learning in primary healthcare. Our findings in the first study showed that the students perceived a need for support from both clinical supervisors and study programmes if interprofessional learning could take place. In our second study, we have developed and assessed a virtual patient model in primary healthcare. The virtual patient model was pedagogically designed to facilitate students learning when working in small groups of three to four students. It included four stages in an iterative learning cycle. The students formulated their learning goals as a team. In the first stage, the students reflected on what they already knew and what they needed to learn more about. There were questions provided to the students for preparation to the next stage. The students were then provided concrete experiences such as short video clips (there were four in total) and textual information about the case and about the different healthcare professions' roles working with the patient. In the third stage, the students were

asked to reflect on the short videos they had watched and were asked questions they were to respond to in open-text format and submit to the system. In the last stage they received pre-prepared teachers' comments to the questions they had been asked. We found that the students perceived the different learning methods in the virtual patient model facilitated interprofessional learning and perceived that they had gained a deeper understanding of team collaboration. The virtual patient model increased interaction and reflections between students. In the last study, we assessed whether the virtual patient model could facilitate learning for groups of solely medical students. We also wanted to know how the medical students perceived working in groups with the virtual patient model when they were connected remotely online. The students reported that working with the virtual patient model deepened their knowledge of the healthcare professions included in the patient case. The students reported that working online remotely in groups was almost as if they had been working in the same room, since they could see the same things on the screen.

Populärvetenskaplig Sammanfattning

Föreställ dig att du har en far eller känner en äldre man som nyligen kommit hem från sjukhuset efter en operation av höftfraktur eller en annan form av fraktur. Han är även multisjuk. Han kanske inte bor ensam utan med sin hustru som har milda symtom av demens. Hans hälsa blev sämre sedan han kom hem från sjukhuset, men klarade inte av att åka till vårdcentralen. Hans hustru var orolig för honom men hon kunde inte hjälpa honom. Vad var det som gjorde att den här äldre mannens hälsa blev sämre och vem kan hjälpa honom?

Detta är ett vanligt fall som kan förekomma i primärvården.

Studier har visat att när olika hälso-och sjukvårdsprofessioner samarbetar resulterar det till ökad patientsäkerhet och effektivare vård. Studenter behöver därför förberedas att arbeta i team inför deras framtida arbetsliv.

Det övergripande syftet med avhandlingen var att hitta nya sätt för att främja studenternas interprofessionella lärande i primärvården. I vår första studie har vi undersökt hur studenter från fyra olika professioner (sjuksköterska, läkare, arbetsterapeut och fysioterapeut) upplevde förutsättningar för interprofessionellt lärande i primärvården. Vårt fynd i första studien var att studenterna upplevde att de behövde stöd och uppmärksamhet från både studieprogrammen och alla professioner som arbetar på vårdcentralen, för att interprofessionellt lärande ska kunna ske. I vår andra studie utvecklade och utvärderade vi en interprofessionell virtuell patientmodell i primärvården. Den virtuella patientmodellen var pedagogiskt designat för att främja studenters lärande när de arbetar i små grupper om tre till fyra studenter. Modellen inkluderar fyra steg i en upprepande lärandecykel. Studenterna började med att formulera lärandemål som ett team. I första steget reflekterar studenterna över vad de redan kan och vad de behöver veta mer om. De får frågor att besvara som är förberedande för nästa steg. I nästa steg får de konkreta upplevelse såsom kort videofilm (det finns fyra filmer totalt) och information i form av texter om patientfallet och om olika professioners roller som arbetar med patienten. I det tredje steget ber vi studenterna att reflektera

över de konkreta upplevelserna som de har tittat på och besvara frågor i fritext och sedan skicka in sina svar in i systemet. I det sista steget får studenterna lärarkommentarer som är formulerade i förväg och dessa får de efter de har skickat in svaren i systemet. Vi fann att studenterna upplevde att de olika lärandemetoder som finns i modellen främjade interprofessionellt lärande och de upplevde att de har fått ökad förståelse för teamsamarbete. Virtuella patientmodellen ökade interaktion och reflektion mellan studenterna.

I den sista studien har vi utvärderat om den interprofessionella virtuella patientmodellen kan främja studenternas interprofessionella lärande med student grupper från bara en profession. Vi ville också undersöka hur studenterna upplevde att arbeta i grupp med vår interprofessionella virtuella patient uppkopplad på distans. Studenterna rapporterade att arbeta med den interprofessionella virtuella patienten gav en upplevelse av fördjupad kunskap om andra professioner som var inkluderade i patientfallet. Studenterna rapporterade att arbeta i grupp uppkopplad på distans upplevdes som om de var i samma rum eftersom de kunde se samma sak på skärmen.

Abstract

Background: The benefits of interprofessional education in healthcare, such as improved communication and ability to teamwork, are well known globally. There is a need to prepare students for interprofessional collaboration in their future participation in the workforce. Healthcare educational programmes usually take place isolated from each other, which is an obstacle for collaboration between different healthcare students.

Aims: The overall aim of the present thesis was to find new ways to facilitate the students' interprofessional learning in primary healthcare. The aim of study I was to explore how healthcare students' perceived prerequisites for interprofessional education in primary healthcare. Study II was aimed to develop and assess an interprofessional virtual patient model for students´ learning. Study III had the aim to explore how a virtual patient could facilitate learning about team collaboration in online groups for students solely from the medical programme.

Material and Methods: A qualitative approach was used in study I and study II. Study III had a mixed methods design. In study II, we created the virtual patient model. The quantitative data in study III was an individual questionnaire before and after each virtual patient session. Studies I, II and III used semi-structured group interviews. In studies I and II, the students came from nursing, medical, physiotherapy and occupational therapy programmes. In study III, they were solely medical students.

Results: Students perceived obstacles for interprofessional education in primary healthcare, such as limited opportunities to meet other healthcare students. Students perceived a need for support and awareness from study programmes and from healthcare professionals working in primary healthcare (study I). The virtual patient model was developed, and it was assessed by students from four different study programmes. The students perceived that the virtual patient model facilitated their learning. The mixture of text and multimedia gave the students a feeling of authenticity in the case and stimulated group discussions

(study II). The medical students in study III perceived that the virtual patient model provided them insight into team collaboration. Working with the virtual patient remotely online functioned well. The results from the questionnaires showed that the students gained insights into the roles and skills and expertise of other healthcare professions.

Conclusions: The students need support and awareness of interprofessional education both from study programmes and clinical placements. The interprofessional virtual patient may assist faculty and clinical supervisors to plan interprofessional learning activities. The virtual patient could be used in groups of students from different healthcare professions or groups of only one profession. It could also be used face-to-face or online remotely.

List of scientific papers

I.   Tran C, Kaila P, Salminen H.
Conditions for interprofessional education for students in primary healthcare – a qualitative study. BMC Medical Education 2018;18(1)

II.   Tran C, Toth-Pal E, Ekblad S, Fors U, Salminen H.
A virtual patient model for students' interprofessional learning in primary healthcare. PLosONE. 2020;15(9)

III.   Tran C, Toth-Pal E, Ekblad S, Fors U, Salminen H.
Medical students' learning about other professions using an interprofessional virtual patient while remotely connected with a study group: Mixed methods study. JMIR Med Educ 2023;9

Contents

List of Terminology

BSAsim	A virtual patient system (Children as next-of-kin in Swedish) used as a foundation for development of the Interprofessional virtual patient system.
Virtual patient	Virtual Patient Case, that run from a virtual patient system
Virtual patient system	A server-based system used for creating, editing and running virtual patient cases from
Interprofessional virtual patient model	A pedagogical model for using a virtual patient in an interprofessional learning activity (uses an iterative learning cycle)
Interprofessional virtual patient system	A virtual patient system was developed according to the interprofessional virtual patient model

Introduction

The World Health Organization in its call for action has encouraged educators, healthcare workers and global health advocates to embed interprofessional education in all healthcare educations that deliver healthcare services (World Health Organization, 2010). Interprofessional education is necessary to prepare students with skills and readiness for future teamwork.

Primary healthcare focuses on the population's needs, from health promotion and disease prevention to treatment, rehabilitation, and palliative care (AlmaAlta, 1978). Healthcare professions in primary healthcare encounter patients of all ages. This implies that a primary healthcare setting may be an excellent arena for students' clinical learning. Unfortunately, conditions for interprofessional learning are not ideal due to several reasons, full timetables and logistical problems where clinical placements in primary healthcare for students are not synchronised (Jill, 2015). For this reason, it is a challenge to arrange interprofessional learning activities for students in primary healthcare.

Technologies such as virtual patients can be used as a complement in clinical education. Virtual patients are a form of educational technology resource that has been used in different settings in healthcare education (Kononowicz et al., 2018). In this thesis one educational technology resource is used and that is a virtual patient. Virtual patients allow students to practice repeatedly without any harm to the patient in a safe environment (Ellaway, Poulton, Fors, McGee, & Albright, 2008). Virtual patients have been used to practice clinical reasoning, teaching communication and clinical skills, for blended learning, etc. (Berman, Durning, Fischer, Huwendiek, & Triola, 2016; Carrard, Bourquin, Orsini, Schmid Mast, & Berney, 2020; Forsberg, Georg, Ziegert, & Fors, 2011; Kononowicz et al., 2019; Posel, McGee, & Fleiszer, 2015). It is very common that virtual patients are designed for only one health profession in a hospital setting (Bateman, Allen, Samani, Kidd, & Davies, 2013; Georg, Karlgren, Ulfvarson, Jirwe, & Welin, 2018; Rothlind, Fors, Salminen, Wändell, & Ekblad, 2021). There are only few studies within virtual

patients for interprofessional learning (Edelbring, Broberger, Sandelius, Norberg, & Wiegleb Edstrom, 2021; Shoemaker, Platko, Cleghorn, & Booth, 2014).

The transition from on-campus learning to distance learning increased due to the COVID-19 pandemic (Armstrong-Mensah, Ramsey-White, Yankey, & Self-Brown, 2020; Schneider & Council, 2021). There are benefits identified with distance learning for the learner, for instance saving time by avoiding travel. Regarding academic achievements some research shows no difference between distance learning and on-campus learning (Croft, Dalton, & Grant, 2010; Davies, Hall, Harpin, & Pullan, 2005).

The focus of the present thesis is how students perceived interprofessional learning and perceptions of using an interprofessional virtual patient model in primary healthcare.

1 Background

In this section, the central concepts used in this thesis will be explained. The main focus will be on students' interprofessional learning in a primary healthcare context. Virtual patients in this thesis are used as an educational tool for students gaining increased learning about other healthcare professions and to gain knowledge about collaboration with other professions in primary healthcare.
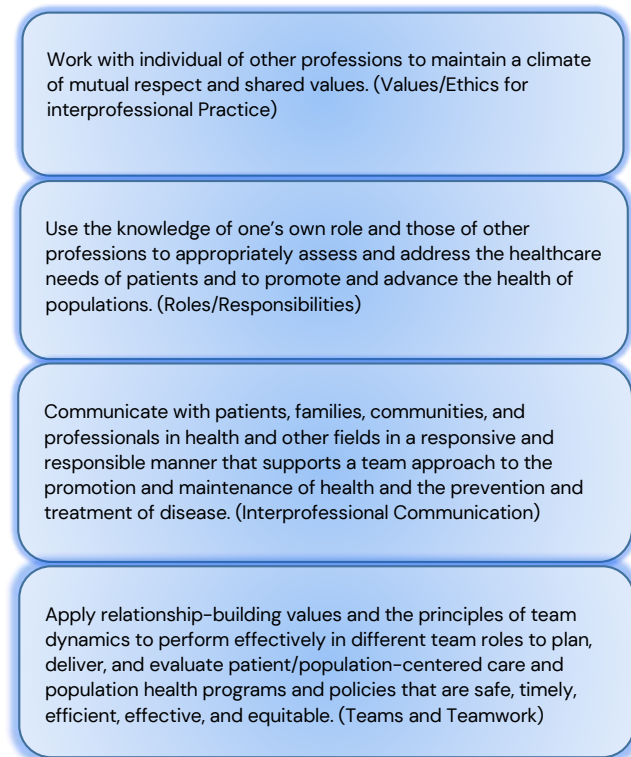
1.1 Interprofessional Learning

Interprofessional education provides students with skills and prepares them to become a part of the collaborative practice-ready healthcare professions in their future teamwork (World Health Organization, 2010). When students from different healthcare professions learn together, their teamwork skills improve, with increased quality of care and increased patient safety (Hammick, Freeth, Koppel, Reeves, & Barr, 2007; World Health Organization, 2010).

Most international studies use the term interprofessional education which occurs when "students from two or more professions learn with, from and about each other to improve collaborative practice and quality of care" (CAIPE, 2017).

Some terms need conceptual clarification. The term "interprofessional" is a widely accepted term, but multiprofessional and interprofessional have been used synonymously (Thistlethwaite, 2012). In multiprofessional learning different healthcare students are brought together to learn in parallel. Unfortunately, students are not taught to work collaboratively in multiprofessional learning (Oandasan & Reeves, 2005). In this thesis we have placed the focus on interprofessional learning which means learning occurs from interactions between two or more different healthcare students. Learning could also occur spontaneously in educational or practice settings (Thistlethwaite, 2012). The preposition "with, from and about" are essential to the students learning experience. In other words, students must interact with each other, whether it takes place in clinical settings, in a classroom or online in an interprofessional learning activity (Thistlethwaite, 2012).

To move beyond education in silos, the Interprofessional Education Collaborative of the United States has created core competencies for interprofessional collaborative practice, with the aim to guide development of the framework for interprofessional education curriculum (IPEC, 2016). These four core competencies are: Values/Ethics for Interprofessional Practice, Roles and Responsibilities, Interprofessional Communication, and Teams and Teamwork (Figure 1).

Figure 1. The Interprofessional Education Collaborative Core Competencies (IPEC, 2016).

Work with individual of other professions to maintain a climate of mutual respect and shared values. (Values/Ethics for interprofessional Practice)

Use the knowledge of one's own role and those of other professions to appropriately assess and address the healthcare needs of patients and to promote and advance the health of populations. (Roles/Responsibilities)

Communicate with patients, families, communities, and professionals in health and other fields in a responsive and responsible manner that supports a team approach to the promotion and maintenance of health and the prevention and treatment of disease. (Interprofessional Communication)

Apply relationship-building values and the principles of team dynamics to perform effectively in different team roles to plan, deliver, and evaluate patient/population-centered care and population health programs and policies that are safe, timely, efficient, effective, and equitable. (Teams and Teamwork)

1.2   Interprofessional Learning in Primary Healthcare Settings

The Swedish Health and Medical Services Act (Riksdag, 2017) has defined primary healthcare as outpatient care provided with no separation regarding diseases, age or patient groups. Primary healthcare is responsible for the basic medical treatment, nursing care, prevention and rehabilitation that does not require

hospitals' medical and technical resources or other special skills. Primary healthcare focuses on the individual's needs and health problems in the community. Healthcare professionals in primary healthcare encounter patients of all ages and patients with chronic illness (AlmaAlta, 1978; World Health Organization, 2010).

Students meet patients in primary healthcare with chronic diseases and other health issues that require integration of a range of different healthcare professions perspectives. In other words, primary healthcare settings offer students a promising arena for interprofessional learning (Kent et al., 2016).

In the Region Stockholm there are approximately 220 primary healthcare centres and around 500 units (including child, maternity care units and rehabilitation). The collaborations between healthcare professions in primary healthcare takes place often by referrals or medical records or telephone contact. Consequently, this way of how healthcare professions collaborate with each other in primary healthcare is not consistent with what students learn about working in teams (Toth-Pal, Fridén, Asenjo, & Olsson, 2020).

There are several challenges to arranging and offering students interprofessional learning activities in primary healthcare settings, as shown in a study from primary healthcare in Stockholm (Toth-Pal et al., 2020). Some of those are:

1) Lack of time from the clinical supervisors due to clinical duties.

2) Difficulties in finding a suitable patient case for an interprofessional learning activity, which is crucial.

3) To arrange for different healthcare students to meet at the same time and have their respective clinical supervisor attending the activity. In other words, arranging an interprofessional learning activity is very time-consuming.

Studies about interprofessional learning in primary healthcare setting are increasing (Fowler, Sterrett, Smith, Bailey, & Cartmell, 2023; Kent et al., 2016; Reeves, Fletcher, McLoughlin, Yim, & Patel, 2017; Toth-Pal et al., 2020) but still not

as much as in clinical education wards in hospital settings (Hood, Cant, Leech, Baulch, & Gilbee, 2014; Hylin, Lonka, & Ponzer, 2011; Kvilhaugsvik & Almås, 2023; Lachmann, Ponzer, Johansson, Benson, & Karlgren, 2013; San Martín-Rodríguez, Beaulieu, D'Amour, & Ferrada-Videla, 2005).

1.3   Clinical Placements for Students in Primary Healthcare

The health education programmes for nursing, occupational therapy and physiotherapy students had three years (six semesters) in total while medical students had five and a half years (eleven semesters) in total in their study programme when the present studies were conducted. Clinical placements in primary healthcare for students from different study programmes are not synchronized. Medical students in Stockholm had clinical placements at primary healthcare centres recurrently in nine of eleven semesters from semester one, between two and eight days per semester. Occupational therapy students had five weeks of clinical placements when they were in their fourth semester. Nursing students had four to five weeks in the middle of the programme. Physiotherapist students had seven weeks in total when they were in their semester five.

1.4   Students' Learning in Clinical Primary Healthcare Context

Learning in a clinical primary healthcare setting is essential for healthcare students' professional development. A clinical setting provides students with opportunities to apply theory and practice in a real situation. Learning in a clinical context takes place by participating in patient care activities (Berkhout, Helmich, Teunissen, van der Vleuten, & Jaarsma, 2018). Clinical learning in primary healthcare is complex because the students usually meet each patient just for 15 to 30 minutes and they most often do not know whether they can meet the patient again. This makes it difficult for the students to follow up on the patient's health condition and treatment. Most often, the patient receives a prescription for medication or instructions for self-care, however health professionals can never know whether the patient follows the instructions and whether their health situation improves until the next contact. There are other complexities regarding home care. Person-centred care is about providing care in a respectful way and

having a holistic approach to the patient's subjective experiences of disability or impairment, because each individual is unique (Edvardsson & Backman, 2020). Healthcare providers have to take all this in consideration. Most patients in primary healthcare do not meet their family physicians on a regular basis unless they have chronic conditions. In primary healthcare, it is more difficult for the students to follow what happens with an individual patient, the patients often have chronic conditions and are monitored over years. However, clinical learning in a primary healthcare setting is not only complex but also flexible since the students meet patients with a wide variety of health issues in the clinic and in the patients' homes. Unfortunately, medical students usually do not participate in-home visits. Most of the family physicians meet the patient at the clinic, while nurses, occupational therapists and physiotherapists are the healthcare professions that are more involved in home visits. Therefore, those students also have more opportunities to take part in-home visits with their clinical supervisors.

Distance Learning

Distance learning and distance education have been used interchangeably. Moore et al. (2011) explained that distance learning is referenced more as ability and distance education is an activity within the ability. In distance learning, the learners and the instructor are involved at different times and/or places.

There are several advantages with distance learning such as participants who are geographically widely scattered are able to receive high quality education and reduce travel time (Davies et al., 2005). Studies have shown no significant differences in distance learning compared to on-campus learning regarding academic achievement (Billings, Ward, & Penton-Cooper, 2001). There are also some disadvantages with distance learning such as the risk for decreased student engagement, reduced sense of belonging to a community of learners and increased student burnout (Kaczmarek, Chen, & Ohyama, 2021).

A number of different tools have been used during the COVID-19 pandemic for learning at a distance and these include: Massive Open Online Courses and social media platforms such as Twitter, and Microsoft Teams, with the online

communication tool Zoom, being the most common tool being used worldwide, having grown from 10 million users to 300 million users between December 2019 and April 2020 (Hilburg, Patel, Ambruso, Biewald, & Farouk, 2020; Tabatabai, 2020).

1.5   Virtual Patients

There is a wide range of uses of the term "virtual patient" in healthcare education. In the present thesis we use the definition of virtual patient formulated by Ellaway et al. (2008) "An interactive computer simulation of real-life clinical scenarios for the purpose of healthcare and medical training, education or assessment."

A well-designed virtual patient could be effective for students' learning when they have limited access to real patients (Ellaway et al., 2008). Ellaway et al. (2008) claimed that there are some requirements for a good virtual patient design. Providing feedback to students is essential when working with virtual patients. Formative feedback which is provided during learning is the most powerful enhancement to learning according to Biggs (Biggs & Tang, 2011). In a review of 12 meta-analyses on feedback in classrooms, Hattie (2007) concluded that, under the right conditions, feedback in a formative context can contribute significantly to students' achievements. Several studies have mentioned authenticity as an important requirement for a good virtual patient design. If the virtual patient case appears authentic the students are likely to have a positive learning experience (Botezatu, Hult, & Fors, 2010; Cook, Erwin, & Triola, 2010; Ellaway et al., 2008; Huwendiek et al., 2009).

The benefit of using virtual patients is to avoid risks of harm to patients and still allow students to practice as a healthcare provider. Virtual patients provide students an opportunity to train repeatedly in a safe and responsive environment (Ellaway et al., 2008). A review study assessing students' preferences when using virtual patients found that students favoured blended learning in a mix of virtual patients and traditional education (Kononowicz et al., 2019). It is well documented that using virtual patients to develop skills in clinical reasoning in healthcare

education (Botezatu et al., 2010; Cook & Triola, 2009; Forsberg et al., 2011; Georg & Zary, 2014; Salminen, Zary, Bjorklund, Toth-Pal, & Leanderson, 2014; Sunnqvist, Karlsson, Lindell, & Fors, 2016). Virtual patients can be used to practise other skills. For example, in a study by Carrard (2020) medical students practised how to deliver bad news to patients in the context of oncology. Medical students in a study by Woodham et al. (2019) used virtual patients for training against mistakes in providing medical care . However, few studies have used virtual patients to practice interprofessional learning, which calls for further studies (Bjorklund & Silen, 2021; Edelbring et al., 2021; Shoemaker et al., 2014).

1.6   Rationale for the Thesis

The use of virtual patients can be applied for example to clinical reasoning and interprofessional learning in different settings, with the aim to prepare students before meeting real patients. Students have limited opportunities for interprofessional learning in primary healthcare. There is still a lack of studies about how a virtual patient model can facilitate students' interprofessional learning in a primary healthcare setting.

2 Research Aims

The overall aim of this thesis was to find new ways for facilitating students' interprofessional learning in primary healthcare. To achieve the aim, the specific research questions in each study were as follows:

- ❖ How do students from four different study programmes perceive conditions for interprofessional education in primary healthcare? (Study I)

- ❖ How to develop an interprofessional virtual patient model for students learning in primary healthcare? How do the students perceive learning with the virtual patient? (Study II)

- ❖ How can an interprofessional virtual patient case facilitate medical students learning about team collaboration in online groups? How do students perceive working with the virtual patient when they are connected remotely to their group? (Study III)

3 Methodology

3.1 Theoretical Stance of This Thesis

The present thesis' theoretical stance is based on a constructivist paradigm (Guba & Lincoln, 1994). A paradigm is a set of theories, assumptions and ideas that contribute to how the world is understood. To understand a paradigm there are three key questions that are central; the ontological question (what is the nature of reality), the epistemological question (what is the nature of knowledge) and methodological question (what is the nature of the research approach) (Guba & Lincoln, 1994; Varpio & MacLeod, 2020). There are multiple realities (constructivist ontology), and knowledge is constructed in interaction between and among researchers and participants (constructivist epistemology). Constructivist methodology was used as an approach to analysing the data. This meant that the research group members interacted, discussed, compared, and negotiated their interpretations of the written text to reach a consensus of the meaning (Guba & Lincoln, 1994; Labonte & Robertson, 1996). The learner develops ways of understanding the world and making sense of new information based on their past experience. There is not one world that is more real than any other since our personal world is created by the mind (Jonassen, 1991). Social constructivism is a theory of learning where the creation of knowledge cannot be separated from the social environment (Adams, 2006; Vygotsky, 1978). According to Jarvis (Illeris, 2009) learning always starts with experience and the experience is always social. Similarly, experiential learning theory was developed by Kolb and conceived as a learning process grounded in experiences (Kolb, 1984). Experiential learning theory describes how learning takes place in cycles that have four stages: Concrete experience, Reflective observation, Abstract conceptualisation and Active experimentation. These four stages are often portrayed as Kolb's learning cycle, and it is an iterative process and supports life-long learning.

3.2 Study Design

Qualitative study (Patton, 2002) has been used in studies I and II, to explore students' perceptions of conditions for interprofessional education in primary

healthcare (study I) and to assess the virtual patient model that we have developed (study II). A convergent mixed-methods design (Shorten & Smith, 2017) has been used in study III to explore medical students perceptions of working remotely online with the interprofessional virtual patient. The data was collected with group interviews and analysed with content analysis. The purpose of content analysis is to provide knowledge, new insights and an understanding of the phenomenon under study (Elo & Kyngäs, 2008; Hsieh & Shannon, 2005). There is not enough former knowledge about how students perceive interprofessional learning and virtual patients in primary healthcare. The analysis had an inductive approach (Elo & Kyngäs, 2008). The results come mostly from qualitative data in study III. The qualitative and quantitative data were collected and analysed in parallel.

3.3 Methods

In this section, an overview of all three studies will be presented (Table 1) and an overview of the participating students in the studies (Table 2). A delineation of how data was collected, a description of the virtual patient model and how data analysis in all three studies was performed are also presented. Furthermore, a brief description of the software simulation system for the development of the interprofessional virtual patient and how the virtual patient case was planned is provided.

Table 1. An overview of the focus of the three studies, participants, data collection and data analysis methods.

Study	Focus of the Study	Participants	Data Collection	Data Analysis
I	Conditions for interprofessional education in primary healthcare	Nursing, occupational therapy, physiotherapy, and medical students	Semi-structured group interviews	Content analysis
II	Development and assessment of an interprofessional virtual patient model	Nursing, occupational therapy, physiotherapy and medical students	Semi-structured group interviews	Construction of an interprofessional virtual patient model

Content analysis |
| III | Medical students' learning with an interprofessional virtual patient. Perception of remotely online learning | Medical students | Questionnaires

Semi-structured group interviews | Content analysis and descriptive/ comparative statistical analysis |

3.3.1 Contexts and Participants

The context in this thesis was the setting of primary healthcare in Stockholm, Sweden. The participating students were from four different study programmes: nursing, occupational therapy, medical and physiotherapy. All students had clinical placements in primary healthcare and the period for these placements could vary between one week to seven weeks. The students were from one medical university (Karolinska Institutet) but some of the nursing students were from two other universities (Sophiahemmet University and Marie Cederschiöld University). Most of the students have or have had clinical placements in primary healthcare.

Table 2. Overview of the participating students in all three studies grouped by gender and healthcare professions.

Student Category					
Study	Total (N) Gender (M/F)	Medical	Nursing	Occupational Therapy	Physiotherapy
I	N=26 8/18	8	4	9	5
II	N=39 13/26	12	16	4	7
III	N=49 18/31	49	–	–	–

3.3.2 Data Collection

The data was collected according to the overall aim of the thesis and specific research questions of each study. Data was collected through group interviews in all three studies. Study II started with planning and the construction of the interprofessional virtual patient model. In study II the students were also asked to answer a questionnaire on how they perceived working with the virtual patient model. They could also provide suggestions for improvement and give comments. In study III, each student was asked to answer separate questionnaires before and after the virtual patient session. Demographic information about the students was included in the questionnaire in studies I, II and III. The students were asked about their age, gender, which semester of the study programme they were currently in, along with prior experiences relating to interprofessional learning activities.

Semi-structured group interviews were used to explore students' perceptions of interprofessional learning in primary healthcare in study I and assess the newly developed interprofessional virtual patient in study II. In study I and study II, the group interviews were performed face-to-face. In study III the interviews were performed online via an online communication tool (Zoom: Zoom Video Communications, Inc). The size of each group varied between two to nine participants. In the semi-structured group interviews, an interview guide with open-ended questions was used. The interviewer helped the participants keep the discussions within the research topic and posed follow-up questions.

In the group interviews, the students were encouraged to exchange ideas and opinions. In order to cover the research objectives, data was collected from groups of students from four different study programmes in study I and study II. Study III explored how groups of solely medical students perceived working with the virtual patient and how they perceived their understanding of team collaboration before and after they had worked with the virtual patient.

The Interprofessional Virtual Patient System

We used the server software "Children as next-of-kin simulation" (BSAsim) as a foundation for the interprofessional virtual patient system. BSAsim was initially developed by Stockholm University to train practising clinicians on the management of patients with issues that are influencing their children' well-being. To suit the aims of this project, the BSAsim was adjusted and re-developed by a team consisting of researchers from Karolinska Institutet (HS, ETP, CT), a specialist on virtual patient cases from Stockholm University (UF), in cooperation with two software developers and a graphical designer at Stockholm University.

We wanted the virtual patient system to have two specific features in order to fit our pedagogical model. Firstly, the system allows open-text format responses to questions, giving the students the freedom and space to respond in as much detail as they like and secondly, the possibility to embed film clips and other material in the system.

The Interprofessional Virtual Patient Model

The interprofessional virtual patient model was based on a pedagogical model originally designed for a virtual patient aimed at medical students in primary healthcare in Stockholm (Salminen et al., 2014). The model used an iterative learning cycle and was designed from social constructivist and experiential learning theory. The virtual patient model was created for students where they construct their knowledge by interacting with other students in a social context (Vygotsky, 1978). In an experiential learning process, the students are learning by doing and by engaging in hands-on experiences (Kolb, 1984). The virtual patient model was inspired by Kolbs' learning cycle and contained four stages. Before entering the iterated learning cycles, the students formulated their learning goals for this interprofessional learning activity with a virtual patient case as a team and reflected on what they already knew and what they needed to expand their knowledge of. In the first stage of the learning cycle there were questions provided to the students so they could be prepared for the short video films or other material of the next stage. The second stage consisted of concrete experiences such as short video clips in Figure 2 (there were four video clips in total). In the third stage, the students were asked to reflect on the short video they had watched, or they were asked to give open-ended answers to questions and submit their responses to the system as a team. In the last stage, they received pre-prepared teachers' comments after they had submitted their answers to the system. This cycle with the four stages was repeated four times with longitudinal contents that covered three weeks in the patient's life. Before closing the session, the students were asked to reflect on what they had achieved during the activity and asked if they had reached their personal learning goals for the learning activity. The virtual patient model was aimed to facilitate self-directed learning (Murad & Varkey, 2008; Silen & Uhlin, 2008). The students formulated their own learning goals and were responsible for taking control of their own learning. Depending upon the students prior knowledge about other healthcare professions, they decided what they wanted to learn more about in this learning activity. The virtual

patient model had the intention to stimulate reflection-in-action in every learning cycle and reflection-on-action at the end of the session (Schön, 1983).

Figure 2. Screenshots from four embedded short video clips showing the patient and his wife acting in their home and the patient receiving home visits by four different healthcare professions and community-based home care
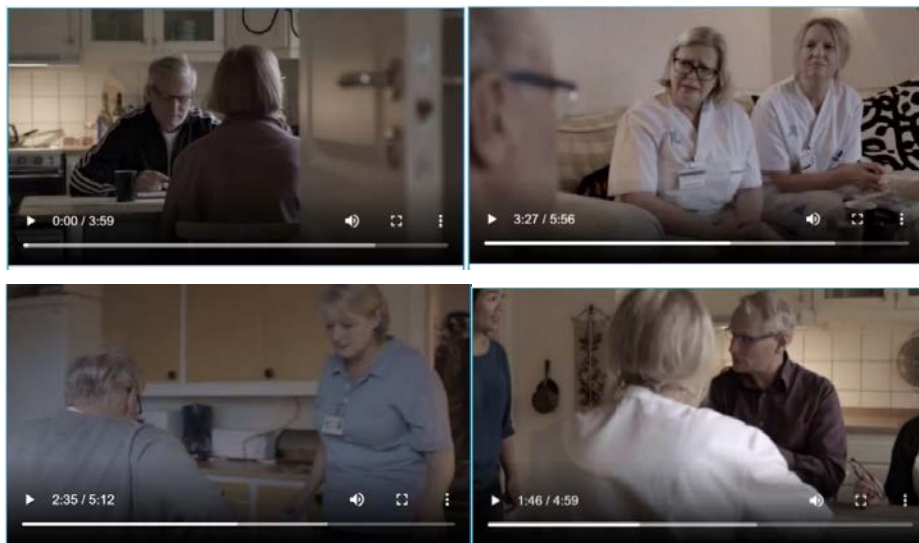
The Interprofessional Virtual Patient Case

The patient case was based on an authentic patient history of a 73-year-old patient who needed care in his home after surgery for a hip fracture. The patient history was then complemented with the perspectives of all healthcare professions who could contribute to the care of the patient.

A district nurse and a family physician who first scripted the patient case worked in primary healthcare. Other healthcare professions outside the research group who were relevant to the virtual patient case were invited to share their perspectives. The involved healthcare professionals who worked in primary healthcare at the time were occupational therapists, physiotherapists, counsellors, dieticians and care managers. A description of the patient's case was sent to representatives of their professions before a face-to-face interview to allow familiarisation with the case and to prevent misunderstandings. When all the contributions were gathered from the involved healthcare professions, three

programme directors at Karolinska Institutet (occupational therapy, physiotherapy and nursing programme) were invited to comment on the pre-prepared teachers´ comments that concerned their professions.

The film recording for the video clips was carried out by a film producer, a film photographer and actors. All participants who acted in the video clips were health professionals who played their own professional role. The role of the patient was played by a family physician and the patient's wife was played by an exam invigilator. The actors received background information about the patient, especially the actor who played the role of the patient. The information included the patient's hobbies, his chronic diseases, information about his family, etc.

The virtual patient case was further developed after receiving feedback from the students in study II. Several minor changes were made to improve the virtual patient case. In some of the sessions in study II we found that there was very little interaction between the occupational therapist and the medical students, and between physiotherapy and nursing students. In order to facilitate those student interactions, we also asked teachers and clinicians for more perspectives from physiotherapists and occupational therapists. The final version of the virtual patient case was then created with help from the specialist in virtual patient cases and his colleagues from Stockholm University.

3.3.3 Data Analysis

Qualitative Analysis of Data

All studies used content analysis to analyse the data. Content analysis (Krippendorff, 2013) is a scientific tool. This research technique aims to provide new insights and increase the researcher's understanding of social phenomena. The process of content analysis involves a systematic reading of a body of text, and coding raw messages such as images and symbolic matters. All the interviews were transcribed verbatim. The analysis deals with both latent and manifest content (Graneheim & Lundman, 2004; Kondracki, Wellman, & Amundson, 2002).

The material in the study was pseudonymised, and in all transcriptions the participants were assigned codes before starting the process of analysis.

The process of content analysis consists of several steps. The transcription needed to be read and reread so as to obtain a sense of the whole. Meaningful parts were chosen as "meaning units." In other words, identify meaning units relevant to the aim. Condensation is a process of shortening the text while preserving the core. The condensed texts are then abstracted into codes. Codes with similar content were grouped into sub-categories. Sub-categories were compared with each other and sorted into categories and a theme was formed. A theme can be seen as expressing underlying meaning through condensed meaning units, codes, and categories on an interpretative level (Elo & Kyngäs, 2008; Graneheim & Lundman, 2004; Krippendorff, 2013). According to Varpio et al. (2017) when the researcher interacts with the data, and with the research team, it makes it possible to bring forth thematic identification and description.

Statistical Analysis of Quantitative Data

Stata/BE (version 17; StataCorp LLC) was used to analyse students' answers to the questionnaires that students filled in before and after the virtual patient sessions. Differences in scores before and after the learning activity was analysed using the Wilcoxon signed-rank test for paired measurements and median scores whilst IQRs were calculated.

3.3.4 Trustworthiness

Trustworthiness is required in qualitative studies and there are four primary criteria to ensure trustworthiness. Those criteria are credibility, dependability, and transferability. Trustworthiness deals with establishing these four criteria, which are described in greater detail below. Furthermore, face validity and reflexivity will be described.

Credibility asks how the findings are in agreement with reality. In the present thesis credibility was ensured by the selection of participants who were relevant and appropriate for the research question. The participants in all three studies

have had or presently have experiences of clinical placements in primary healthcare. All participating students in the three studies received information informing them that their participation was voluntary, and they could withdraw from the study without that having any impact on their future studies. The interviewer had no relationship as a teacher to the students, which enhanced credibility. Furthermore, credibility was enhanced by using statements from the students to present the findings (Graneheim & Lundman, 2004). Investigator triangulation was used, via the involvement of multiple researchers from a variety of healthcare professions in order to reduce bias in gathering, reporting and analysing data. In qualitative research, the focus is not on numbers, e.g. not on how many students from each profession have a certain opinion, but rather the aim is to gain a more in-depth understanding of the process that provides answers to the research questions.

Dependability refers to the consistency of the findings (Marshall & Rossman, 2016). Qualitative group interviews were used in studies I and II. In study III we used mixed methods with both questionnaires before and after the virtual patient sessions, and then in group interviews after the sessions. Group interviews were performed directly after each virtual patient session in studies II and III. Data collection was performed over a short period of time and that makes the consistency stronger.

Transferability refers to the study findings that can be transferred to other settings or contexts with other respondents (Polit & Beck, 2008). The pedagogical model in the system was created to be used in many different professional contexts within clinical teaching, which can enhance transferability. The pedagogical model for the interprofessional virtual patient can be used in many different clinical courses and also at other universities. Indeed, the same software simulation system can be used to create other patient cases.

Face Validity was confirmed by teachers and clinicians from professionals working in primary healthcare. In order to increase the authenticity of the patient case, we asked occupational therapists and physiotherapists to review the patient

case, and to provide any suggestions they might have. They found the content in the virtual patient case valid from the perspective of their respective healthcare professions.

Reflexivity involves self-questioning and self-understanding and requires researchers to explore their influence on research. Cause and effect are interconnected, interviewer and the interviewee are mutually influencing each other (Patton, 2002). Olmos et al. p. 3 (2023) define reflexivity as "a set of continuous, collaborative, and multifaceted practices through which researchers self-consciously critique, appraise, and evaluate how their subjectivity and context influence the research processes."

My professional background as a district nurse working in primary healthcare was an advantage. I recognised the problems that have been discussed in the background and between the students. The knowledge and experience I have with primary healthcare meant I may have taken things for granted; it is however important to discuss with the research team during the data analysis stage to enhance reflexivity. Our discussions during the analysis process made it possible for me to bring other perspectives and enabled me to bring my pre-understanding to the surface. Although the analysis of what the text talks about always involves some degree of interpretation, this might vary in depth and level of abstraction (Graneheim & Lundman). On the other hand, in the role of district nurse in primary healthcare I have provided clinical supervision of students. For this reason, when deriving codes, I have highlighted the exact words from the text. The key thoughts and concepts come from the students.

During the interview, I was a researcher who asked questions related to the research aim and did not perceive myself as in the role of a district nurse. I stayed close to the interview guide and asked follow-up questions related to the aim of the research (Berger, 2015).

3.3.5 Ethical Considerations

Ethical approval was obtained from the Regional Ethical Review Board in Stockholm, for all three studies (Dnr: study I and III 2012/1011–31/5 and study II 2013/2267–31/4).

In studies I and II, all the participating students were informed verbally and in writing before giving consent to their participation. Study III was performed during the COVID–19 pandemic and due to the constraints at that time, the request for informed consent and students' responses were communicated in writing online. The information about the study was in the learning platform including the information document for participants. Students were informed that signing up on the calendar for a session with the virtual patient meant that they gave their informed consent to participate in the study. In studies I and II. nobody in the research team was involved in teaching those students who participated in the study. In study III two of the authors were involved in teaching medical students who participated in the study. Their role in actual contact with the participating students was however very limited.

Students in study II were video recorded when working with the virtual patient model. All material is stored in servers at KI, where only the research group has access.

4 The Results

The table below presents an overview of the findings from the three studies in relation to the research questions.

Study	Research Questions	Findings
I	How did students from four different study programmes perceive conditions for	The students made several statements about difficulties in collaboration with other healthcare students in primary healthcare. The

	interprofessional education in primary healthcare?	students perceived a need for support and awareness of interprofessional learning from health professions in primary healthcare and from the faculty at their study programmes.
II	How to develop and assess an interprofessional virtual patient model for students´ learning in primary healthcare? How could this virtual patient facilitate students´ learning? What have students learned about other healthcare students with this interprofessional virtual patient?	A virtual patient system was developed and BSAsim was used as a foundation, the virtual patient model which uses an iterative learning cycle. Students reported that the virtual patient case facilitated their learning in an interprofessional context. The patient case helped them to learn more about their own role and the roles and responsibilities in other healthcare professions. The interprofessional virtual patient case increased their understanding of the importance of teamwork in clinical practice. Working with the virtual patient deepened their understanding of collaboration with other healthcare professions in order to help the patient.
III	How could an interprofessional virtual patient case facilitate medical students learning	The medical students described that by working with the virtual patient they had gained an understanding of the role and responsibilities of other

about team collaboration in online groups? How did students experience working with the virtual patient when they were remotely connected to their study group?	healthcare professions. It also provided students insight into team collaboration and promoted interaction between the students. Working online remotely connected with their group was perceived as functioning well. The largest increase occurred in the understanding of the role of occupational therapy according to the students' reports in both the interviews and the questionnaires.

4.1   Study 1.

In the first study, we investigated how students perceived prerequisites for interprofessional education in primary healthcare. The data analysis was performed with inductive content analysis and the data was collected with group interviews. Twenty-six students participated:8 males and 18 females. Four group interviews were conducted. Each group had students from all four healthcare professions: medical, nursing, occupational therapist and physiotherapist.

The main findings showed that students perceived a need for support and awareness both from study programmes and healthcare professions in primary healthcare when students were in their clinical placements. One medical student stated: "to have practice days or as now, primary care together with other professional groups had contributed a lot."

Next, due to the geographical distances, they did not meet other student studying other healthcare professions. In the present study, students reported several obstacles for learning with, from and about other healthcare students. One physiotherapy student stated: "that one calls the doctor, for example, or something similar because we are not sitting near anyone at all, then it may not

trigger interprofessional learning." In clinical placements, the students did not feel comfortable initiating interprofessional learning without support from tutors at their study programmes and their clinical supervisors. The students expressed a need for role models that could show how best to work in teams. Despite the obstacles, the students found it important to collaborate with other healthcare students and asked for more opportunities. The students had some thoughts and suggestions of what kind of healthcare problems were suitable for interprofessional learning activity. They suggested that elderly patients and multiple health problems were suitable for collaboration. The students reported that these complex health problems required perspective from different healthcare professions to help the patient. However, patients who just had a common were not regarded as suitable for interprofessional learning. The analysis resulted in one theme and five categories (Figure 3).

Figure 3. Students' perceptions of interprofessional education in primary healthcare, as described in the interviews with the students. The analysis resulted in one theme and five categories.
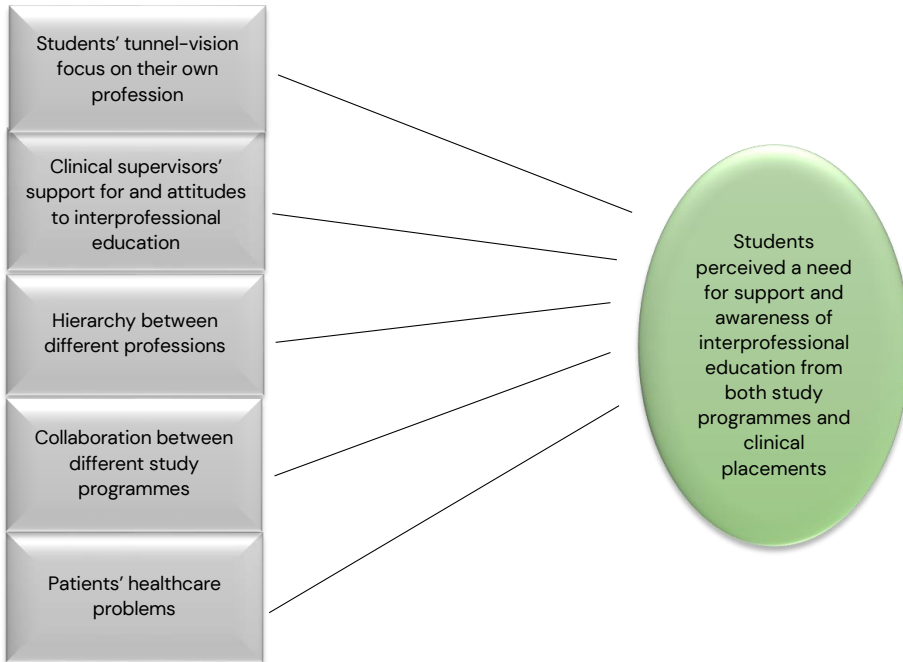
4.2 Study II.

4.2.1 The Interprofessional Virtual Patient model and case

In the second study, an interprofessional virtual patient model was developed and assessed. There were ten groups of students with two to five students in each group who worked with the virtual patient. The session was limited to two hours. They worked with the virtual patient in physical meetings in their groups.

When the students started their session with the virtual patient, they were introduced to the interprofessional learning objectives for all programmes at Karolinska Institutet. After this introduction, the students were asked to formulate their own learning goals in their team. After that students got introduced to the patient case and had to reflect on what they already knew about the problems

the case presented and what they needed to learn more about. In the next step, the students could watch short video clip showing the patient's home situation that highlighted difficulties for the patient in his home, such as thresholds between rooms, an empty refrigerator, medicine packets on the table, empty wine bottles, etc. The video clip also showed that the patient's wife had mild symptoms of dementia after suffering from a stroke some years ago. The case included three more short video clips showing the patient receiving home visits by four different healthcare professionals and community-based home care. The students could view additional medical data about the patient such as laboratory results, X-rays indicating congestive heart failure and results from other investigations. The students could also choose among specific questions to put to the patient about his medical history, medications, daily life and hobbies, and then see pre-prepared answers. They could also find results from assessment tools used by different healthcare professions assessing for example the patient's nutritional status, drinking habits, etc. There was also a section with textual information for the students to read with descriptions of the roles of all the healthcare professions relevant to be involved in the patient case.

In the next step of the session, the students were asked questions they had to formulate a common answer to in open-text format and submit it to the system. They received pre-prepared teachers comments each time they submitted their answers.

In the second video clip, the students could see when the patient received a home visit by a family physician and a district nurse. In the third video clip, the students could see a physiotherapist and an occupational therapist visiting the patient in his home. The last video clip showed how the patient's health conditions had improved and both his and his wife's everyday life had got better. At the end of the case, the students were asked to reach a conclusion as to whether or not they had achieved their own learning goals and then to submit it to the system. To assess it, they were here presented with their own learning goals that they had formulated at the beginning of the sessions.

4.2.2 Students Perceptions of the Interprofessional Virtual Patient

We wanted to find out how students perceived working with the interprofessional virtual patient, group interviews were conducted to collect data, and content analysis was used to analyse the data.

The analysis of the group interviews in study II resulted in four main categories; 1. The virtual patient model facilitated the learning process; 2. It was beneficial to have students from several professions in the group when working with the virtual patient; 3. Working with the virtual patient helped the students to better understand the roles and competencies of their own and other professions; 4. All professions are needed in clinical work in order to help the patient. In Figure 3 the four main categories and 16 sub-categories can be found.
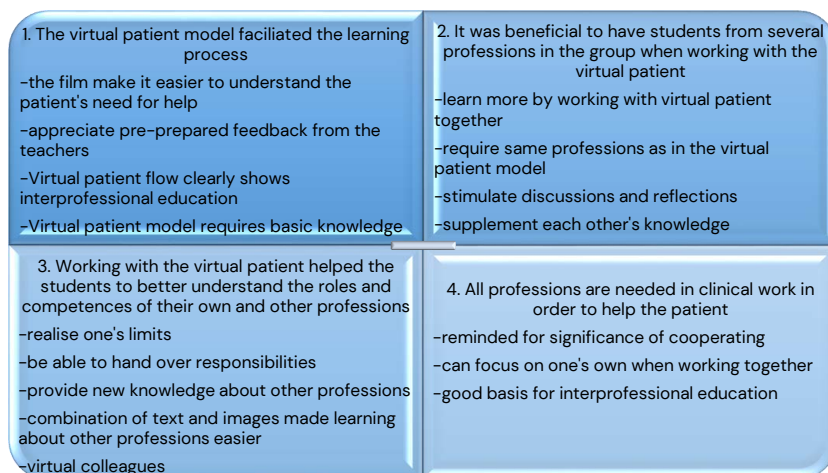
Students in studies II and III reported that the virtual patient stimulated discussions and reflections within the student group. The mix of the different methods in the virtual patient case, including short video clips, respond in open-text format, pre-prepared teachers' comments and other additional information about the patient promoted students' learning. The interprofessional virtual patient case increased interaction and discussions between students when working with the virtual patient. One nursing student stated: "But it leads to … what was good, I think, is that it leads to a discussion. I think we've certainly learned more from our discussion, you said… Certainly, but where do you get this information from? And then we say… 'no, but we take the specimens, but we don't analyse them.'" (group 7)

Medical and nursing students in study II reported that they had gained knowledge about occupational therapists' and physiotherapists' perspectives and vice versa. An occupational therapist was quoted as saying: "I learnt that doctors and nurses make home visits or at that level… I didn't know that it is… was really like that, just in this case as well." (group 4) One medical student in the same group stated: "that there is a profession that deals with assistive devices and not that it's just some nurse who found it in the ward and throws it in, but they are contacted so that they evaluate the situation and then put in assistive devices, and like a grab bar in

the shower, that it hasn't always been there, but rather it's someone who has sort of evaluated the situation and taken the initiative to take a measure."

Four main categories and 16 sub-categories were found in the group interviews (Figure 4).

Figure 4. Four main categories and 16 sub-categories.

1. The virtual patient model faciliated the learning process
   –the film make it easier to understand the patient's need for help
   –appreciate pre-prepared feedback from the teachers
   –Virtual patient flow clearly shows interprofessional education
   –Virtual patient model requires basic knowledge

2. It was beneficial to have students from several professions in the group when working with the virtual patient
   –learn more by working with virtual patient together
   –require same professions as in the virtual patient model
   –stimulate discussions and reflections
   –supplement each other's knowledge

3. Working with the virtual patient helped the students to better understand the roles and competences of their own and other professions
   –realise one's limits
   –be able to hand over responsibilities
   –provide new knowledge about other professions
   –combination of text and images made learning about other professions easier
   –virtual colleagues

4. All professions are needed in clinical work in order to help the patient
   –reminded for significance of cooperating
   –can focus on one's own when working together
   –good basis for interprofessional education

4.3 Study III.

In the last study mixed methods have been used to investigate how groups of solely medical students can gain insights into other healthcare professions' skills and expertise and into team collaboration, with a virtual patient designed for interprofessional student groups. We also wanted to investigate if an interprofessional virtual patient could facilitate learning in online groups and how students experienced learning with the virtual patient when they were remotely connected with their groups. In this study, 49 students had signed up to participate.

The quantitative results showed that the majority had no previous experience in learning activities together with other healthcare professions. Those students who had reported having previous experiences with other healthcare professions, had it with nursing students. The results from the pre-virtual patient and post-virtual

patient questionnaires showed an increased understanding of the roles of the other healthcare professions.

The qualitative results showed the interprofessional virtual patient promoted student interactions and gave insight into team collaboration. The students reported that the structure of the virtual patient facilitated learning about their own and other healthcare professions. The short videos in the virtual patient helped them to understand in detail how different healthcare professions act in their roles during home visits. One student noted: "It was useful to watch the video in order to see how the professions work together and not just what they do individually." (group 13). Another student stated, "a page where you had summarised very well what all the professions did. By reading, it I think I got an excellent overview of what they did." (group 9). The students reported the largest increased knowledge of the role of physiotherapist and occupational therapist in the questionnaire and in group interviews. One student put it this way; "Sure, but it's more than anything about what an occupational therapist does – because that was the biggest mystery to me, not really a mystery as I guessed what they did, but when I saw it, I was able to get a better overview." (group 14) Furthermore, they reported working with the virtual patient remotely functioned well. Since they all saw the same thing on their own screen, they perceived being together in the same room. One student commented: "I think it worked just as well as it would have looked in a room all together." (group 12)

Study III was conducted in response to the call for social distancing due to the outbreak of the COVID-19 pandemic. We found an interprofessional virtual patient as a learning activity could be transitioned to a distance online activity and meet the challenges that most of the faculty were facing during the COVID-19 pandemic.

The analysis of study III resulted in one theme, two categories, and nine sub-categories (Table 3).

Table 3. One theme, two categories, and nine sub-categories

The interprofessional virtual patient promoted student interaction and gave insight into team collaboration	
Students perceived the collaboration in their remotely connected group as well-functioning and effective	The structure of the virtual patient facilitated students' learning
Work with the virtual patient remotely was effective	A mix of different methods with the virtual patient promotes learning
The discussion would have been richer if there were other professions in the group	The virtual patient provides an understanding of the students' own and other professionals' roles and responsibilities
It was good for the students to be able to choose who they wanted to work with	The virtual patient provides insights into the importance of collaboration between professions
The students' experiences of communication in the group during the session	The virtual patient provides as much information about handling the patient case as a real home visit
Roles were distributed	

Additional Results

The students in study II were video recorded when working with the interprofessional virtual patient case. We have not analysed the data yet, but we have an overall view of the content. The preliminary findings showed that the virtual patient case facilitated interactions and discussion in different ways. The students showed verbally or through body language that they wanted to discuss something they just had seen, for example from the short videos. They explained verbally and used body language to communicate their perspective on the patient case and sometimes also they taught each other. We could also observe the students' discussions about the patient case were well aligned with the Interprofessional Education Collaborative core competencies.

Discussion

This thesis had the overall aim of finding new ways for facilitating students' interprofessional learning in primary healthcare.

I will first discuss the development of the virtual patient system and then discuss the virtual patient model. The discussion will continue about the present thesis findings aligned to the Interprofessional Education Collaborative core competencies (IPEC, 2016). The intention was to facilitate interprofessional learning when developing the virtual patient model and we found that the findings seemed to cover the interprofessional education collaborative core competencies well.

4.4 Discussion of Interprofessional Virtual Patient System and Model

4.4.1 The Interprofessional Virtual Patient System

The virtual patient system allowed students to write open-ended answers and submit them to the system. The intention with the open-text format for the responses was to provide the students possibilities for interaction within the student group when formulating the answers before submitting them to the system. The findings in studies II and III showed active interactions between the students through discussions within their group when they discussed their answers. The students appreciated their discussion and reflection about the patient's situation, and how they could help the patient during the whole learning activity.

4.4.2 The Interprofessional Virtual Patient Model

The pedagogical design of our virtual patient model, such as the iterative learning cycles, was intended to promote for students' learning and gain an understanding of team collaboration. Virtual patients have been previously used for interprofessional learning (Bjorklund & Silen, 2021; Edelbring et al., 2021; Shoemaker et al., 2014). but to our knowledge these virtual patient cases were not based on a pedagogical model for interprofessional learning that characterised our model.

The virtual patient model provided the students with measures from a variety of healthcare professions' perspectives for patient care and the students had opportunities to expand their knowledge about different healthcare professions.

The students described that the virtual patient model generated interactions and they perceived through discussions having learned more about other healthcare professions. This resonates well with research on virtual patient design that highly interactive learning activity facilitates for the students' learning (Huwendiek et al., 2009).

The students were required to answer questions as a team before submitting their answers. They read information and watch video clips together about other healthcare professions and reflect and communicate with their peers about roles and responsibilities. They had the possibility to ask each other questions and confirm their knowledge about the roles and responsibilities of others. All this occurs repeatedly during the whole learning activity. This description by the students is in agreement with how students construct knowledge in constructivist epistemology, where the students construct their knowledge by interacting with their peers in a social environment (Vygotsky, 1978). Moreover, constructivism emphasises that students are active learners who discuss, exchange experiences and share knowledge in order to understand new information (Lattuca, 2005). Our intention was to apply this constructivist learning theory to students as active learners in a social context. Working with the virtual patient model required students to be both active and interact with each other. After having shared the concrete experience of the short video clips, students in study II investigated and then made arguments about what was good or what was bad for the patient in terms of rehabilitation and medical treatment. The students constructed and reconstructed information for the purpose of learning and developing ways of understanding new information together with what they already knew (Jonassen, 1991; Lattuca, 2005). The students were sharing a common concrete experience and contributed to each other's understanding. In interactions with other healthcare students, they could ask questions, share thoughts with each other,

confirm each other's clinical reasoning in social interactions with other peers (Guba & Lincoln, 1994).

The virtual patient model has been studied in different context where students worked in real life and online remotely. Students who worked with the virtual patient model were interprofessional student groups and groups solely from one single profession. The findings in both studies found that the virtual patient model increased interactions between students through discussions, because the students were active learners in a social context. As a result, the interprofessional virtual patient was implemented as a learning activity for all medical students.

4.5 Discussion of Results Aligned to the Interprofessional Education Collaborative Core Competencies

4.5.1 Roles and Responsibilities

The students in studies II and III found that working with the virtual patient case, they perceived an understanding of their own and other professionals' roles and responsibilities. Students especially appreciated working with those healthcare professions they did not have so much prior exchange with. Specifically, the participation of occupational therapist and physiotherapist students was highly appreciated by the medical and nursing students. Our findings are similar to the study by Gysin et al (2022) with five different healthcare professions involved in an interprofessional learning activity. Occupational therapy, physiotherapy, nursing and midwifery students had not had much exchange with medical and pharmacy students before the described activity, so their participation was highlighted as a strength by the other students in that study.

The students were required to answer questions and then submit the answers as a team to the system. There was comprehensive information in the form of texts and concrete experiences such as short videos. The requirements and information provided to the students made them to communicate with other healthcare students within their group to clarify each other's responsibilities. This is in line with one of the sub-competencies in the domain of Role/Responsibilities (IPEC, 2016).

4.5.2 Interprofessional Communication

Communicating with other health professionals in a responsive and respectful way is essential in patient care. Avoiding discipline-specific terminology when possible has importance for patient safety (IPEC, 2016; World Health Organization, 2010). This was observed by our research group and described in the additional results. The respectful manner was shown in the way students communicated with each other, both verbally and in body language. They communicated with each other in a helpful way, listened to each other's questions and tried to explain their statements to their peers thoroughly. Students in study II are practising their communication skills through discussions and reflections about the care of the patient when working with the virtual patient case, which is a safe environment for students.

4.5.3 Teams and Teamwork

The students in study II reported that working with the interprofessional virtual patient case reminded them about the importance of collaboration with other health professionals. Students in study II felt that they gained an understanding of how collaboration could be of benefit for the patient's care and to be better able to meet all of the patient's needs. This has been found in previous studies which highlighted the importance of collaboration and how detrimental working in silos could be (Leadbeater, Pallett, Dunn, & Bashir, 2021; Robertson, McDermott, Star, Lewin, & Spell, 2021).

In their study, Poulton and Balasubramaniam (2011) stated that authoring virtual patient cases was easy but there is a challenge in authoring a patient case that required engagement from different healthcare professions. All the students in study II found the patient case authentic in the context of home care and the case seemed to suit all the students involved since they reported their discussions were rewarding. Once the students perceive the patient case as authentic and realistic for team collaboration it will increase students' motivation and satisfaction for learning according to previous studies (Cook et al., 2010; Ellaway et al., 2008; Huwendiek et al., 2009; Tran, Kaila, & Salminen, 2018)

Our interprofessional virtual patient case was a suitable way for the students to practise teamwork and gain an understanding of other healthcare professions. Lingard (2016) formulated the following statements after having studied working teams: "competent individuals can form an incompetent team, teams can be competent even when one team member is incompetent, an incompetent team member can derail one team, but another team carries on around her, the same team can be competent in one situation and incompetent in another" (Lingard, 2016). For the students in study II the virtual patient provided an opportunity to train team collaboration in the context of home care. They had different healthcare students to discuss with, which they perceived as being rewarding and beneficial to their learning. So that they will have the opportunity to acquire team collaboration skills in different situations and contexts as Lingard (2016) stated, students need more opportunities to practise teamwork during the whole process of their educational journey.

4.5.4 Values and Ethics for Interprofessional Practice

The findings in study II showed that students expressed that all healthcare professions were needed in order to help the patient due to the complexity of the patient case. Students reported that they had acquired new knowledge about and respect for other healthcare professions competencies in-home care. This expression could be interpreted as one of the competencies in the domain of Values/Ethics: "respect the unique cultures, values, and expertise of other health professions" (IPEC, 2016).

4.6　Methodological Reflections

We have constructed an interprofessional virtual patient for undergraduate education that can be used for different study programmes involved in patient care in Swedish primary healthcare. This virtual patient has specific features that are not common in this context. It is based on a pedagogical model and contains authentic illustrations of real-life scenes in home care via video clips (played by actors). In studies II and III we received evaluations from four different healthcare students in two different contexts about the benefits and weaknesses of our virtual patient as a learning tool. The members of the research team were from different healthcare professions to increase credibility. This might have contributed to being able to include different professions' perspectives on the topics that were studied. The patient history was built on an authentic patient case. All contributors to the creation of the virtual patient were healthcare professionals themselves; the script writers were active doctors and nurses. All roles in the videos were played by professionals in their actual healthcare professions, the pedagogical model for the virtual patient was formed by experienced teachers, and all teachers' comments given to students were formulated by active teachers in their professions. As a result, the students perceived the patient case and the teachers' comments in the virtual patient model as being authentic.

The present thesis used group interviews in studies I and II to collect data. Study III had a mixed methods approach. The reason for group interviews was to stimulate discussions between students and enable them to exchange thoughts with each other. Investigator triangulation has been used within the research team. A diverse range of perspectives from different healthcare professions to ensure that the findings were from the students' perceptions increased credibility. The research team were from different healthcare professions and had continuous discussions during the analysis phases, with the aim to increase credibility. The questionnaire pre and post virtual patient sessions supported the findings of the group interviews and vice versa.

In study III we used the online platform Zoom as a data collection method, due to the COVID-19 pandemic. The students were instructed to be physically separated and choose the learning environment themselves when working with the virtual patient model. Some of the students chose to be in a public space such at a café or on campus, but most of the students were at home. The students reported that by using Zoom they saved travel time and were able to be more relaxed. The positive impression from the students could be seen as a strength and enhanced credibility.

A limitation is that not every group in study II consisted of all four healthcare professions. Another limitation was some of the students in study II had not yet had their own experience of home care. As a result, their contribution to the group discussions might be limited. A potential limitation is that one of the researchers was involved in the medical programme as a teacher. This might have influenced the study participants questionnaire answers in study III due to teacher-student relationships. Most of the group interviews were performed by the first author in study III. The second author performed only two interviews. The questionnaire that was used before and after the learning activity in study III was not validated or pilot-tested before it was used, and that could be seen as a limitation. Another limitation could have been the students being able to form their own groups in study III. The positive impression from the students and how they experienced their discussions, i.e., if they went smoothly could have been influenced by the free group forming process.

Two of the authors in study I were teachers who have worked in primary healthcare. The first author was an active clinician in primary healthcare during the time the study was conducted. All authors had a pre-understanding and experience with working in primary healthcare and this may have an influence when interpreting the data collected. Therefore, discussions were repeatedly held between the authors until a consensus was reached. This enhanced the credibility.

5 Conclusions

The overall aim of this thesis was to find new ways to facilitate students' interprofessional learning in primary healthcare. Our virtual patient model has the focus on interprofessional learning with a pedagogical design which makes our virtual patient model special. The findings show that the virtual patient model can be used face-to-face or online remotely in groups of students, either with interprofessional student groups or student groups consisting of a single profession. The students reported that they perceived the virtual patient model facilitated their learning and increased interactions through discussions between students. The comprehensive information about the patient case provided the students a perception of increased knowledge about other healthcare professions and enabled an understanding of collaboration. We also found that working online remotely with the virtual patient model functioned well according to the students.

5.1 Clinical Implications

This thesis aims to find new ways for facilitating students' interprofessional learning in primary healthcare. The findings in this thesis showed that the virtual patient model with a pedagogic design facilitated interprofessional learning and the students perceived they had gained an understanding of team collaboration. This may help to decrease the barriers for students and to increase opportunities for interprofessional learning activities in primary healthcare settings. The interprofessional virtual patient could be used as a complement and preparation before a real home visit.

5.2 Future Research

This thesis has given insight into the students' perceptions of learning with other healthcare students and with their peers within the same healthcare professions when working with the virtual patient model. Future research could explore in greater detail how and in what way the virtual patient model facilitated students' interprofessional learning. We have collected data via video recording when

students worked with the virtual patient model in study II but these data have not been analysed yet. Future analysis of these video recordings can assist to gain a more in-depth understanding of the interactions between students when conducting training in interprofessional communication.

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