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Technology in education:  
necessary but not sufficient.  
Understanding learning  
with virtual patients

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*To those who care for the health of others*

## ABSTRACT

With the rapid technological development and the broadening access to computers over recent decades, several technological innovations have emerged in medical education, including virtual patients. Students' use of virtual patients is proposed to fill gaps in clinical exposure, and train clinical reasoning. However, higher education faculties have been slow to adopt new technology as a regular part of curricula. Virtual patients and similar technologies have either been implemented by enthusiastic teachers or by university policy directives. A possible reason for the low uptake of virtual patients in curricula is a lack of a clear understanding of how their use contributes to student learning.

The four studies described in this thesis address learning with virtual patients from three perspectives: the student perspective on learning with virtual patients; the course integration perspective; and the individual study strategy perspective. A mixed methods approach was used given the overarching interest to seek understanding and clarification of student learning with virtual patients.

Data were gathered by research interviews with medical students during clerkship, and by questionnaires in clerkship preparatory courses. Interview data was analysed by a phenomenological approach, and scales were formed from questionnaire responses which were analysed cross-sectionally for the four teaching hospitals affiliated with the medical programme at Karolinska Institutet. Use frequency, students' perceived benefit of virtual patients, their wish for more guidance on using virtual patients and, wish for more assessment and feedback on virtual patient work were targeted in the questionnaires. Furthermore, the students' preferences of study strategies were analysed in relation to the virtual patient activity using regulation strategy scales from the Inventory of Learning Styles devised by Jan Vermunt.

The findings suggested that virtual patient learning activities offer possibilities of applying biomedical knowledge to clinical cases in a way that was engaging and supported decision-making. Furthermore, the virtual patient learning activities were perceived as having an intermediate function between textbook learning and learning with actual patients. The consequences of integration strategies in the course context were influential for how students perceived the benefit of learning with virtual patients. Intensity of processing of virtual patient cases, and presenting cases for other students were associated with high perceived benefit of virtual patient learning activities. Students' self-regulation abilities were also associated with perceived benefit of the virtual patient learning activities, although to a lesser extent than the influence of the course context.

The technology of virtual patients provides possibilities that enhance student learning, and should thus be a necessary part of education. However, this research show that an educational integration strategy is needed that supports students' active processing of virtual patient cases.

## SAMMANFATTNING PÅ SVENSKA

Den snabba teknikutvecklingen har inneburit nya möjligheter att använda IT i utbildningen. Datoriserade virtuella patienter används i medicin- och hälso-utbildningarna bl.a. för interaktiv träning av beslutsfattande i virtuell klinisk miljö. Omfattningen av användningen av virtuella patienter är dock blygsam och systematisk kunskap om hur dessa bidrar till studenters lärande är begränsad.

Avhandlingens fyra delarbeten undersöker studenters lärande med virtuella patienter från tre perspektiv: ett subjektivt upplevelseperspektiv, kursintegreringsaspekter samt i relation till studenters studiestrategier.

Den metodologiska ansatsen använder flera metoder för att närma sig studenters lärande med virtuella patienter. Det pragmatiska syftet var att skapa en bred kunskap som grund för en förbättrad användning av virtuella patienter. Data har insamlats med forskningsintervjuer av studenter under en verksamhetsförlagd klinikplacering, samt med enkäter i tvärsnittsstudier av en klinikförberedande kurs på Karolinska Institutets fyra undervisningssjukhus. Intervjudata har analyserats med fenomenologisk ansats och skalor har bildats av enkätdata för statistisk associationsanalys.

Användningsfrekvens av virtuella patienter, studenters upplevda nytta, önskan om mer vägledning i arbetet med virtuella patienter samt önskan om mer uppföljning av detta var fokus för enkätfrågorna. Dessutom undersöktes sambandet mellan den upplevda nyttan med virtuella patienterna och studenternas studiestrategier vilka undersöktes med enkätformulär om självstyrt lärande som översatts från Jan Vermunts ”Inventory of Learning Styles”.

Intervjudata visade att studenter upplever arbetet med virtuella patienter som något som bidrar till att bättre tillgodogöra sig en klinikplacering. Karaktären på studiesituationen beskrevs som ett mellanting mellan lärande med lärobok och att lära med verkliga patienter. Den upplevda nyttan på de klinikförberedande kurserna var större, och användningen mer omfattande, i de sammanhang där virtuella patienternas kursintegrering uttryckligen stödde mer intensiv bearbetning av de virtuella patientfallen. Ett positivt samband fanns mellan självstyrd studiestrategi och den upplevda nyttan, men inte så starkt som det mellan kursintegreringsaspekter och den upplevda nyttan.

Virtuella patienter möjliggör stöd till lärsituationer men behöver användas tillsammans med en medveten pedagogisk kursintegreringsstrategi.

## PROLOGUE

The unit of analysis in the thesis is the use of a learning tool—a piece of the large jigsaw puzzle that is medical education. I entered the project equipped with a degree in pedagogy, and with experience of developing educational computer software—but without medical background. I consider myself as contributing a perspective of how students learn in conjunction with technology, and also contributing a citizen perspective—as a tax payer in future need of care—not coloured or constrained by the primary objectives of practitioners in medical programmes.

By objective standards the biology of how people learn is stable. However, our practices—the way we go about doing things—are changing, implying a need to adapt formal education accordingly. How to bring about the best possible medical education has been, and will continue to be, of crucial concern both for society and medical schools. In Sweden, the medical programme is one of the most expensive educational programmes and has high status as a profession.

Eleven years ago I stumbled into a group of people developing “Interactive Simulated Patients” materialised in the Interactive Simulated Patient (ISP) software system. The late Rolf Bergin, chair of the department of HIS at Karolinska Institutet, introduced the core meaning of ISP with the story of him being a medical student: “I cannot for the life of me remember my first lecture, but I'll NEVER forget my first patient”. He pioneered work in the area of virtual patients with the objective of making medical education meaningful and engaging. The emphasis was on having a patient as the focal point of knowledge instead of de-contextualised knowledge in a book.

Over the years I have met programmers, graphical designers, entrepreneurs, project managers and professors involved in making, implementing, and sustaining virtual patients. I myself was very much a part of the emerging heydays of virtual patient when developing the NUDOV virtual patient system, inspired from Bergin's ISP and itself contributing ideas to the widespread Web-SP system. In experiences with developing and implementing NUDOV I became aware of the lack of systematic knowledge on how students learn with simulations in general and virtual patients in particular. Throughout the years, in close contact with proponents of virtual patients, I have retained a sceptical but curious stance towards the use of this technology. Consequently, when the opportunity arose to fulfil a PhD project on student learning with virtual patients, I was quick to grasp it. In grateful respect to researchers and doctoral students approaching other aspects of virtual patients before me, I would like to contribute food for thought, confirm knowledge that previously was tacit, and contribute new elements into the exiting field of knowledge where technology and human learning meet.

## LIST OF PUBLICATIONS

- I. **Edelbring S**, Dastmalchi M, Hult H, Lundberg IE, Dahlgren LO.  
Experiencing virtual patients in clinical learning: A phenomenological study.  
Advances in Health Sciences Education Theory and Practice. 2011;16(3):331-45.
- II. **Edelbring S**, Broström O, Henriksson P, Vassiliou D, Spaak J, Dahlgren LO, Fors U, Zary N. Integrating virtual patients into courses: follow-up seminars and perceived benefit. Medical Education. 2012 Apr;46(4):417-25.
- III. **Edelbring S**, Measuring external- and self-regulated learning in medical education: scale reliability and dimensionality in a Swedish sample.  
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- IV. **Edelbring S**, Wahlström R, Zary N. Is the perceived benefit of virtual patients influenced by individual study strategies or external course regulation?  
(Manuscript)

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# 1 INTRODUCTION

This thesis concerns technology for student learning. More specifically, it explores educational practices with virtual patients—a technology whereby patient cases are presented interactively by text, images and movies on the computer screen for learning purposes. Computerised patients as a learning tools were used 40 years ago in the clinical training of students with the “C.A.L.” (de Dombal et al., 1969) and the “CASE” early (Harless et al., 1971) virtual patient computer systems. Since then, computer software, hardware and access to networked computers have developed tremendously, especially during the last 15 years. However, the educational side—how computers are used for learning—has not seen an equivalent development.

Technology is a necessary part of human culture. Innovations in society and education come and go, or rather, get transformed into new technologies. A link between technology and educational practices has been pointed out, especially given the flexible opportunities that the digital technology provides (de Boer & Collis, 2005). Some innovations get seamlessly incorporated in our practices while others disrupt on-going practices and requiring adaptation of current practices. However, specific contributions of technology are difficult to elicit when they becomes parts of our everyday practices (de Boer & Collis, 2005). In higher education practices the traditional mediums—text and oral communication— are challenged by introduction of digital learning technologies (Laurillard, 2002). Digital technology entails possibilities to enrich traditional media but also transform the way we relate to media and other technologies in education. Handheld and tablet devices using ‘apps’ enable mobile learning; this, and game based learning, are current trends in higher education that were unimaginable only a few years ago (Johnson et al., 2012). New practices emerge in the intersection between technology and traditional educational practices. As digital technologies become more frequently used in education, some learning situations change as they require changes in practices as compared to lectures, printed material and supervised patient contact which have constituted the backbones of medical education.

In making current practice with innovations explicit, we achieve a better position to develop future technology and their practices. Learners—and even more the teachers—are still quite unaccustomed to using digital tools in a systematic way in curricula. Educational practices with technology are different as compared to technology use in everyday life since the different practices have different goals. When innovation enters into communities of practices, the adoption rate and usage patterns do not follow linear rules based on their inherent possibilities, and are instead largely dependent on the practices of other people (Rogers, 2003). In this process the conception of the innovation is guided by forerunners, and metaphors, such as the horse-cart as a model for how people thought of the automobile. The first cars resembled coaster wagons in appearance and steering mechanisms, and had little real impact in society. It took decades before the possibilities with the new technology brought about real benefits. These development processes are discernable in retrospect. However, a challenge for contemporary educators and education researchers is to elicit the nature and possibilities of innovations as the technologies and practices emerge and become natural parts of students’ and teachers’ everyday life.

There is a dynamic interplay between different stakeholders' approaches to technology for learning. Educators, students and entrepreneurs of the software industry— sometimes represented by enthusiastic early adopters within academia— all have different needs and agendas. Researchers interested in technology use for learning need access to, and an understanding of, all of these perspectives. The role of the researcher is to question, highlight new aspects, and systematically investigate the technology itself and its use. The entrepreneur perspective influenced politicians in the 1980s to push computers into school classrooms without bringing teachers' voices into the process. This led to a heavy 'underuse' of the potentials with computers in schools (Cuban, 1988). Some decades after Cuban's report, the role of educators is still crucial—including in a medical higher education context—for creating meaningful educational practices with the technology at hand. Digital technology, similar to other technologies in the past, has a tendency to get people investing all sorts of hope in its power. Inventor Thomas Edison expected the motion picture to revolutionise education, and to supplant the use of textbooks.

*"I believe that the motion picture is destined to revolutionize our educational system and that in a few years it will supplant largely, if not entirely, the use of textbooks."* (Thomas Edison, 1922 in Cuban, 1988)

However, educational use of technology does not emerge just from technology being available. Furthermore, an understanding of how people learn gives insight into the more complex character of the educational endeavour. Concerns have also been raised about threats of using technology. Media researcher Marshall McLuhan directs awareness to the nature of technology itself as bearing meaning, not only the content that is embedded in it, in society.

*"The medium, or process, of our time—electric technology is reshaping and restructuring patterns of social interdependence and every aspect of our personal life. It is forcing us to reconsider and re-evaluate practically every thought, every action, and every institution formerly taken for granted. Everything is changing: you, your family, your education, your neighborhood, your job, your government, your relation to 'the others'. And they're changing dramatically. Societies have always been shaped more by the nature of the media by which men communicate than by the content of the communication."* (McLuhan & Fiore, 1967, p. 8)

Much effort has been invested in researching in what ways the technology co-determines and supports learning in formal educational environments. No uniform or linear contribution can be concluded about the relation between technology and education, the answers have to be sought in each application of technology for learning in relation to other co-constitutive aspects (Säljö, 2010). In seeking these answers an awareness of current practices and possibilities of technology is created. Educators need examples from use, labels and metaphors in order to productively use technological innovations at hand.

## **1.1 OUTLINE OF THE THESIS**

The purpose of the thesis is to further understand student learning with the technology of virtual patients for the pragmatic purpose of improving future practice with this technology. The background, Chapter 2, provides entry-points to current use of virtual patients for education, highlights aspects of student learning, and provides the rationale for the project. The aim of the thesis, and the research questions that guided the studies are then put forward in Chapter 3. Acknowledging the young phase that the field of research into learning with virtual patients is presently undergoing, a broad mixed methods approach was taken. In Chapter 4, this approach and the overarching pragmatic purpose is discussed. The specific methods used in the studies are presented in Chapter 5 together with contextual descriptions of the research settings. The main findings from the four studies are summarised in Chapter 6. The main findings and overarching discussion of pertinent aspects that were brought up by the research are discussed in Chapter 7. Lastly, a summary of the findings and conclusions from the project are presented in Chapter 8.

## **2 BACKGROUND**

### **2.1 VIRTUAL PATIENTS**

Virtual patients are defined as patient cases presented by digital technology that provides an “interactive computer simulation of real-life clinical scenarios for the purpose of healthcare and medical training, education, or assessment” (Ellaway et al., 2008). Various names other than virtual patients are being used for these, such as interactive simulated patients (Bergin et al., 2003). The virtual patients, uses of which are investigated here, are computerised patient cases presented interactively on a computer screen. Learners take the role of a health care professional and make diagnoses and therapeutic decisions based on the case. A typical virtual patient session includes a stepwise unfolding of the case scenario by interviewing, examining, and ordering diagnostic tests related to the virtual patient. Whereas the virtual patient characteristics above fit descriptions of experimental and small-scale use of early computer based clinical cases (Friedman, 1995), it is only recently—with the contemporary omnipresence and familiarity with digital technology—that virtual patients are becoming regular part of curricula (Ellaway et al., 2009). Consequently, from a pedagogical perspective they could be considered as educational innovations in the early beginnings of their established practice.

#### **2.1.1 Rationales for current use of virtual patients**

In the USA and Canada virtual patients were used in 26 of 108 medical schools that were surveyed in 2005 (Huang et al., 2007). In the discipline of paediatrics use has increased to more than 70 US and Canadian medical schools using virtual patients (Berman et al., 2011). A survey of participants of the largest European medical education conference (The Association for Medical Education in Europe, AMEE) found that 55% of the respondents (n=216) had used virtual patients, mostly for clinical (67%) or preclinical (48%) undergraduate teaching (Davies et al., 2009). Incentives for using virtual patients range from training patient communication to clinical problem solving. The problem solving—clinical reasoning—is currently being proposed as the main contribution of virtual patients to student learning (Cook & Triola, 2009).

The predominant rationale for utilizing virtual patients is students’ lack of exposure to patients because of changes in contemporary health care systems. The virtual patients “fill gaps in clerkships by exposing students to diseases that they would not otherwise experience because of short clinical rotations and limited ambulatory care experiences” (Huang et al., 2007). Students do not get patient sufficient contact over time in order to follow illness or recovery progress, and common illnesses are typically not treated at teaching hospitals but in outpatient settings (McGee et al., 1998). The accreditation body for medical programmes in the USA and Canada, the Liaison Committee for Medical Education, has, in its ED-2 standard, stated that students should encounter the types of patients and clinical conditions that are defined by the faculty. Gaps in this clinical exposure may be remedied by virtual patients or other simulated experiences (LCME, 2011).

### 2.1.2 Different virtual patient designs and uses

The overarching idea when using virtual patients as an educational tool is to present a patient, or more specifically, aspects of a patient, to a learner. A common way to do that is by means of text, images and video clips. At first sight, this may seem straightforward, and does not present much of an educational dilemma. However, different software designs influence how users interact with the representations. The design and what procedures are available decide and limit what users can do, and how progress is made through patient cases. The overarching design in virtual patients is modelled on a virtual patient-healthcare professional encounter, following a sequence of a patient presenting complaint, patient interview, diagnosis and management. This design was present already in the early 1960's systems of virtual patients (de Dombal et al., 1969; Harless et al., 1971) and is still the backbone of conceptual design of the virtual patients systems of today, although the range of possible activities is now wider.

The possible dimensions of design variability are, of course, numerous. Virtual patient software designs are for example recently discussed in terms of 'narrative' and 'problem solving' designs (Bearman et al., 2001), and inclusion or not of built-in feedback on performances with the virtual patient case (Zary et al., 2009). The predominant design categories to date in the literature are however 'linear' or 'branched' designs of virtual patients platforms (Huwendiek et al., 2009). With a linear design, the case has a pre-defined route with a definite end point, whereas in the branched design, the users may end up at different end points of the case depending on their actions.

As has been observed in distance education, the software design influences student interactions with the subject matter (Hillman et al., 1994). However, whereas the design influences and sets the limits for interaction procedures, humans always find creative ways to redefine and work around limitations in the context depending on their needs. An intended technology design that in theory would imply a certain kind of interaction or behaviour may be redefined and used in other ways by users. A striking example is how the SMS interface in cellular phones was intended to provide cost- and bandwidth-effective means for technicians to communicate, that, when discovered by teenagers, paved the way for a new role of the telephone (Crystal, 2008). A more educationally fruitful approach to discern the contributions of virtual patients is first to consider how they are conceived of based upon their *use* rather than upon their technological *attributes*. The use-approach is put forward in the philosophical reflections of Martin Heidegger considering the ontological status of tools—the nature of a hammer is defined by its being 'ready-to-hand' (how it is perceived based upon how it is being used) rather than by its physical attributes (Heidegger, 1962). The perceptions of a tool—what it is and for what purposes it can be used—relate also to the surrounding context. It is thus necessary to zoom out from the technological attributes and incorporate contextual features of the learning activity. Feedback to students when learning with virtual patients has been targeted as one area where the software design and the design of the surrounding educational framework need to be integrated (Tworek et al., 2010).

Ellaway and Davies (2011) outlined an activity theory approach in order to understand different uses of virtual patients. The educator and the course design have important roles in defining the context in which the learning activity is performed. Consequently, the same technology (and individual virtual patient cases) can be used

for different purposes and hence be approached in different manners by learners (Ellaway & Davies, 2011). This is no different than any case-based learning activity—be it a paper description or an actual patient in bedside teaching: it can be carried out in a variety of pedagogical models (Irby, 1994).

### **2.1.3 Virtual patients as simulations**

Virtual patients present aspects of clinical scenarios on the computer screen. Therefore, it is appropriate to locate virtual patients within the realms of simulations used in medical education (Rosen, 2008). The Association of American Medical Colleges (AAMC) categorises virtual patients as screen-based simulations, which means “a program, exclusively computer-based, that allows learners to interview, examine, diagnose, and treat patients in realistic clinical scenarios” (Passiment et al., 2011).

Some virtual patient cases are based on actual patients who lend their story, pictures, movie clips, lab test results, and so on, to the case. However, the majority of virtual patient cases described in the literature are fictitious cases where data and pictures are combined from several sources. Both the authentic and fictitious cases are, however, authored in the sense that the information is structured into the interface and described in the case author’s words.

While simulations always reduce some aspects of reality, the dis-similarity from reality need not be a drawback. Technology offers the possibility of enhancing aspects of reality and directing the learners’ focus towards them. In a way the simulation supersedes reality and contributes—for better or worse—something that is not present in physical reality (Behling, 2005). The dis-similarity of the simulation to reality gives rise to the very educational possibilities of simulations. For example, an airplane simulation is performed with the rationale that it does *not* actually transport people. To realise what aspects are similar and what aspects are deliberately dis-similar is foundational in using simulations for educational purposes.

#### *2.1.3.1 Authenticity*

Shaffer and Resnick (1999) have identified four kinds of authenticity in learning situations: a) learning that is personally meaningful to the learner (personal authenticity); b) learning that relates to the real-world outside of school; c) learning that provides an opportunity to think in the modes of a particular discipline (disciplinary authenticity); and d) learning where the means of assessment reflect the learning process (authentic assessment). They argue that although these distinctions can be made, the concept of authenticity is better treated with aspects being integrated because of their interrelational character. The term they propose for this is “thick authenticity”. They propose that the connectivity-modelling and representational capacities of computers can contribute to various aspects of thick authenticity.

Van Merriënboer and Kirschner (2007) use the terms physiological and psychological fidelity for describing the relation between simulated aspects and the world outside. The fidelity within the actual simulation is also related to the “sociological fidelity” (how professionals and other role models relate to issues brought up in the simulation): this fidelity is proposed as more influential than the others (Sharma et al., 2011). Hence, better fidelity to reality in the simulation does not equal better learning (Gulikens et al., 2005), and aspects of psychological, or functional, fidelity are more important than the physiological similarities.



Gestalt and phenomenology theories approach the meaningfulness of representations from the perspective of meaning as not being inherent in the attributes of the representation but in “gestalts” or intentionality with the user of the simulation (Ihde, 1977). Taking this approach means that the environment surrounding the simulation, and users’ subjectivity co-constitute the meaning of the simulation. Consequently, this view breaks with the objective view that knowledge, or the object of learning is placed solely in the software and in the virtual patient case, but rather in the space shared between the learner and the simulation. The meaning of the same content of an image can shift with design of the surrounding context.

#### **2.1.4 The clinical encounter**

The clinical encounter in health profession practice acts as the guiding idea for virtual patients’ design. An early description of virtual patients states: “The computer assumes the role of a patient and the student that of a practicing physician” (Harless et al., 1971, p. 443). However, despite its modelling function, the functions and expectations of the clinical encounter have rarely been discussed in virtual patient contexts. It is therefore worthwhile to reflect, however briefly, on what constitutes a clinical encounter, and some of the functions that it should fill.

A philosophical reflection based on observations of clinical encounters identified an outcome-directed view of the doctor-patient relationship in practice, focusing on diseases before the patients’ experiences (Svenaesus, 2001). The preferred outcomes are described in the literature as health, compliance, and patient autonomy. The roles of the professional can take different approaches towards the patient ranging from paternalism to patient autonomy (Emanuel & Emanuel, 1992). However, the questions of what a medical meeting is, and of the nature of the knowledge that is established, are seldom asked and made explicit. Consequently, the everyday conception of the clinical encounter prevails, serving contemporary views on medical service. The dimensions of a patient’s experience of his or her situation are often unclear to students in the first years of medical study (Prince et al., 2000). The doctor can adapt treatments in a way that relates in a deeper sense to the patient by inquiring as to his and her own beliefs about the illness. In fact, for the patient the meeting is often an intrinsic part of the treatment (Leder, 1990). The nature of the meeting and the knowledge created in it is, therefore, a co-constructive process between the professional and the patient (Svenaesus, 2001). The hermeneutic view of the clinical encounter is as, foremost, a meeting with the patient as person (not the disease). However, the hermeneutic view is foremost held in theory, whereas the biomedical diagnostic perspective seems to be the predominant one in current clinical practice.

Thus, the “ *patient’s voice indeed rarely surfaces in the texts of the clinic in any direct way*” (Svenaesus, 2001, p. 136)

The clinical meeting requires sound judgement to balance dimensions of biomedical explanations and the patient’s beliefs and life-world. The skilled professional needs to find ways to reach this balance. Feinstein (1967) puts forward the idea that this judgement is learnt through direct contact with sick people. The patient has a natural position at the centre throughout medical education (Spencer et al., 2000). Learning in interaction with actual patients is not, however, straightforward and requires efforts from students and teachers to handle unstructured symptoms and

idiosyncratic experiences in relation to expectations of generalised typical cases for education (Spencer et al., 2000).

Approaching virtual patients from a hermeneutic perspective exerts high demands on their design in order to allow for the life-world perspective to be expressed. Concern has been raised that patients risk being downgraded from active partners in the medical meeting to being medically filtered objective texts (Anspach, 1988; Baron, 1990; Donnelly, 1997; Kenny & Beagan, 2004). The patient representations—mostly by text—that are used for education have a role in forming attitudes and values of students. Attitudes are reflected in text wordings of cases and what procedures are possible in the software interface. Nevertheless, the overall sociological context—for example how role models act in practice—is far more influential in that respect. However, this aspect is often neglected in simulation designs (Sharma et al., 2011).

Currently, we know *that* virtual patients can contribute to student learning. However, we know less about *how*, under what conditions educational aspects need to be considered in order to contribute to student learning in an optimal way. A critical review of virtual patient research literature reveals that “their effective use requires evidence to guide design and integration”, and calls for rigorously performed studies, that, at the time of the review, was “virtually non-existent”

(Cook & Triola, 2009, p. 308). Educators and students are still somewhat unclear on how to approach virtual patient activities effectively in their educational practice. In order to benefit from this innovation we need to make explicit what kind of learning tools they may be, what we may expect from this technology and what educational frameworks are needed to bring about practices that support meaningful student learning.

## 2.2 STUDENT LEARNING

Virtual patients need to be understood in terms of how students learn with them; consequently, ideas on how students learn needs to be considered.

The everyday conception of learning is that declarative knowledge is accumulated in a person later to be retrieved (Dahlgren, 2005; Sfard, 1998). With this view of learning technology has the role of making the information available in an engaging manner. However, meaningful learning is more than storing and retrieval of facts. It involves changing one’s view of the world and making use of new knowledge to act upon the world (Colaizzi, 1978; Dahlgren, 2005; Marton & Booth, 1997). The process of learning can be described from many theoretical stances, which contribute to a multi-faceted picture of positive development. A fruitful perspective on learning is presented by Marton and Booth whereby learning is a new way to experience the world as a consequence of learners actively engaging in meaningful activities (1997). Biggs and Tang (2007) adhere to the crucial aspect of student engagement, and present a framework for aligning course structures around students’ actions in learning activities. The interaction with learning activities takes place between students, professionals, books and other learning tools together with the situation and cultural context in which the student is participating (Brown et al., 1989; Wenger, 1998).

In this work, focusing on learning with an innovative technology tool, it is necessary to retain an open and holistic perspective on student learning in order to discover the possibilities. Influences from several strands of educational theories can

throw light on influences both from the surrounding context as well as from cognitive aspect from within individuals on student learning. The context is functional on several interconnected levels, for example curriculum planning and the immediate learning activity while the individual learner brings previous knowledge, experiences, and preferences for studying. Hence, outcomes of student learning occur as a function between learner activity and the educational environment. Technologies used for virtual patients have the possibility to provide a structure for students to see what teachers would emphasise as important in the learning context (Laurillard, 2002).

### 2.2.1 Experiential learning theory

A framework for learning often applied in learning through simulations is the experiential learning theory (ELT) first put forward by David Kolb (1984). The ELT builds on ideas of student engagement and reflection on experiences and refers to the works of Kurt Lewin (1890 – 1947), John Dewey (1859 – 1952), and Jean Piaget (1896 – 1980). In ELT, emphasis is placed on personal involvement based on humanistic values related to personal experience. The means to achieve this is through a dialectic relationship between action and reflection. This relationship is considered necessary and action and reflection should not outbalance one another. In addition to the personal involvement, Kolb mentions “a spirit of inquiry, expanded consciousness and choice, and authenticity in relationships” (Kolb, 1984, p. 10) as guiding ELT-based work. Furthermore, ELT focuses not only on the outcomes, but also the process of learning, thereby preparing the future professional for a changing society by preparing for continuous enquiry and self-reflection. The works of Lewin, rooted in phenomenology and gestalt theory contributed the four stages learning cycle of concrete experience; observations and reflections; formation of abstract concepts and generalisations; and testing implications of concepts in new situations (figure 1).

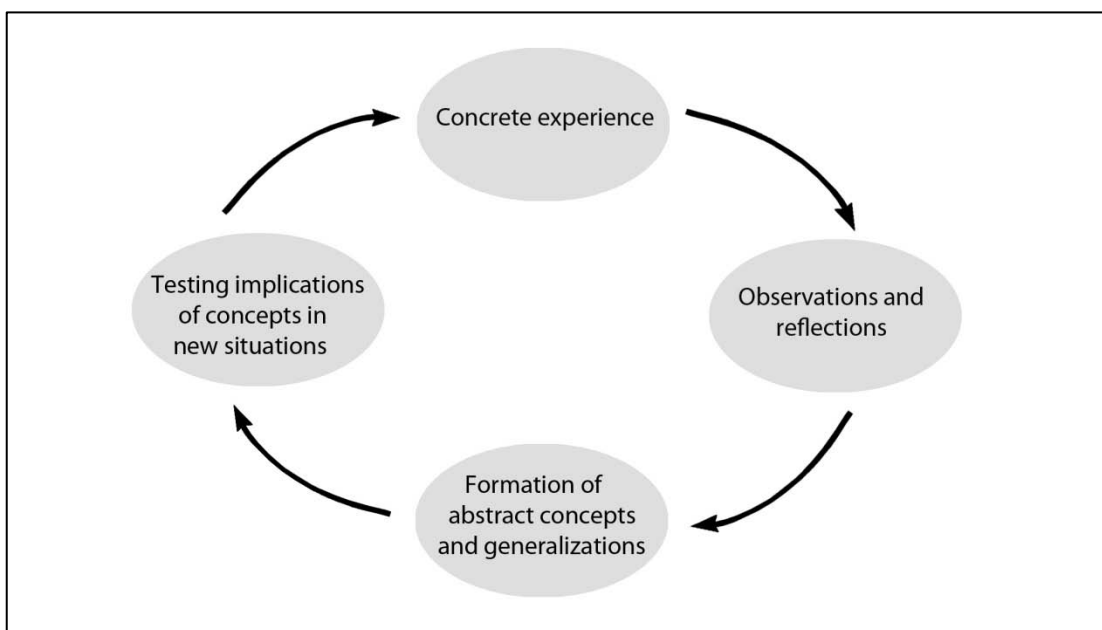


Figure 1. The Lewinian experiential learning model. (Adapted from Kolb, 1984).

The four stages also represent four modes of learning: affective, perceptual, symbolic and behavioural learning, respectively. The *affective mode* emphasizes experience of concrete events aiming at simulating or mirroring what they would do as professionals. Feelings and values are encouraged in this mode. The *perceptual mode* is characterised by experiencing conceptual relationships, or the notion that learners define problems based on observation. In the *symbolic* mode the learner deals with abstract symbols emphasising thinking processes, whereas the *behavioural* mode focuses on the ‘doing’. Learning situations can simultaneously encompass one, several, or all of these modes.

The framework of ELT and other models for dealing with learning from experience makes it possible to see (and improve) mechanisms needed in order for students to benefit from simulated and actual experiences. Learning environments need support from teachers and the environment in order to remove barriers to reflection and promote application and integration of knowledge; just exposing students to experiences does not lead to optimal learning (Boud & Walker, 1993; Dornan et al., 2007).

### 2.2.2 Clinical reasoning based on cases

Health professionals’ expertise is commonly crystallised into the concept of clinical reasoning. Clinical reasoning is explained in broad terms as being the thinking process occurring while dealing with a clinical case (Boshuizen & Schmidt, 2008). It is mostly connected to the diagnostic reasoning, but also to the

*“thinking and decision-making processes associated with clinical practice /.../ it enables practitioners’ process directed towards enabling the clinician to take ‘wise’ action, meaning taking the best judged action in a specific context.”* (Higgs & Jones, 2008, p. 4).

One way of explaining how clinical reasoning skills develop towards expertise is by a process of knowledge encapsulation whereby biomedical knowledge merges into larger functional concepts such as ‘sepsis’. The process develops further by knowledge of enabling conditions from case experiences being intertwined with pathophysiological fault and consequences into a narrative structure termed ‘illness script’ (Schmidt & Rikers, 2007). Alternative models exist, and the area of clinical reasoning is likely to remain a cause for debate on what model best explains expertise, and how this expertise should be developed. Clinical reasoning competence develops hand in hand with biomedical content knowledge and professional attitudes (Boshuizen & Schmidt, 2008). Moreover, a common feature is the exposure to several clinical cases. This means meeting actual patients in clinical practice; however, a great deal of students’ clinical reasoning development occurs when working with patient cases presented as written case reports. The case provides a realistic context that brings about reasoning functions other than those brought about when only presenting factual knowledge questions (Schuwirth et al., 2001). However, the written case restricts variation in reasoning because it lacks auditory or visual cues in patient interviews and is restricted to the author’s line of reasoning and scope of information (Rivett & Jones, 2008). Different case modalities (paper, videotaped cases, CD-ROM) have been compared for clinical reasoning purposes concluding that the different modalities all contribute—albeit in different areas, such as adequacy of information, insight into usage, and student control (Lysaght & Bent, 2005).

### 2.2.3 Student responsibility and self-regulation of learning

A current trend in society is that persons expect to access study activities and learn whenever and wherever they want to (Johnson et al., 2012). Virtual patient use is much regulated by students themselves, and certainly not confined to university campus locations. Virtual patients are often accessed through the Internet at a time and place that is not regulated by schedules. Furthermore, the patient cases are sometimes aimed at learning that is not tightly connected to a specific course assignment (Berman et al., 2009; Hege et al., 2007). The ability for students to autonomously monitor and regulate their learning processes is termed self-regulated learning (SRL), a concept that is regarded as a key for academic success (Boekaerts, 1997). Furthermore, SRL is proposed as a necessary skill in order for students to benefit from possibilities with flexible online learning activities (Winters et al., 2008). Drawing on research in other academic domains, the concept of self-regulation is now gaining interest also in medical education (Brydges & Butler, 2012). A relationship between teachers' and students' regulation of learning has been theorised whereby some combinations of teachers' and students' strategies are constructive while others are destructive for the learning process (Vermunt & Verloop, 1999). Hence, more knowledge is needed on how individual study strategies come into play in learning activities.

## 2.3 RATIONALE FOR THE RESEARCH PROJECT

The phenomenon of virtual patients has already been approached to some extent from different perspectives. The technical development perspective has been a recurrent theme over the years. Virtual patients are seen as technical innovations that enhance case presentations—making them interactive through enhanced modalities (images, sound, and video), and accessible through Internet anytime any place. Furthermore, as a computerised innovation, the technical systems development and its acceptance and applicability has been investigated, suggesting that although the technology sometimes have glitches, students appreciate this way of studying with cases (Cendan & Lok, 2012; Deladisma et al., 2008; Leong et al., 2003; Wahlgren et al., 2006; Zary et al., 2006). Students have also been found to respond empathically to virtual patients (Bearman, 2003; Deladisma et al., 2007). The impacts of virtual patients with regards to their learning outcomes has also been studied and reviewed, and the findings suggest *that* they can be effective in terms of different learning outcomes, especially for clinical reasoning (Botezatu et al., 2010; Cook et al., 2010; Cook & Triola, 2009). However, the question of *how*—the character of virtual patient learning activities and their educational functions—have not been addressed in much detail. In line with the increased use, the intuitive practical knowledge is increasing. However, there is a need to make explicit how different aspects of learning with virtual patients are brought about. Consequently, there is a gap in systematic knowledge concerning the nature and educational functions of virtual patients in medical education. This lack of systematic knowledge leads to the problem of virtual patients not being used to their full potential in medical education. By investigating uses of virtual patients we can uncover their possibilities, and what areas need further scrutiny or development regarding student learning.

When technical innovations enter into educational practice, the research community tends to approach it in phases where justification comprises the first phase, then continuing to efficient use for different purposes. A historical review of research

into educational films identified three phases of researchers' interest. "*Can film teach?*", "*How do films teach?*" and "*Who learns from films?*" (Bowie, 1986). Research concerning virtual patients is now on the verge of leaving this first effect-oriented phase starting to delve into the more fruitful *how*-question. Calls for directing research into the *how* aspect have been raised both for general computer-based learning (Cook, 2005) and virtual patient-based activities (Cook & Triola, 2009). The question of *what* will be addressed in looking for possibilities of virtual patients in a clinical practice setting. The *how* will be addressed by looking at circumstances influencing learning aspects in terms of how the virtual patients are perceived by students, as well as—to some extent—*who* learns from virtual patients in regards to how individual learning strategies relate to the perceived benefit of virtual patients. Knowledge is needed on the educational functions of virtual patients, and on how to best develop educational practices using these. At current this knowledge is implicit with practitioners. The next step towards improved educational practice with virtual patients is to establish systematic knowledge on how virtual patients are conceived of in relation to learning.

### **3 AIM**

The aim of this thesis was to reach a better understanding of student learning with computerised virtual patients, thereby contributing to efforts to improve educational practices with these tools in medical education.

The specific objectives were to explore learning with virtual patients from different perspectives:

- The student perspective (addressed in study I)
- A course integration perspective (addressed in study II) and
- A study strategy perspective (addressed in studies III, and IV).

#### **3.1 RESEARCH QUESTIONS**

The overarching research question was: How can we better understand learning with virtual patients in medical education?

This question can be subdivided into more specific questions as follows:

- How do students experience learning activities with virtual patients?
- In what way do course integration strategies influence the perceived benefit of virtual patient learning activities?
- How do students' study strategies influence the perceived benefit of virtual patient learning activities?

## 4 RESEARCH METHODOLOGY

The choice of methodologies must be seen in relation to the research purpose and the intended audience of the research. In this section, the thesis will be positioned regarding its type of research interests, and the rationale for choosing the mixed methods approach will be presented. Specific methods used in the studies will be presented in chapter 5. The overarching purpose is to create knowledge that increases a pragmatic understanding of learning with virtual patients. To that end a mixed methods approach was determined to be appropriate for the research project. The knowledge that is produced is intended to be interpreted and used by persons adapting it to their own context of theory or practice.

### 4.1 POSITIONING THE RESEARCH PROJECT

Cook, Bordage and Schmidt (2008) propose that medical education research studies falls into one of the three categories of *description*, *justification* and *clarification*. Description informs us about “what is out there”. Justification studies try to answer the question “does it work?”. The clarification category tries to answer the questions “How does it work?” and “why does it work?” This latter category of studies is underrepresented, but needed in medical education in general (Cook et al., 2008). Furthermore, it is of interest for research into virtual patients in particular; this is because of this technology being considered an innovation that lacks a strong conceptualization, and systematically informed directions regarding its use being lacking (Cook & Triola, 2009). Following the above typology, this thesis adheres to the *clarification* category of research in aiming for a further understanding of learning with virtual patients. Furthermore, the nature of the knowledge produced by this research could be labelled pragmatic in kind as it aims to be applied in practice as interpreted and adapted by the intended audiences. The pragmatist perspective stems from philosophers of science and educationalists such as C.S. Peirce (1839-1914), W. James (1842-1910), and J. Dewey (1859-1952). The epistemological standpoint is that knowledge is situated, and that the action in practice is brought to the fore in the research purpose (Johnson & Onwuegbuzie, 2004).

The knowledge from this project is targeted towards three main audiences. It is aimed towards educators and policy makers who implement virtual patient systems into current educational practices. Another audience is comprised of researchers aiming at increasing scientific knowledge of student learning with technology and the methodologies used in that process. A third audience is comprised of software developers that determine the technical and design implications of virtual patient technology. However, students and patients in the society are the true stakeholders in the improved learning that should be the objective of educational innovations. Consequently, this research is positioned in the intersection of research areas of pedagogy, influenced by philosophy of science and by informatics. The interdisciplinary flavour is further accentuated by the fact that the academic habitat for this pedagogic research is a university known for its strength in natural science, and that the research collaborators mostly have their roots in natural science and clinical practice. How, then should the use of virtual patients be studied in order to understand it from a learning point of view?

The gold standard of knowledge production in natural science is the randomized controlled trial (RCT) whereby the effect of induced stimuli is determined in a control



group versus an experimental group. This method falls into the category of *justification* and tells us whether ‘it works’. However, if we want to provide quality learning with innovations we cannot settle with answers such as ‘*it does work*’. Neither can we satisfy with methods focusing on the technology itself describing what it can do. The educational possibilities of virtual patients are encoded in its attributes and reveal themselves only in their use situations (Ellaway & Davies, 2011). Hence, virtual patients as a concept are a cultural object rather than a physical object. Instead of focusing on the technology itself, and thereby deriving what you *can do* with it, we have to set out in observing how it is used in action, focusing on its users and their perceptions. It is then possible to change future practices in beneficial directions.

The pragmatic knowledge interest is foremost found in hermeneutic and cultural sciences where the aim is for an *understanding* of a phenomenon as interpreted by persons within a context. This kind of knowledge interest differs from the technical knowledge interest commonly applied in natural science aiming at *explaining* law-abiding phenomena where less of contextual interpretations are needed (Habermas, 1971). The ideal of the pragmatic knowledge interest is to gain an understanding of the phenomenon with the awareness of its cultural situatedness (Gadamer, 1975/2004). Furthermore, the knowledge is not frozen into an objective standalone entity, but targeted at coming alive as interpreted by the intended audience. This perspective was chosen because of the need for a knowledge base on effective educational practices with educational technology. An awareness of pertinent aspects of student learning with virtual patients is hereby proposed. This awareness, and the knowledge about these aspects are intended to serve an improved change in practices with virtual patients.

## **4.2 THE MIXED METHODS APPROACH**

The core of the pragmatic approach is expressed as a challenge to researchers to: “Study what interests and is of value to you, study it in the different ways that you deem appropriate, and use the results in ways that can bring about positive consequences within your value system” (Tashakkori & Teddlie, 1998, p. 30). The use of a mono-method approach is often advocated in other research traditions because of different methods being paradigmatically incompatible, for example stemming both from qualitative and quantitative research. (Howe, 1988). However, the pragmatist perspective does not determine the methods being used, or kinds of data, nor the analytic framework, thereby opening up for using different methods in achieving an overarching goal. The use of results for improved practice is prioritised before coherence of methods, proposing that an unbalanced preoccupation with selecting, and defending methods may shade the actual substance, and thus hinder the practical use of their results (Janesick, 1994).

The mixed method perspective aims for an overarching goal using different rigorous perspectives (Johnson & Onwuegbuzie, 2004). The goal of medical education research—improving people’s health through top quality education of health professionals—should guide production and use of knowledge. This goal is reached from a dialectic relationship between reflection and practice using different sources of data and methods. Furthermore, it calls for interdisciplinary collaborations between researchers and educators who may not share common theoretical approaches or world-views. Consequently, using a mixed methods approach in a pragmatist research interest

allows for creating broad knowledge of innovations to be used in interdisciplinary contexts.

In the current research project it was considered helpful to approach the use of virtual patients from different learning dimensions (student perspective, course integration, and study strategies) in order to understand and create awareness of pertinent aspects. The use of virtual patients needs to be investigated both in regards to their meaning to the individual student, and also regarding larger patterns of meaning distributed over many students.

The two approaches used in these studies pertain to very different philosophy of science traditions. These are being combined with the assumption that all paradigms have something to offer and that the dialectical combination will contribute to a greater understanding of the object of study. Phenomenological philosophy relates to a paradigm that addresses questions of meaning making and subjective experiences. The other approach—correlational questionnaire design—addresses relationships among variables measured in numerical representations—does not address subjective experiences, but explores patterns in pre-determined variables with larger groups of persons.

The two approaches are here used for a common goal—to take the student perceptions (from interviews and from questionnaires) as data source. Entrusting students with defining the characters and benefits of a learning activity has bearings on motivation and effort that are put into the education without which no education could serve a meaningful purpose. However, perceptions of benefit can change with time and experience and should not be taken directly at face value but be interpreted considering views from societal demands on the profession as well as educators with overarching curricular responsibilities.

#### **4.2.1 The phenomenological approach**

The rationale for using the phenomenological approach was primarily to explore students' perceptions of learning activities with virtual patients. The present author's personal background as virtual patient software developer and theoretical educationalist has created pre-conceptions on functionalities of virtual patients. In order not to be shaded by prejudice and theoretical explanations, a research perspective was needed that focussed on the object of study as it shows itself directly to persons experiencing it. Phenomenology is used as a research approach, but began as a philosophical project. Husserl (1859-1938) set out with the ambition to also make it a foundation for science, since he believed the sciences lacked roots in the world as directly experienced by persons—the life-world. Phenomenology refers to knowledge as it appears to consciousness, the science of describing what one perceives, senses, and knows in one's immediate awareness and experience (Kockelmans & Husserl, 1994). It is foremost used as a method to uncover the nature of phenomena as experienced by persons. Phenomenology aims at making explicit that which is taken for granted, and where a clear view of phenomena is shaded by strong pre-conceptions or tradition (Heidegger, 1962).

Phenomenology has also developed into branches of empirical research directions. In empirical phenomenology the radical first person perspective is applied vicariously, through a researcher adopting the phenomenological attitude (Karlsson, 1993).

Because of its strong connection to philosophy, phenomenology is still a research approach relying more of researchers' attitude and position than on technical procedures. However, for practical reasons, adaptations to suit the research object and circumstances have to be considered in terms of feasibility of carrying through the research in practice (Sixsmith & Sixsmith, 1987). In later years psychological researchers have developed Husserl's existential philosophy into empirical research methods (Giorgi, 1985; Karlsson, 1993; Moustakas, 1994). Karlsson's (1993) rationale for developing the Empirical Phenomenological Psychological (EPP) method was to translate the phenomenological attitude into concrete steps.

The phenomenological attitude is manifested in the phenomenological and the eidetic reductions. The *phenomenological reduction* breaks with the non-reflective belief in the factual world that is used in everyday life, termed the *natural attitude*. In this process objects are reduced to the meaning they have for the experiencer (Karlsson, 1993). Merleau-Ponty describes this process as a slackening of "the intentional threads which attach us to the world and thus brings them to our notice" (1945/1981, p. xiii). The *eidetic reduction* is used in the analysis to reach the meaning structure and lay bare the character of the phenomenon (Karlsson, 1993). The goal of the eidetic reduction is to reach the nature of the phenomenon that transcends variation in how the phenomenon shows itself and how people experience it.

On a critical note, one could argue that the phenomenology used in empirical research—with a phenomenological researcher working with "naïve" research participants—does not really reach the phenomenon itself, nor accesses first-hand experience. Through the empirical research being made we reach the manifestations of the research participants' experiences in perspective. The phenomenological researcher needs to take a vicarious role in terms of access to experiences, and interpret participants' un-reflected accounts using the phenomenological attitude (Moustakas, 1994).

#### **4.2.2 The statistical correlational approach**

Another way to approach students' perceptions is by means of questionnaires whereby results are analysed statistically regarding patterns of items grouped into variables i.e., the correlational tradition within the quantitative research paradigm (Norman & Eva, 2010). Relationships between variables are analysed with the purpose of understanding influences and relations to aspects in the participants' context. The method being used relies on psychometric qualities—the way to measure what is not directly observable. The concepts being measured are often abstract theoretical constructs, and, thus need to be linked to theories explaining those.

To some extent the responses to pre-defined questions—or ranking of statements—de-contextualize responses with regards to the situation from which it pertains. This implies interpreting results in relation to what is known about respondents' contexts. Furthermore, the results need to be analysed regarding their consistency and uni-dimensionality when grouping several items into variables.

Likert scales used in questionnaires have ranked item answer categories, and hence, produce data of an ordinal character. Using parametric methods—such as ANOVA or regression analysis—on ordinal data is not considered good practice by theorists because these require assumptions of continuous interval scale and a normal distribution of data (Svensson, 2001). However, as experienced researchers have

noticed, in practice parametric functions mostly function well, and produce fruitful results (Norman, 2010). Consequently, a pragmatic approach to this conflict would be to use non-parametric methods where they exist, such as Spearman's *Rho* for correlations, and take advantage of the more complex parametric methods where contribute to the studies where non-parametric methods are non-existent or awkward to use.

### 4.2.3 Approaches to data

Interpretative research approaches acknowledge the role of reflexivity as playing a central role for the researcher in gathering and reporting of data (Savin-Baden, 2004). In the empirical phenomenological approach an awareness of pre-conceptions and subjective contributions is created, and dealt with in the phenomenological reduction. Experience and judgement are used also in the correlational research tradition, although researchers use statistical validation measures to evaluate the data, and do not incorporate subjective influences into the research reports. Consequently, the researcher's relation to data differs between studies in this project on empirical study levels. However, the overarching perspective taken in the project is the interpretative approach for a pragmatic purpose. This means that data are not considered as standing objectively for themselves, but are connected to contexts and need to be interpreted by readers—practitioners or researchers—in relation to the contexts in which they are to be used. The pragmatic knowledge is not a prescriptive 'recipe' but requires responsibility of the readers to adapt and translate to their context. Dewey argues against educational science providing recipes to educators, and furthermore reinforces the artistry responsibility of the teacher to use available science in conjunction with situational knowledge:

*"It is very easy for science to be regarded as a guarantee that goes with the sale of goods rather than as a light to the eyes and a lamp to the feet."*  
(Dewey, 1929, p. 15)

Knowledge that serves practice does not stand free from values and context of interpretation. Adhering to knowledge intended for understanding and practical use, we can consider Gadamer's position on philosophical hermeneutics.

*"It [hermeneutics] corrects the peculiar falsehood of modern consciousness: the idolatry of scientific method and of the anonymous authority of the sciences and it vindicates again the noblest task of the citizen – decision-making according to one's own responsibility – instead of conceding that task to the expert. In this respect, hermeneutic philosophy is the heir of the older tradition of practical philosophy."* (Gadamer, 1975, p. 316)

The knowledge is therefore not aimed at being *directly* applied in practice, but interpreted and enriched by the person taking part of it. The richness is produced when readers (such as educators and other researchers) understand the results both from the perspective they were created in and from their own culture of practice. The perspectives of the researcher and readers coincide towards a pragmatic end in an enriching process similar to the fusion of experiences of the author and the reader in interpreting cultural understanding of texts (Gadamer, 1975/2004). The interpreter of pragmatic research (him- or herself) needs to combine the views in relation to the context in which the knowledge will be applied, aiming for a good outcome.

## 5 EMPIRICAL SETTINGS AND METHODS USED

### 5.1 EMPIRICAL SETTINGS

The empirical context was the medical programme at the medical university of Karolinska Institutet, Stockholm. Data was collected at the rheumatology unit at the Karolinska University hospital, Solna (Study I), and the four teaching hospitals affiliated to Karolinska Institutet (Studies II-IV). The medical curriculum is based on “traditional” sequence where students initially study theoretical knowledge in the basic level, and begin clinical clerkships in their third year (figure 2). Study I was undertaken at the rheumatology clinic where students performed clerkships in 2008. Studies II to IV were undertaken at a clerkship preparatory course during Spring 2009. Regular course-planning group meetings were held, during which the course directors and teachers planned integration of virtual patients as a part of the continuous course development. Previously, Problem-based learning (PBL)-inspired cases presented by PowerPoint formed a way to contextualise factual and case knowledge taught in the course. These were subsequently replaced by web-accessed virtual patient cases. Initially four cases were developed by teachers in the group and different approaches to integrate them into the course were tried out. The author participated as an educational researcher and observer during meetings and course activities between 2008 and 2012.

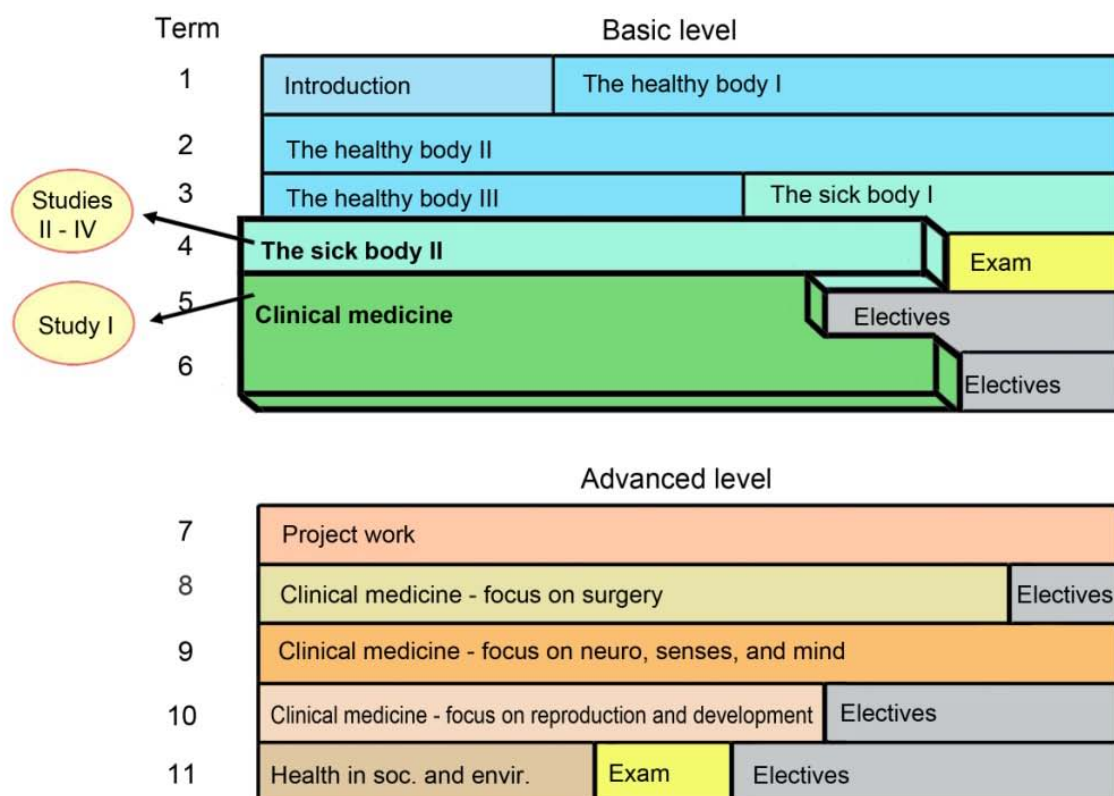


Figure 2: Empirical settings in relation to the medical programme at KI

### 5.1.1 The virtual patients platforms used

Two virtual patient platforms were used in the empirical settings, ReumaCase and Web-SP.

#### 5.1.1.1 ReumaCase

ReumaCase is adapted to the Rheumatology context from the NUDOV platform described in Wahlgren et al. (2006). This platform is installed directly on the PC on which it is to be used. The four cases currently available are based on authentic rheumatology patients, albeit with fictitious names. The cases were chosen because of their representativeness of common disorders in society. A short video-clip introduces each case, in which the patient is invited from the waiting-room into the consultant's room. Different sections, such as 'write medical record', 'further investigations', and 'examine', are reached from a navigation page.

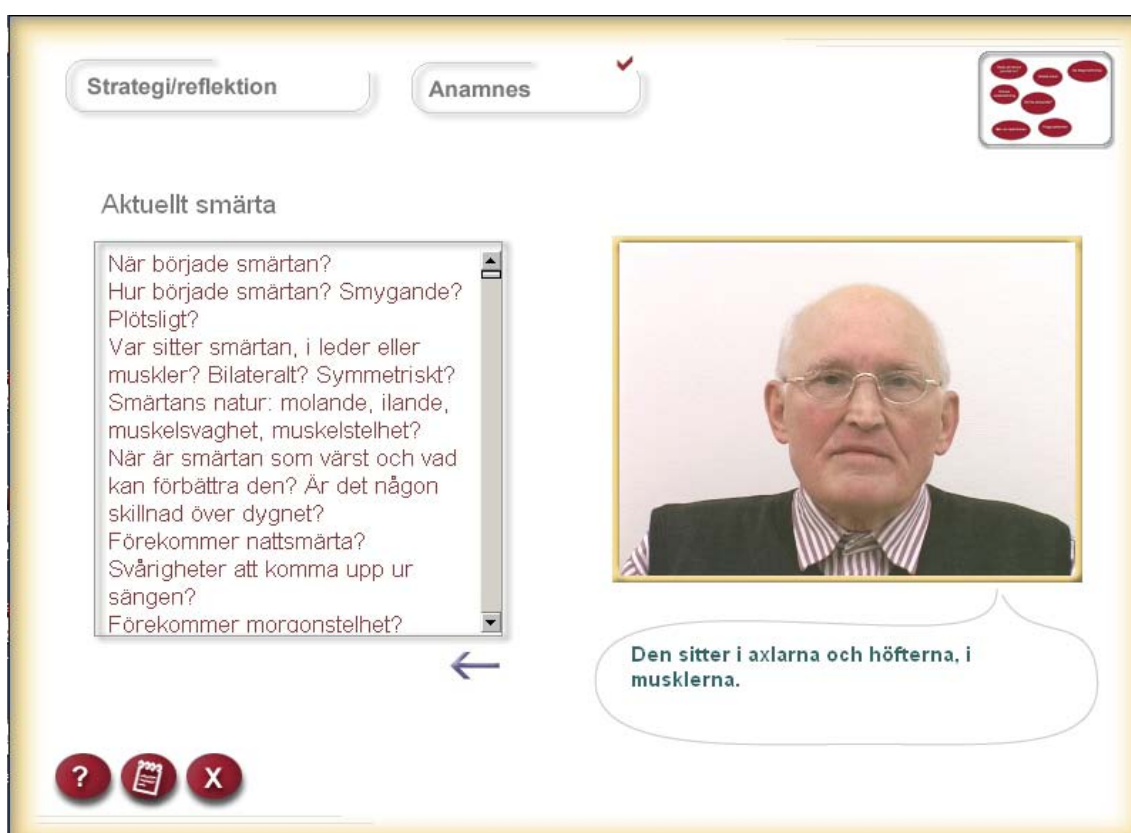


Figure 3: The interview section in ReumaCase. The virtual patient answers either through text, or by a short video-clip.

### 5.1.1.2 Web-SP

Web-SP was developed for supporting web access to virtual patient cases in a wide variety of medical specialities (Zary et al., 2006). The design enables free navigation between different sections of for example physical examination and patient interview.

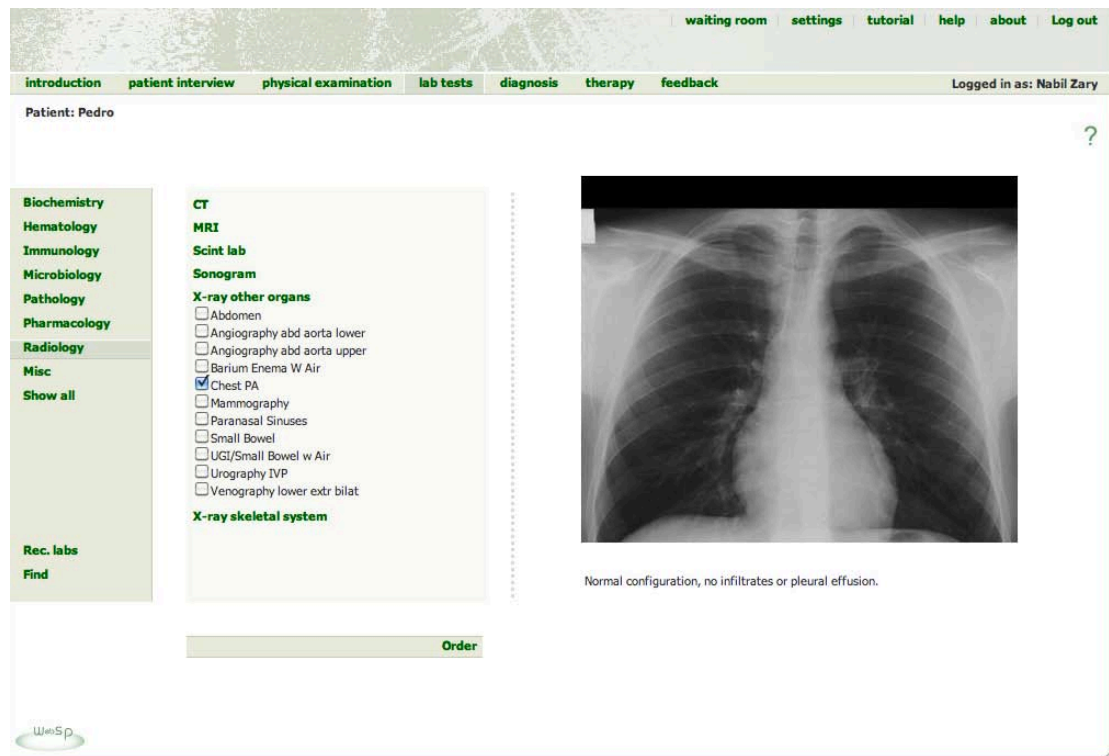


Figure 4: Web-SP lab test section. A broad range of lab tests are available in one of the Web-SP sections

### 5.1.2 The researcher's role

Data were gathered in natural, non-experimental settings where the researcher did not intervene in setting up or controlling the learning situations. However, the virtual patient software being used in study I (ReumaCase) had been developed by the author, and the platform being used in studies II and IV (Web-SP) was developed in a research and development group of which the author was a part. In collaboration with co-researchers, teachers, and students, the role of the education researcher was emphasised making an effort not to promote, but to investigate, the use of virtual patient technology.

## 5.2 METHODS USED

A graphical overview of the research focus, virtual patient aspect addressed, type of data and settings is outlined in figure 5.

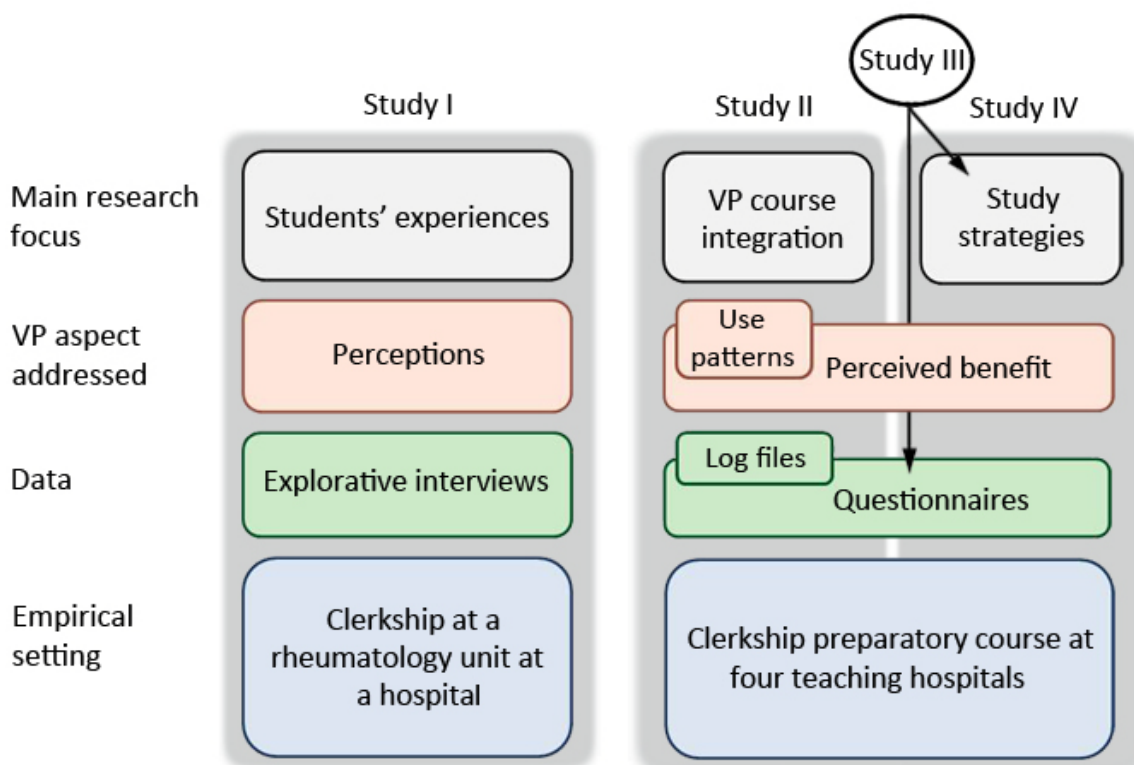


Figure 5. Overview of studies. Aspects of learning with virtual patients (VPs).

### 5.2.1 Study I

The purpose of study I was to elicit students' experiences of learning with computerised virtual patients during a clinical practice period (one to two weeks of clerkship). Considering virtual patients as an educational innovation, it was necessary to emphasise the users'—the students'—perspectives and disregard teachers' and researchers' preconceptions about the phenomenon. Consequently, a method for handling preconceptions and focusing on users' direct experiences was needed. Data consisted of exploratory student interviews analysed using the Empirical Phenomenological Psychological (EPP) method (Karlsson, 1993). By adhering to the phenomenological approach and using this attitude in interviews and analysis, the life-world of students and the contributions of virtual patients during the clerkship were elucidated.

A key aspect in the phenomenological approach is the phenomenological reduction. By assuming this reduction the researchers actively disregard preconceptions about the phenomenon of study. A concrete step in this direction was to bring existing preconceptions to the fore. All co-researchers (listed as authors in the published paper) wrote a text describing their individual conceptions of virtual patients, and how they expected them to contribute to student learning during clerkship. The preconceptions were not considered as faulty; however, having made them explicit, it was easier to temporarily disregard them during the analysis.



The interviews were conducted directly at the hospital at the end of the clerkship rotation. The location contributed to connect the perceptions to the environment in which the virtual patients were used. Most interviews were conducted by the primary researcher (SE) and two by a clinician teacher involved as co-researcher due to practical reasons. Practical circumstances (student-allocations in couple of pairs, and logistic reasons) determined the number of participants at each occasion, from individual to settings of four. Students' descriptions were transcribed in full by SE. The transcripts that constituted students' non-theorised expressions of perceptions were then analysed by SE in conjunction with co-researchers, using the EPP method as a structure (Karlsson, 1993). This structure followed the procedures of first getting an overall acquaintance with the data through reading. Then, text passages were organised in themes. The data was processed in iteration in condensing passages into meaning units relating to invariant meaning (essences) of the phenomenon. Quotes were then translated into English and themes and quotes were condensed into a textual meaning structure in the report.

### **5.2.2 Studies II-IV**

A different approach to students' perceptions was taken in studies II-IV. Instead of explorative interviews a set of pre-defined questionnaire items were devised and piloted. The question areas concerned how four web-based virtual patients in a clerkship preparatory course were perceived, how they contributed to the students' learning and how they were used. In addition to the questions pertinent to virtual patients, questionnaire scales regarding preferred study strategies were used in studies III and IV. These three scales were translated from the Inventory of Learning Strategies (Vermunt, 1998), and piloted in the study setting.

A non-experimental explanatory cross-sectional survey design (Johnson, 2001) was used in studies II and IV. Data consisted of questionnaires, observations of seminars and analysis of computer log files. The primary results rest on questionnaire data in relation to different strategies for integrating virtual patients into courses.

Concepts (variables or scales) were formed by grouping several items (questions or statements): then, these were analysed statistically for associations (Spearman's Rho on summed scores). The validity and psychometric properties of the translation and use of the study strategy scales were investigated in study III. The method used for assessing these scales, and also to form the variables used in studies II and IV is the Mokken scale analysis based on non-parametric item response theory (Sijtsma & Molenaar, 2002).

## 6 SUMMARY OF RESULTS

### 6.1 STUDY I: EXPERIENCING VIRTUAL PATIENTS IN CLINICAL LEARNING

Thirty-one students studied four virtual patients during their stay at the rheumatology unit. The virtual patient cases were developed keeping representativeness of common rheumatology diseases in mind because of the specialised character of the ward meaning (i.e., students were not ‘guaranteed’ to meet patients with the most common symptoms.)

The key findings in study I were as follows.

- Virtual patient learning situations were regarded as intermediate situations between textbook study and learning with actual patients contextualising biomedical knowledge into clinical scenarios.
- Virtual patient study sessions were very active. Students were taking decisions on their own, “played detectives” and took on the role of physicians.
- The virtual patient cases provided a framework for meeting actual patients at the clinic and catalysed the learning at the clerkship stay.

The opportunities for interacting with actual patients and performing real procedures—such as the physical investigation of the joints—was the first priority for the students during their stay. Consequently, the motivation for doing virtual patient study was driven by this activity being mandatory, and was asked about during the last day of the stay. The virtual patient study session were typically carried out in pairs. Using the virtual patients allowed for active decision making and diagnostic ‘detective work’. The activity allowed for reasoning around the case with peers in a way that was not considered feasible in actual patient encounters. Students gained knowledge about typical rheumatological illnesses and about related investigations and procedures. This knowledge in conjunction with a framework for patient interviews based on the available set of interview questions, contributed to getting into the clinical placement more quickly and making the stay more meaningful. The students were unused to working with virtual patients and, consequently, did not label the learning situation, or describe the kind of learning very explicitly. However, the analysis of their descriptions positioned virtual patient learning situations as intermediate, between textbook study and learning with actual patients. The virtual patients contextualised the biomedical knowledge of the students—that they had beforehand—into a relevant situation where they had to be active.

This virtual patient software (ReumaCase) did not allow for web access; the virtual patients were only available at computers at the clinic. This fact, in addition to encouragement from teachers to work pair-wise with the virtual patients, led to much collaborative work in front of the virtual patients in the environment of clinical care.

Many students in this setting worked pair-wise in front of the virtual patients. The students who did so reported that the pair-wise setting opened up for more discussion around the case and provided a deeper and broader perspective on the case.

## 6.2 STUDY II: INTEGRATING VIRTUAL PATIENTS INTO COURSES: FOLLOW-UP SEMINARS AND PERCEIVED BENEFIT

This study set out to examine how different virtual patient course integration strategies influenced the virtual patient use, and the perceived benefit of studying with virtual patients. Different integration strategies were compared in a cross sectional explanatory study design. The context was a clerkship preparatory course for third year medical students (N=247). The four settings (A-D) were analysed regarding their virtual patient integration strategies.

In total, 161 questionnaire responses were obtained (65%). Questionnaire items were synthesized into three scales by exploratory factor analysis: *perceived benefit of virtual patients*, *wish for more guidance on using virtual patients* and, *wish for more assessment and feedback on virtual patient work* (Box 1). Virtual patient use was data were gathered from questionnaires and log files.

Box 1. Items included in the three variables, translated from Swedish

### **Perceived benefit of virtual patients, (11 items, Cronbach's alpha: 0.89)**

Does it help you to perform better on the examination?

Is it something that is beneficial for your future professional practice?

Does it influence your understanding of the topics in the course?

Does it facilitate learning new facts about symptoms and diagnoses?

Does it train your ability to reach diagnoses?

Does it connect the topics you study to reality?

Has it caused you to make more use of Internet sites relating to the subject?

Do you prefer web cases to paper-based patient cases?

*Please state to what degree you appreciate different aspects of web case activity:*

Get acquainted with more patient cases

To lead an investigation on one's own

To get an overview of diagnostic and investigation possibilities

### **Wish for more guidance on using virtual patients (3 items, Cronbach's alpha: 0.73)**

Has it been clear to you what you can expect of the web cases? (reversed scoring)

Has it been clear to you how the web cases relates to the course? (reversed scoring)

Did you wish for more guidance concerning working with the web cases?

### **Wish for more assessment and feedback on virtual patient work (2 items, Cronbach's alpha: 0.74)**

Did you wish for more course assignments relating to the web cases?

Did you wish for more seminar discussion of the web cases?

The strategies for virtual patient integration were most clearly expressed in how virtual patient activities were followed-up in the course. Three levels from low to high on an 'overall case processing intensity' scale were found in the respective courses at the four teaching hospitals. Several aspects contributed to this scale (e.g. the kind and degree of case knowledge that was expected from students) (table 1).

The perceived benefit of virtual patients was significantly higher in settings with higher case processing intensity (figure 6). The use of virtual patients were also more frequent, and displayed a more focused pattern in settings with high case processing intensity as compared with the corresponding low and medium ones. The results

suggest that the virtual patient case follow-up is an important virtual patient course integration aspect.

Table 1. Characteristics of the virtual patient (VP) follow-up seminars

Hospital settings	A (n=57)	B (n=48)	C (n=72)	D (n=70)
Group size	-	≈48	≈12	≈12
Clinicians present per session	-	3	1	2
Requested of the students	Be acquainted with cases	Know the cases	Know the cases	Be able to present cases
No. and length of sessions	-	1 à 1.5 hour	4 à 1 hour	1 à 1.5 hour
No. of VP cases	-	2	4	2
No. of related non-VP sessions	5	4	-	6
Overall case processing intensity	Low	Medium	High	High

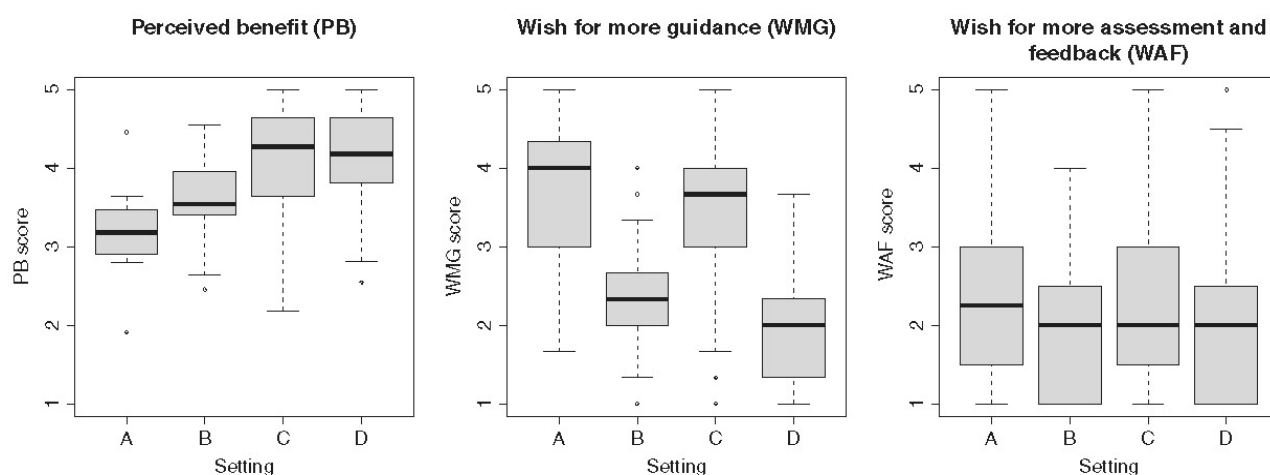


Figure 6. Main outcome variables *PB*, *WMG*, and *WAF* in the four hospital settings. (©Blackwell Publishing Ltd 2012. Medical Education 2012; 46(4): 417–425.)

### **6.3 STUDY III: MEASURING EXTERNAL- AND SELF-REGULATED LEARNING IN MEDICAL EDUCATION: SCALE RELIABILITY AND DIMENSIONALITY IN A SWEDISH SAMPLE.**

This study concerned students' strategies to study in terms of self- and externally regulated learning. A central concept is self-regulated learning—the ability to monitor and plan one's learning process autonomously. More specifically, it seeks to thoroughly validate established questionnaire scales on regulation strategies in medical education. Twenty-eight questionnaire items were grouped into three scales of self-regulated learning, external regulation and lack of regulation by previous research (Vermunt, 1998). These were translated into Swedish, piloted, and used in the four settings of the clerkship preparatory course, described in Study II. A thorough psychometric evaluation suggested that, estimates and comparisons taken together, these scales have an adequate capacity for detecting the three theoretically proposed learning regulation strategies in the medical education sample. The reliabilities of the scales were on par or exceeded other reported results in Europe (Cronbach's alpha: 0.82, 0.72, and 0.65 for the self-regulation (SR), external regulation (ER), and lack of regulation (LR) scales respectively). However, the scales *ER* and *LR* displayed less unidimensionality as measured by Mokken coefficient *H* (Mokken *H*: 0.32, 0.21, and 0.26 for the *SR*, *ER* and *LR* scales respectively), suggesting that these concepts should be further investigated in relation to the study environment, and how the items relate to students.

### **6.4 STUDY IV: IS THE PERCEIVED BENEFIT OF VIRTUAL PATIENTS INFLUENCED BY INDIVIDUAL STUDY STRATEGIES OR EXTERNAL COURSE REGULATION?**

This study set out to investigate the relations between individual study strategies, teacher regulation, and three variations of course regulation of a virtual patient learning activity. The primary outcome variable was students' perceived benefit as measured by a synthesis of beneficial aspects brought up by 11 questionnaire items (box 1).

There was a positive correlation ( $Rho\ 0.27, p<0.01$ ) between self-regulated learning strategy (*SR*) and the perceived benefit of the virtual patient activity (*PB*). However, this relation differed between the three settings. In setting 3, with high teacher-regulation, and group-based student-presentations of cases, there was no such correlation. The external regulation strategy (*ER*) correlated positively with *PB* in the two settings with high teacher regulation of the activity ( $Rho\ 0.32, 0.36, p<0.001$ , for settings 2 & 3, respectively). A negative correlation between *ER* and *PB* was found in the settings with medium teacher regulation of the activity ( $Rho\ -0.39, p<0.05$ ). The regression analysis showed that *ER* and *SR* influenced the *PB* (regression coefficient 0.19 and 0.14, respectively) though not as much as the coefficient for the settings (-0.75 and -0.29 for settings 1 and 2, respectively). Two questionnaire items got highest possible score (median 5) in all settings: *Does it train your ability to reach diagnoses?* And *[I appreciate] The flexibility to work when and where it suits me.*

## 7 DISCUSSION

The aim was to reach a better understanding of learning with virtual patients through exploring their use from different perspectives. Several aspects pertinent to learning with virtual patients were found, and some implications concerning future use of virtual patients can be derived.

### 7.1 MAIN FINDINGS FROM THE EMPIRICAL STUDIES

A salient aspect in both empirical settings was students' perceptions of learning activities with virtual patients offering possibilities to apply previous knowledge in taking own decisions in clinical cases. In the rheumatology clerkship, the students mentioned "playing detective" in identifying the virtual patients' diagnoses (Study I). In the clerkship preparatory course (Studies II & IV) one top-ranked questionnaire item concerned the ability to train the ability to reach diagnoses. The technology makes it possible to present a rich patient case containing images, video-clips and other means of providing a holistic representation of a person. Furthermore, it allows for stepwise presentation of data, so that the students have to decide on how to proceed to gather further knowledge about symptoms and signs that determine how they continue with the case. The problem-solving aspect of the virtual patients' work was perceived as similar to the real patient situation, albeit with the added value of ability to reason with a peer, or consulting the textbook at the same time in a safe and relaxed environment. Students at this transitory level—between learning theoretical knowledge and the world of clinical practice—sometimes describe the first contact with real patients as dealing with different kinds of knowledge as compared to theoretical study. In clinical practice they encounter patients with multiple and vague symptoms—not clearly defined diagnoses, as are often the case in basic theoretical education (Prince et al., 2000). The virtual patients appeared as an intermediate link, and seemed to smooth the transition between theoretical knowledge and clinical practice. Furthermore, the virtual patient work contributed a framework for interacting with the actual patients that facilitated and catalysed the learning experience at the clinic.

The time at the clerkship was very precious to students, and their priority lay with patient contact, preferably to practice physical examinations. They first set out doing virtual patient study because it was made mandatory, and the supervisor would check on the cases the last day. Similarly, at the clerkship preparatory course, the virtual patients were not much used in the setting that did not follow up the activity. However, where performed, the virtual patient activities were much appreciated by students. Study II demonstrated that not only the use, but also the perceived benefit, were much higher in settings that required more case processing in the integration of virtual patients into the course. The findings suggest that the more case processing being done by students, the more they benefit from the activity. Different approaches to case processing can be proposed on different levels. The follow-up seminar was an arena where case data were put in perspective by clinicians. In several seminars the clinicians also discussed between themselves, for example various approaches to interpret lab data. Students brought textbook knowledge to the seminar but were somewhat unfamiliar with interpreting it in the clinical context. Although some students described the follow-up seminar as a superfluous activity, observing that the seminars disclosed a rich availability to clinical experience to students. The practice of

requiring small groups of students presenting cases to each other seemed also to have increased their processing of cases, and correlated with high perceived benefit.

The self-study part of the virtual patient activity was to a large extent performed off-campus (65% only at home, 15% both at home and campus). This implies that the influence on how the study activity is actually brought about is largely dependent on aspects other than those regulated by the course. Solitary self-study use of virtual patients is promoted by the flexible web-accessed technology. Students mostly worked alone with virtual patients—79% in Study II, which is in line with 95% of the students in Canadian paediatric settings (Fall et al., 2005). This flexibility increases the demands on students' own regulation abilities, regarding both when and where to work with cases, but also regarding what learning outcomes they aim for. The learning regulation scales developed by Jan Vermunt (1998) provided means to elicit patterns of students' preferences for regulating their own learning in courses, and to relate those to how they approached the virtual patient activity. Furthermore, they provide knowledge as to how to better integrate virtual patients as regards the level of course regulation needed. The connections between self-regulation of learning and aspects of teacher regulation were based on the findings in Study IV, suggested to be related to each other, much in line with the theory presented by Vermunt and Verloop (1999) in which increased teacher regulation leads to students exerting less of their own regulation strategies.

Education researchers have pointed out the necessity of self-regulation in academic learning (Boekaerts, 1997; Winters et al., 2008). Based on this, one would expect the self-regulation aspect to be dominating over external regulation in the influence of perceived benefit. Indeed, the self-regulated learners did seem to benefit the most from the virtual patient activity in the loosely teacher-regulated settings. The more teacher-regulation, the less the students' self-regulation abilities were brought into play to influence the perceived benefit. However, overall, the external course regulation influenced the perceived benefit to a greater extent than the individual study strategies did.

### **7.1.1 Methodological considerations**

The mixed methods approach provided multiple angles into the multi-faceted phenomenon of learning with virtual patients. Furthermore, it presented several entry-points which create awareness of this field of research and stimulates further investigations. However, the strength of each aspect brought up, and possibility to go into depth into each, was limited by the scope and resources possible in a doctoral project.

An important insight was reached through the phenomenological reflection using the phenomenological reduction during Study I. A consequence of applying this reduction was how the object of research changed from the outset of the study during the analysis. At first the object was considered to be the VP software itself in educational use at the clinic. By phenomenological reflection on this phenomenon it had to be revised to be the learning experience itself that constitute the phenomenon. The next step possible to take when disregarding presuppositions was to realise that the taken-for-granted *learning* experience was rather a *study* experience that of course is intended for learning. What students foremost experienced is more correctly denoted as an arranged study situation as a part of their everyday lives, more than it was conceived of as a learning experience.

Considering the empirical settings in which the studies have been performed, generalisations to other contexts should take into account the stage of the participants within the programme as well as the curriculum orientation (e.g. not problem based) into account. Furthermore, the software platforms of virtual patients are expected to evolve dramatically which may alter some aspects of consequences for student learning with virtual patients as compared to the possibilities with the platforms used in this project.

## **7.2 LEARNING OPPORTUNITIES ENABLED BY VIRTUAL PATIENT TECHNOLOGY**

Learning with virtual patients can take different shapes in relation to software design, the purpose and approach of the learning activity, and other aspects. Nevertheless, some aspects of learning will be highlighted here that the virtual patient technology seems to enable more readily than other educational tools and designs. In addition to these, some areas of concern and future directions for virtual patient research are addressed.

### **7.2.1 Taking a professional role**

The interactive character of virtual patients whereby the learner decides on investigations, interview questions and the like supports learners taking on a professional role in active decision making. Role taking, and ‘thinking like a doctor’ supports activation and personalisation of knowledge (Schön, 1987). Learning with patient cases are beneficial for developing and applying cognitive parts of clinical reasoning (Rivett & Jones, 2008). Using the virtual patients can contribute in this respect to providing a decision-making platform and a representation of a clinical context, whereby clinical data is transformed into action by the student. Active participation and decision making is an important step in the development of professional identity. Different levels of participation have been identified (Dornan et al., 2007). Although decisions in the virtual patient scenario do not have real consequences the decision aspect was much appreciated and seemed to help students develop active participation due to its intermediate position between factual knowledge and the real clinical context.

### **7.2.2 The safe zone**

A dimension that was often brought up in the interviews in Study I was the safe zone in which the virtual patient encounter occurred. The benefits of this were that students dared to make decisions, and that it allowed for discussion and browsing in textbook and Internet resources while studying the case. During contact with actual patients students sometimes felt blocked by the pressure of the situation and felt they could not turn to textbooks for gathering data in the presence of the patient. Practising in a safe protected environment is supported by cognitive theories of learning (van Merriënboer & Sweller, 2010) and clinical reasoning literature (Byrne, 2012) as well as in Experiential Learning Theory, more specifically in the idea of the ‘practicum’ presented by Schön (1987). Due to the fact that the complexity of real patients is missing, and aspects and real consequences not being at stake, it cannot replace, but rather prepare for, clinical work.



### **7.2.3 Technology mediating real life experiences**

There is no doubt that in learning with representations of reality some of the complexities of the real world get lost. The possibility with digital technology to convey a rich picture of life-worlds of patients and clinical procedures is not always used to its full extent. Similarly to possibilities with text—that since historical times has provided us with insights into people’s feelings, experiences and biographies—it could represent and facilitate hermeneutic aspects of medicine. However, this has to be deliberately designed into the software and the actual cases. This implies narrative skills with case authors in order to make these aspects come to life and be functional.

However, lack of richness is not necessarily negative, but could supersede reality in the sense that aspects of reality get enhanced in a way that is not possible in real life. The single focus on one aspect is one approach that has been demonstrated to be successful in training decision making in fighter pilots where relatively unsophisticated technology were used to enhance the silhouettes of fighting aircrafts, and display them at a fast tempo to learners. By exaggerating characteristics (nose, wing, or cockpit shape) of aircrafts, the pilots quickly learned to distinguish between friendly and enemy aircraft in order to react quickly in a future fighting situation (Dror et al., 2008). Requirement of context richness and authenticity within the simulation itself is thus reduced to what is necessary and functional in the situation (Salas et al., 1998; Shaffer & Resnick, 1999).

### **7.2.4 The patient encounter as model for virtual patients**

The trinity of biological, phenomenological (patients’ life-world experiences), and cultural dimensions of illness has been brought to the fore by Svenaeus (2001). These dimensions are always present, to some extent, in patient encounters. In the clinical day-to-day practice they work in a dialectic relationship that is not made explicit. In theoretical parts of the formal education, the biomedical perspective dominates over the others by a diagnosis-driven approach to medicine (Prince et al., 2000). Therefore, there is a need to balance this perspective in the clinical oriented education where symptoms and the patients’ experiences are the focus.

The clinical encounter inevitable lies at the centre of medical practice. No matter what aspect of healthcare we encounter, there is always a person involved that in some way or another meets the health professional. This meeting has all parts of the trinity of dimensions mentioned earlier. In light of this, a learning activity that purports to simulate the clinical encounter has much to live up to.

The phenomenological dimension is presented by the patient’s voice, from their own life world. This voice was not very salient in the virtual patient cases used in this study. However, in one setting (Study I) the cases were based on actual patients and included short video clips of the patient in the waiting room and in the interview setting. This aspect resonated to some degree with students who referred to the personalities of the four virtual patients. However, the majority of virtual patient cases are authored with still images, patient data and histories assembled from several patients (or altogether fictitious). The biological, phenomenological and cultural dimensions are always present, to some extent, in patient encounters. However, concerns have been raised in learning with authored cases learning about patients’ perspectives getting into the background (Kenny & Beagan, 2004). It is necessary to acknowledge what dimensions should be brought to the foreground in different learning activities, and give opportunities for students to develop their own synthesis of the three dimensions.

Patient cases authored for paper media often tend to convey views that are criticised for being depersonalised, de-contextualised, and taking the doctor's viewpoint, divorced from patient perspectives (Bizzocchi & Schell, 2009; Kenny & Beagan, 2004). The technical opportunities with virtual patients give ample opportunities for case authors to incorporate phenomenological and cultural perspectives to counter this critique and balance the different dimensions. However, the surrounding course framework and role models have been proposed to be more influential than single learning activities in forming students' attitudes by connecting authenticity and relevance to the learning activity (Sharma et al., 2011). Consequently, the context surrounding virtual patient practices should counter the biomedical overweight and promote the under-developed perspective of patients' lived experience.

Current hopes on virtual patient technology development concern increased authenticity and possibility to actually interact with the virtual patient. Poulton and Balasubramaniam (2011, p. 936) foresee possibilities of 'authentic patient management' and 'clinical and communication skills training' in the extension of the "lightweight" VPs of today. There is no doubt that the patient representations and interaction interfaces (e.g. voice and haptic devices) will radically improve from current levels. However, the co-constructive relation present in the professional doctor-patient relationship (Leder, 1990; Svenaeus, 2001) is not re-created in the virtual patients available presently or in the near future. Considering the life-world perspective, even the near-perfect will not do in terms of replacing human communicative situations. Consequently, the educational endeavours should (instead of hoping for next generation technology) be targeting aspects of the communication situation, management issues, and diagnostic reasoning already with the technology available at hand. Because of many of the implicit dimensions in the patient encounter are lacking in the virtual patient technology, these need to be supported by other activities in the surrounding educational framework.

### **7.3 PROPOSED THEORETICAL FRAMEWORKS ON STUDENT LEARNING FOR VIRTUAL PATIENT INTEGRATION**

Ellaway and Davies (2011) redirect focus from the attributes of virtual patients as a technical tool to instead lay bare the activities that are performed with it. Although the designs of virtual patient software (Huwendiek et al., 2009) and the cases (Kenny & Beagan, 2004) have implications for learning, the activities performed with it seem to have greater influence on its use and benefit.

Educational problems need to be addressed by appropriate tools and theoretical frameworks. Virtual patients are now available as valuable assets for medical educators, but needs to be used in conjunction with a strategic planning of the surrounding educational context in the integration of virtual patients into the curriculum. Such strategies should be grounded in theoretical learning frameworks, providing mechanisms to detect and support aspects pertinent to the learning outcomes. Two lines of educational frameworks will be suggested here as possible candidates.

#### **7.3.1 Experiential learning theory**

In seeing virtual patients as a platform for acting upon clinical knowledge the Experiential Learning Theory (ELT) provides mechanisms to detect and plan both for reflection and action on clinical cases. Two kinds of learning dimensions are elaborated

in ELT: direct apprehension of concrete experience, and indirect comprehension of symbolic representations of experience (Kolb, 1984). The virtual patient learning situation as identified in Study I, constitutes an intermediate position with aspects pertaining to both these kinds of knowledge. In Dewey's work on experiential learning he emphasised the link between education and personal experience. However, a deliberate reflection is needed. *"...to learn from experiences, a person must reflect on them. Observation is not enough, learners need to "stop, look and listen" and understand the significance of the experience"* (Dewey, 1938, p. 68).

A framework that guides the experience in favour of learning that supports reflection on experiences is therefore an important component besides the experience itself. In ELT, its dialectic view of action and reflection provides conceptual tools for deconstructing what learning processes are at play in virtual patient learning situations. In line with ELT, Schön (1987) describes different kinds of "reflective practicums"—low risk environments where learners gain experiences through interaction with situations—ranging from unproblematic ones in which learners apply facts, rules and procedures to instrumental problems to complex ones lacking a right answer and in which the learner needs to apply a sense of professional thinking to construct new categories of understanding and description of problems. This idea has been adopted as a model for using digital technology in a 'virtual practicum' (Henderson, 1998). This model provides a means to work with aspects of action and reflection in clinical education.

### **7.3.2 Clinical reasoning**

Theories of clinical reasoning are not uniform in approach or explanations of reasoning mechanism. However, the focus and connection to possibilities with virtual patient activities make them interesting for developing learning situations with this technology (Cook & Triola, 2009). Generally, two approaches are developed in this line of research: analytic reasoning, whereby a person deliberately gathers information for deliberate analysis as a basis for rational decisions, and non-analytic reasoning where large amounts of cases creates a sense of pattern-recognition of causes and symptoms (Byrne, 2012; Norman, 2005). Both these approaches are possible to apply with virtual patients.

### **7.3.3 Constructive alignment**

The higher education scholars Biggs and Tang (2007) address how quality teaching at university should be organised in order to achieve quality learning. They emphasise that 'Learning is constructed as a result of the learner's activities'. Consequently, what the student does is more important for learning than the lectures or activities performed by teachers. Nevertheless, in formal education students perform activities much as a consequence of the course integration design by teachers and course directors. In this design the importance of 'constructive alignment'—aligning activities with the curriculum objectives and assessment procedures—is emphasised. Principles from 'constructive alignment' can serve as a tool in integrating virtual patient activities with intended outcomes of the rest of a course or curriculum.

### **7.3.4 Future directions**

Several questions emerged during the project, and some of the data requires further investigation. The follow-up seminars were not much appreciated by students although the overall perceived benefit were greater in settings where these were present and more intense. Therefore, different approaches to follow-up of virtual patient work by clinicians should be further investigated. Findings concerning collaborative versus individual learning with virtual patients were also pointing in more than one direction. In the clerkship setting the collaborative aspect was prominent as regards its educational contributions. However, no difference was detected on perceived benefit between those working individually and collaboratively. The educational contributions of the collaborative aspect, and exploration on what kind of student interactions are taking place is needed. Studies where different educational theories are put into play into learning would also benefit the medical education community and software developers of virtual patient platforms.

## 8 SUMMARY AND CONCLUSIONS

The conclusion can be drawn that the digital technology provides opportunities for media richness and flexibility, and allows for students to make their own clinical decisions, taking a professional role. Hence, technology is necessary for these aspects to bring these opportunities to students in a practical manner. However, the presence of the technology itself does not suffice to bring about meaningful learning. It needs to be integrated into courses in contact with clinician teachers in order to be appreciated as beneficial and relevant by students. Furthermore, specific conclusions can be drawn in relation to specific studies:

- Virtual patients provide an arena for applying prior biomedical knowledge on clinical cases (Studies I and II).
- Virtual patients are conceptualised as providing intermediate learning activities between textbook learning and learning with actual patients (Study I).
- Course integration aspects influence the use, and the perceived benefit of virtual patients (Study II).
- Self-regulation and external regulation strategy scales from the ILS are appropriate tools to study the relation between individual, and external course regulation of learning activities with virtual patients (Studies III and IV).
- Individual study strategies and external course regulation influence the perceived benefit of virtual patients, the latter being the more influential (Study IV).

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