Looking around in the classroom

Developing preservice teachers' interpersonal competence with classroom simulations

Hanneke Theelen

Propositions

1. In blended learning environments that combine theoretical lectures and 360-degree videos, theory is the most important ingredient. (this thesis)

2. Classroom simulations make face-to-face education less relevant for teaching non-verbal teacher behaviour. (this thesis)

3. The tradition of propositions in a PhD defence is undervalued.

4. Research on information technology is focused too much on tools rather than their purpose.

5. In times when people dispute the truth, social sciences become the most important of all.

6. Personal information should never be a currency to pay for digital services.

Propositions belonging to the thesis, entitled

Looking around in the classroom
Developing preservice teachers' interpersonal competence
with classroom simulations

Hanneke Theelen
Wageningen, 12 May 2021

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This research was conducted under the auspices of the Wageningen School of Social Sciences (WASS).

Looking around in the classroom

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Hanneke Theelen

Thesis

submitted in fulfilment of the requirements
for the degree of doctor
at Wageningen University
by the authority of the Rector Magnificus
Prof. Dr A.P.J. Mol,
in the presence of the
Thesis Committee appointed by the Academic Board
to be defended in public
on Wednesday 12 May 2021
at 1.30 p.m. in the Aula.

Hanneke Theelen
Looking around in the classroom
Developing preservice teachers' interpersonal competence with classroom simulations,
214 pages.

PhD thesis Wageningen University, Wageningen, the Netherlands (2021)
With references, with summaries in Dutch and English

ISBN: 978-94-6395-689-5
DOI: https://doi.org/10.18174/539846

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Chapter 1

General introduction

1.1 Rationale: Preservice teachers' classroom management-related professional anxiety

The case of Tim

Since Tim (17 years old) was a little boy, he wanted to become a science teacher at a school for secondary education. He dreamt about teaching young students all about the ins and outs of science. A couple of weeks ago, Tim finally started his teacher education programme. Although he always dreamt of becoming a teacher, now that the time has come to start teaching during an internship at a secondary education school, Tim has become a little anxious. Will the students listen to him? How could he connect with students? How could he create a positive learning atmosphere in his classrooms? How to reward positive student behaviour? How to handle difficult classes? What to do when a student is showing disruptive behaviour? Should he show kindness or authority? Do his own rules match with the school rules? Tim feels he does not yet have the tools and experience to handle demanding situations in the classroom and school context. Driving towards his internship school, his stomach aches from anxiety. "Will today go fine?"

Similar to Tim, many preservice teachers (PSTs) deal with feelings of stress and anxiety when they enter the actual classroom context (e.g., McCarthy, Lineback, & Reiser, 2015; Alontaga & Durban, 2013; Murray-Harvey et al., 2010). In this dissertation, we define stress related to teachers' professional actions that manifests itself in feelings of fear and anxiety as PSTs' *professional anxiety*. PSTs lack prior practice and skills needed to keep order in a classroom. This management of classrooms is one of PSTs most pressing concerns during their teacher education trajectory (e.g., Pillen, Beijaard, & den Brok, 2013; Chang, 2009; McCarthy, et al., 2015; Alontaga & Durban, 2013). PSTs find themselves in a predicament: their anxiety arises from a lack of experience, but the only way to gain this experience is to start teaching.

Classroom management concerns are also one of the main reasons for (preservice) teachers to leave the educational profession (Evertson & Weinstein, 2006). In the Dutch context this is unfortunate, not only because of the possible loss of potentially high-quality teachers, but especially so in times of teacher-shortage and nation-wide attention to attract people for the teaching profession (OECD, 2019).

Sources of PSTs' professional anxiety have been of interest for researchers in the educational context for a few decades. One leading study into the nature of PSTs' professional anxiety was the literature review by Veenman (1984) about perceived problems of beginning teachers. Eight most frequently perceived problems were derived from the studied literature, with classroom management issues as the most pressing concern (e.g.,

classroom discipline, motivating students, dealing with problems of individual students). A decade later, Admiraal, Wubbels, and Korthagen (1996) found 9 (minor) disruptions in the classroom routine experienced by PSTs, which they categorised as daily hassles. Similar to the study of Veenman (1984), classroom management issues appeared to be PSTs' major concern (e.g., off-task behaviour class, off-task behaviour pupil, criticism of pupils). More recent studies have supported these findings, indicating that classroom management issues are still a major concern for PSTs (e.g., Pillen, et al., 2013; Chang, 2009; McCarthy et al., 2015; Alontaga & Durban, 2013). Especially PSTs (such as in our example, Tim) appear to be affected by students' disruptive behaviour (Alontaga & Durban, 2013).

For teacher education institutes, it is a challenge to prepare PSTs as fully as possible for educational practice and to prevent dropout (OECD, 2019). To date, teacher educators indicate having few suitable methods at their disposal to bridge the gap between theory offered at the teacher education institute and teaching practice at the internship school, to improve PSTs' classroom management competence and reduce their anxiety (Wubbels, 2011). The main reason for the studies in this dissertation arose directly from this gap.

The current dissertation aims to give more insight into the training of PSTs' classroom management competence to smoothen the transition from teacher education institutes to educational practice. Over the past decades, classroom management has been of great interest for educational scientists (Evertson & Weinstein, 2006; Emmer & Sabornie, 2015) and a vast number of studies regarding classroom management and teachers' interpersonal behaviour have been conducted (Wubbels, Brekelmans, den Brok, & van Tartwijk, 2006; Wubbels et al., 2015). However, limited research is available about how teacher education institutes can best train and improve PSTs' classroom management competence and interpersonal behaviour (van Tartwijk & Hammerness, 2011).

Many have argued that information and communication technology (ICT) can help to bridge the gap between theory and practice, for example via virtual internships or simulations of actual classroom situations (e.g., Cho, Mansfield, & Claughton, 2020; Herrington & Herrington, 2006; Shaffer, 2006; Rayner & Fluck, 2014). However, little is known about if and how ICT can train PSTs' classroom management competence and interpersonal behaviour. This is surprising, since classroom management and teachers' interpersonal teacher behaviour form an integral part of many teacher educations courses. The current dissertation aims to help fill the void in this educational –and currently even socially– relevant field of knowledge.

1.2 Theoretical background

The next sections outline the conceptual framework used in this dissertation. First, PSTs' self-efficacy will be discussed as a coping resource for dealing with professional anxiety, as described above. Second, the concept of 'classroom management' will be explained from an interpersonal perspective. Furthermore, the use of computer-based classroom simulations in teacher education to prepare PSTs for the actual teaching practice will be discussed. More specifically, attention will be paid to two types of computer-based classroom simulations: virtual internships and 360-degree videos. Finally, since affordances of ICT are important when using technology in teacher education, a definition of affordances will be given as well.

Preservice teachers' self-efficacy

An important coping resource for PSTs when dealing with professional anxiety is their *self-efficacy* (McCarthy et al., 2015). Self-efficacy can be defined as PSTs' belief in their own capability to influence student behaviour and achievement (Friedman, 2003). Teaching experience in classroom management and instructional preparation for classroom management can improve self-efficacy, yet also reduce PSTs' anxieties (Morton, Vesco, Williams, & Awender, 1997). Therefore, training PSTs' classroom management competence appears an effective strategy to increase PSTs' self-efficacy for classroom management and reduce PSTs' professional anxiety.

Classroom management from an interpersonal perspective

Contributions in the history of research in classroom management have been conducted from different perspectives. Wubbels (2011) argues that there are at least six approaches and perspectives to classroom management. The first approach focused on external control of behaviour from a behaviouristic perspective. This approach aimed to shape desired student behaviour by programs focused on behaviour modification, for example by positive and negative reinforcement (Brophy, 2006; Wubbels, 2011). In the second approach teachers focused on developing students' internal control in order to behave according to the standards of society (Elias & Schwab, 2006; Wubbels, 2011). The third approach derives from a teacher-centred orientation in class; the classroom ecology. Teachers create productive classroom environments, for example by orchestrating classroom activities and creating routines, and continuously being alert and reacting on what is happening in the classroom (Doyle, 2006; Kounin, 1970 as cited in Wubbels, 2011). The fourth approach is discourse centred, emphasizing communication, constructivism, and teacher-student interactions (Morine-Dershimer, 2006; Wubbels, 2011). In the fifth approach, the curriculum is the starting point to engage students in classroom activities. By these engaging activities, students can be intrinsically motivated, and misbehaviour can indirectly be reduced (Hickey

& Schafer, 2006; Wubbels, 2011). Finally, the sixth approach focused on creating positive teacher-student relationships also known as interpersonal relationships (Wubbels, Créton, & Hooymayers, 1985; Wubbels, 2011). The interpersonal perspective combines insights and focal points of several of the other perspectives (den Brok & van Tartwijk, 2015) and is widely used in Dutch teacher education institutes. The interpersonal perspective on classroom management is also widely used internationally (Emmer & Sabornie, 2015). Therefore, in this dissertation, we use the interpersonal behaviour perspective on classroom management to train student teachers and investigate their classroom management development.

From an interpersonal behaviour perspective, the systems approach to communication forms the starting point, considering classrooms as social systems in which teachers and students are continuously interacting and influencing each other mutually via verbal and non-verbal behaviour (Watzlawick, Beavin, & Jackson, 1967; Wubbels, et al., 2006; Horowitz & Strack, 2011). This mutual influence can be expressed in two dimensions, forming a circumplex structure: (1) communion, the extent of warmth in the teacher-student relationship, and (2) agency, the influence of communication with students (Horowitz & Strack, 2011). Eight types of interpersonal teacher behaviour can be derived from these two dimensions: directing, helpful, understanding, compliant, dissatisfied, uncertain, confrontational, and imposing (den Brok & van Tartwijk, 2015). The two dimensions and eight types of interpersonal teacher behaviour are visualised in the Teacher Interpersonal Circle (Figure 1.1).

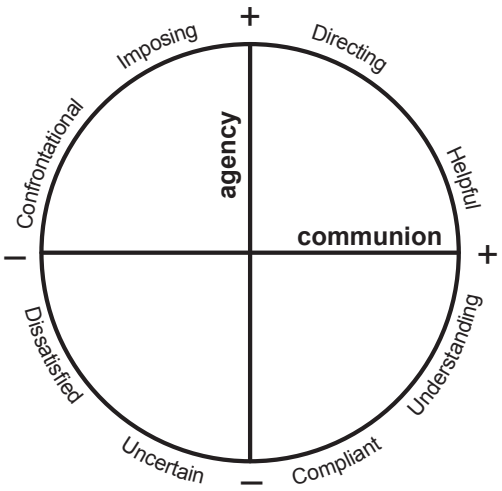

Figure 1.1 Teacher Interpersonal Circle (Pennings et al., 2018; Figure is used with permission of the authors)

Interpersonal teacher behaviour that is characterised by high levels of communion and agency is associated with positive teacher-student relationships (Wubbels et al., 2006). PSTs' actions to create these positive teacher-student relationships and the meaning teachers and students give to their interactions is also known as PSTs' *interpersonal competence* (Wubbels et al., 2015; Wubbels et al., 1985). In this dissertation, we define PSTs interpersonal competence as the combined set of abilities to notice, interpret, and anticipate on classroom events, aiming to positively influence the teacher-student relationship (Theelen, van den Beemt, & den Brok, 2019a, see chapter 3). Three important components of interpersonal competence can be distinguished: (1) *professional interpersonal vision*, (2) *theory-based interpersonal knowledge*, and (3) *professional interpersonal repertoire* (Theelen et al., 2019a). PSTs' professional interpersonal vision means that PSTs have to be aware of and interpret relevant classroom events to respond on (van Es & Sherin, 2002; Theelen, van den Beemt, & den Brok, 2019b, see chapter 5). For these interpretations, PSTs need theory-based interpersonal knowledge to make sense of observed classroom events (van Es & Sherin, 2002; Theelen, van den Beemt, & den Brok, 2020b, see chapter 6). After noticing and interpreting a relevant classroom event, PSTs have to make a pedagogical decision about actions to undertake which, in turn, create a positive teacher-student relationship (van Es & Sherin, 2002). PSTs can make these decisions by applying their knowledge into authentic classroom situations (Stürmer, Könings, & Seidel, 2013). In this dissertation, we refer to this knowledge application as PSTs' professional interpersonal repertoire.

Computer-based classroom simulations

PSTs practice their interpersonal competence mainly at internship schools (Brekelmans, 2010), while they obtain the theoretical background mainly at the teacher education institute. *Computer-based classroom simulations* offer the opportunity to connect theory and practice and as such, teacher education institutes and internship schools. Using classroom simulations, PSTs can engage in a safe learning environment with rich learning opportunities before they enter the internship schools and assume full responsibility over a real classroom (Rayner & Fluck, 2014). Computer-based classroom simulations are imitations of relevant classroom events, giving teacher educators control of content and structure of the training, and timing of events (Clark & Mayer, 2011). Classroom simulations are useful to improve PSTs' professional repertoire (e.g., Yeh, 2004; Dalgarno, Gregory, Knox, & Reiners, 2016).

Computer-based classroom simulations in teacher education can take various forms (e.g., Rayner & Fluck, 2014; Cheong, 2010; Dalgarno et al., 2016). In this dissertation, two types of classroom simulations were studied: (1) virtual internships (Theelen, Willems, van den Beemt, Conijn, & den Brok, 2020a, see chapter 2) and (2) 360-degree videos in combination with theoretical lectures (Theelen et al., 2019b, see chapter 5; Theelen et al., 2020b, see

chapter 6; Theelen, van den Beemt, & den Brok, 2020c, see chapter 4). Both types of classroom simulations were embedded in blended learning environments combining online materials with face-to-face instruction and support (Driscoll, 2002).

Virtual internships contain simulated online learning environments in which students are confronted with learning tasks where they need to think and act as professionals. Subsequently, tasks are evaluated with peers and supervisors (Shaffer, 2007). Virtual internships are based on situated learning theory which suggests that the best learning opportunities for students arise when they learn in authentic settings where actions have consequences (Sadler, 2009). In this dissertation, two virtual internships (see chapter 3) were designed with a simulated secondary education school as authentic setting. PSTs had to think and act as a teacher in these virtual internships.

In this dissertation, 360-degree videos were used as computer-based classroom simulations and combined with theoretical lectures (together referred to as the Virtual Classroom) to supply PSTs with real-life authentic cases by capturing the richness and complexity of classrooms (see chapters 4, 5, and 6). Earlier research showed that videos offer learning opportunities for PSTs when they watch examples of different teachers, students, settings, and pedagogies and by discussing their observations with peers afterwards (Star & Strickland, 2008). This makes videos useful to bridge the gap between teacher education institutes and internship schools (Gomez, Sherin, Griesdorn, & Finn, 2008). The spherical view of 360-degree videos offers PSTs a classroom wide view on classroom events. By dragging the video up, down, left, and right, PSTs can decide themselves on which aspects in the video they want to focus (Reyna, 2018). Furthermore, 360-degree videos can be viewed with a virtual reality (VR) headset (Figure 1.2). This creates a sense of presence and immersion, disconnecting PSTs from their surroundings in a realistic and authentic situation (Aguayo, Cochrane, & Narayan, 2017; Olmos, Cavalcanti, Soler, Contero, & Alcañiz, 2018; Yoh, 2001).

Affordances of ICT play an important role when using technology to design simulations. In the context of this study, we define ICT affordances as the perceived and actual properties of technology that determine how the simulation could possibly be used (Salomon, 1993, as cited in Conole & Dyke, 2004). An example is the feeling of being present in an authentic situation (immersiveness) that a 360-degree simulation can offer when watched using a VR headset. Affordances can be distinguished in three types: technological, social, and educational (Kirschner, Strijbos, Kreijns, & Beers, 2004). Where technological affordances relate to the technology itself, social affordances concern opportunities for interactions, while educational affordances focus on how learning takes place. All three types of affordances should be considered when designing and evaluating simulations using advanced technology.

Figure 1.2 VR headset

1.3 This dissertation

The main research question for this dissertation is: *How can computer-based classroom simulations be used in teacher education to train preservice teachers' interpersonal behaviour to reduce their professional anxiety and increase their self-efficacy?*

Sub-questions are:

1. *How can virtual internships in blended learning environments positively support PSTs' professional anxiety? And how are virtual internships experienced by PSTs?*
2. *What main issues regarding computer-based classroom simulations, affordances, hindrances, learning experiences, interpersonal competence, professional anxiety, and self-efficacy have emerged in the field of research on teacher education?*
3. *How can 360-degree videos, combined with theoretical lectures, support PSTs' interpersonal competence, their self-efficacy and their professional anxiety? And how is the video-lecture combination experienced by PSTs?*

To answer the overarching research question and sub-questions, three studies were conducted, which are reported in five empirical chapters. All chapters were published in international peer reviewed journals. Figure 1.3 presents a dissertation overview, showing the research questions, respondents, theoretical concepts, design of the computer-based classroom simulation, and methods. Furthermore, this figure shows which design, method, and theoretical concept appear in which chapter (lines denote presence in that particular chapter).

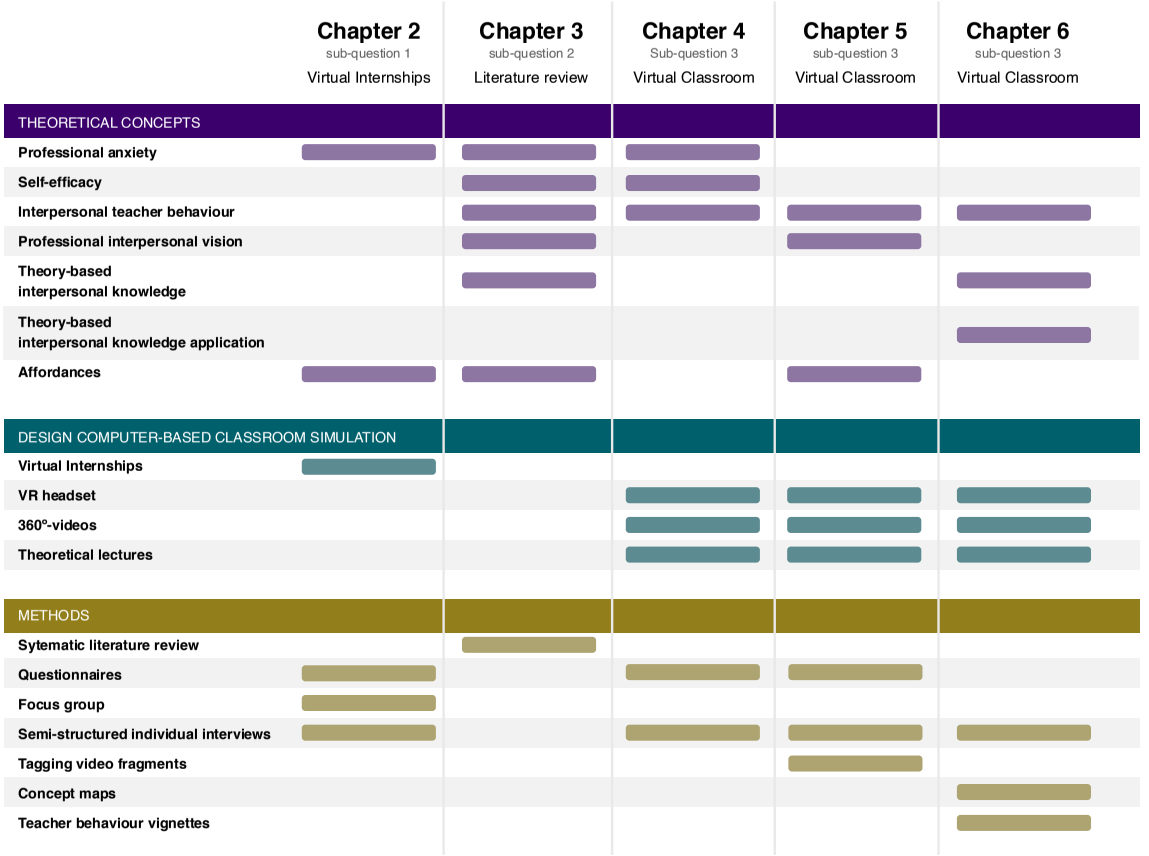

Figure 1.3 Dissertation overview

Study 1: Virtual Internships

Our conceptual framework shows that PSTs experience a gap between theory at the teacher education institute and the actual teaching practice (Korthagen, 2010). Engaging PSTs with real-world, complex problems and their solutions using authentic cases, may help PSTs to bridge the gap between theory and educational practice (Keppell, 2006). Virtual internships, as an example of computer-based classroom simulations, can be used to create authentic cases in realistic settings (Sadler, 2009). Therefore, the first study of this dissertation was a small-scale exploratory study on the use of virtual internships in teacher education to reduce PSTs' professional anxiety, focusing on sub-question 1, and is described in Chapter 2. This exploratory study also investigated how PSTs evaluated virtual internships in blended learning environments in terms of technological, social, and educational affordances. The following research questions were answered:

- *What is the effect of virtual internships in blended learning environments on PSTs' professional anxiety?*
- *How are virtual internships in blended learning environments evaluated by PSTs in terms of technological, social and educational affordances?*

Participants of this study were PSTs of a teacher education programme at the Eindhoven School of Education enrolled in two courses (N = 27 and N = 16). A mixed-method design was used with pre- and post-intervention questionnaires measuring PSTs' professional anxiety and perceived affordances. A focus group (Virtual Internship 1; n = 6) and semi-structured individual interviews (Virtual Internship 2; n = 9) were used measuring PSTs' experiences with virtual internships. Results of the pre- and post-intervention questionnaires were compared using a paired samples t-test. Because of the small sample size, the non-parametric Wilcoxon signed-rank test was used to verify the differences between pre- and post-scores. With respect to the analysis of the qualitative data, sensitising concepts (professional anxiety, technical, social, and educational affordances) were derived from the theoretical background and used to categorise answers from the focus group and interviews in an analysis matrix. This chapter reveals which technological, social, and educational affordances are important for designing virtual internships. Furthermore, this chapter gives insights in the influence of virtual internships on PSTs' professional anxiety.

Study 2: Literature review

Because the use of computer-based classroom simulations in teacher education is a relatively new method in teacher education, a systematic literature review was conducted. Chapter 3 presents a systematic literature review that gathered and analysed existing research about interrelations between computer-based classroom simulations, learning

experiences, ICT-affordances, interpersonal competence, professional anxiety, and self-efficacy. In this literature study, an effort was made to answer sub-question 2 of this dissertation:

What main issues regarding computer-based classroom simulations, affordances, hindrances, learning experiences, interpersonal competence, professional anxiety, and self-efficacy have emerged in the field of research on teacher education?

Studies were found in the databases Scopus, ERIC, PsycINFO, and Web of Science. The review was limited to 2000 until 2016. Included studies were peer reviewed and investigated computer-based classroom simulations and one of the following concepts or synonyms of these concepts: affordances, hindrances, learning experiences, interpersonal competence, professional anxiety, and self-efficacy. Fifteen studies were found eligible for inclusion. A theoretical coding scheme was applied to describe and categorise, revealing similarities and dissimilarities between results of the included studies. This literature review gives insights into what is already known and into the knowledge gaps about classroom simulations in teacher education in relation to the above-described concepts. In addition, the found ICT-affordances guided the development of the second type of classroom simulations used in this dissertation: 360-degree videos in combination with theoretical lectures.

Study 3: 360-degree videos combined with theoretical lectures (the Virtual Classroom)
Two types of virtual internships (VI-1 and VI-2) were used in the first study. In VI-2 more videos were used than in VI-1, and PSTs reported that the use of videos offered them a better image of the teaching practice. Therefore, for the remainder of this dissertation, the use of 360-degree videos to simulate classrooms was further investigated in one study consisting of a series of three more specific investigations concerning a specific intervention (chapters 4, 5, and 6) answering sub-question 3 of this dissertation. In this intervention, 360-degree videos were used as computer-based classroom simulations and combined with theoretical lectures (together named the Virtual Classroom) providing PSTs with real-life authentic cases. Participants of this study were first-year PSTs of a teacher education programme at the Fontys University of Applied Sciences (N = 141). Due to the setup of this dissertation in terms of journal articles (all published), with some studies using the same research sample, there is overlap in the description of theory and used methods in chapters 4 to 6.

Similar to chapter 2, the influence of the Virtual Classroom on PSTs' professional anxiety will be investigated in chapter 4. For this study, a blended learning environment was created by using 360-degree videos in combination with theoretical lectures as a simulated context to train PSTs' interpersonal competence. Besides PSTs' professional anxiety,

PSTs' self-efficacy and self-perceived interpersonal behaviour were also investigated using questionnaires and semi-structured individual interviews. The following research questions were examined:

- *What is the effect of the Virtual Classroom on PSTs' professional anxiety?*
- *What is the effect of the Virtual Classroom on PSTs' self-efficacy?*
- *What is the effect of the Virtual Classroom on PSTs' self-perceived (anticipated) interpersonal behaviour?*
- *Which meaningful clusters of PSTs concerning their professional anxiety and self-efficacy can be distinguished before the start of the intervention?*
- *In what way do the various clusters mentioned in the previous question differ from each other in terms of professional anxiety, self-efficacy, and self-perceived interpersonal behaviour after the Virtual Classroom?*

A mixed-method design was used with pre- and post-intervention questionnaires measuring PSTs' professional anxiety, self-efficacy, and self-perceptions of interpersonal teacher behaviour. Semi-structured individual interviews (n = 12) were used gathering more insights on the effect of the video-lecture combination on PSTs' professional anxiety and self-efficacy. Results of the pre- and post-intervention questionnaires were compared using a paired samples t-test. With respect to the analysis of the qualitative data, sensitising concepts (professional anxiety and self-efficacy) were derived from the theoretical background and used to categorise answers from the interviews in an analysis matrix. To obtain a deeper understanding about PSTs' professional anxiety and self-efficacy at the pre-test, a hierarchical cluster analysis on the cases was conducted. To determine if PSTs from different clusters developed their interpersonal behaviour differently, an analysis of variance (one-way ANOVA) was conducted with the cluster-solution as an independent variable and self-perceived interpersonal behaviour as dependent variable. This chapter offers insights in the influence of the video-lecture combination on PSTs' professional anxiety, self-efficacy, and self-perceived interpersonal behaviour.

Chapter 5 focused on the influence of the Virtual Classroom on PSTs' professional vision. In addition, the technological and educational affordances of the Virtual Classroom were under investigation. The following research questions were examined:

- *What is the effect of the Virtual Classroom on PSTs' interpretations of noticed classroom events as part of their professional interpersonal vision?*
- *How is the Virtual Classroom evaluated by PSTs in terms of technological and educational affordances?*

A mixed-method design was used by conducting pre- and post-intervention video fragment tagging, in which PSTs tagged three video fragments of secondary education teachers to measure PSTs' interpretation of notice events. At the post-test, a questionnaire was used to gather insights in PSTs' perceived affordances of the Virtual Classroom. To obtain more insight in the manner in which PSTs tagged the video fragments and PSTs' experiences with the Virtual Classroom, semi-structured individual interviews (n = 12) were conducted after the intervention. For data-analysis, the tags were coded into four levels: descriptive tags, evaluation tags, analytic tags, and prescriptive tags (van den Bogert, 2016). After establishing a high interrater reliability score, results of the pre- and post-test were compared using a paired samples t-test. A one-way ANOVA was used to determine if the device used for watching the videos (e.g., mobile phone in VR headset, only mobile phone, laptop, tablet) influenced the level of tagging for professional interpersonal vision. Regarding the interviews, sensitising concepts (professional interpersonal vision and affordances) were derived from the theoretical background and used to categorise answers from the interviews in an analysis matrix. This study revealed in what way PSTs' professional vision evolves using the video-lecture combination. Furthermore, this study gives insights into how the Virtual Classroom, and especially the 360-degree videos watched with VR headset, are evaluated by PSTs regarding the affordances.

Chapter 6 describes the last study that used the Virtual Classroom. Here, PSTs' theory-based interpersonal knowledge structures, development, and application were of interest. The following research questions were examined:

- *What is the effect of the Virtual Classroom on PSTs' theory-based interpersonal knowledge structures?*
- *What is the effect of the Virtual Classroom on PSTs' theory-based interpersonal knowledge development?*
- *How do PSTs apply their theory-based interpersonal knowledge after the Virtual Classroom?*

For the first research question we were interested to see if PSTs' theory-based knowledge structures changed after the intervention. These knowledge structures were measured using pre- and post-intervention concept maps. For the second research question it was investigated if PSTs used more relevant concepts at the post-test concept map compared to an expert in interpersonal teacher behaviour theory. For the third research questions, post-intervention teacher behaviour vignettes were used to determine if PSTs could apply their theory-based interpersonal knowledge in descriptions of authentic classroom situations by scoring vignettes on the Teacher Interpersonal Circle.

Several analyses were conducted on the data. For the first research questions, concept maps were analysed using social network analysis measuring the concept maps' density, distance between concepts, and reciprocity between concepts (Borgatti, Everett, & Freeman, 2002). Furthermore, the number of concepts, links between concepts, depth of the network, and the number of clusters were established at the pre- and post-test. Regarding the second research question, concept maps were compared at the pre- and post-test with an expert on level of agreement. The above-mentioned measurements of the pre- and post-intervention concept maps were compared using a paired samples *t*-test. For the third research question, the post-intervention vignettes were compared with expert vignettes by calculating absolute differences between PST and experts. Finally, an ANOVA was used to determine if the device used for watching the videos (e.g., mobile phone in VR headset, only mobile phone, laptop, tablet) influenced PSTs' theory-based interpersonal knowledge structures, development, and application.

This chapter gives insights about the influence of the Virtual Classroom on PSTs' theory-based interpersonal knowledge structures, theory-based interpersonal knowledge development, and theory-based interpersonal knowledge application.

Discussion and reflection

Chapter 7 supplies an overall discussion and reflection on this dissertation. The main research and sub-questions will be answered. Furthermore, a reflection on the interventions (respectively the Virtual Internships and the Virtual Classroom), a reflection on the theoretical concepts, a reflection on the methodology, implications for practice, and suggestions for future research are given.

Chapter 2

Virtual internships in blended environments to prepare preservice teachers for the professional teaching context

This chapter was published in adapted form as:
Theelen, H., Willems, M. C., van den Beemt, A., Conijn, M. A., & den Brok, P. (2020). Virtual internships in blended environments to prepare preservice teachers for the professional teaching context. *British Journal of Educational Technology*, *51*(1), 194-210.
doi:10.1111/bjet.12760

Abstract

This study investigated to what extent virtual internships in teacher education were able to reduce preservice teachers' (PSTs) professional anxiety. Simultaneously, this study investigated how virtual internships in blended learning environments were evaluated by PSTs in terms of technological, social, and educational affordances. PSTs followed virtual internships during two different educational pedagogy master's courses (27 and 16 participants) in a teacher education programme. A mixed methods design was employed, consisting of pre- and post-test questionnaires, a focus group interview, and individual interviews. A significant decrease was found in PSTs' professional anxiety after having followed Virtual Internship 2. PSTs reported they obtained a more realistic image of teaching and felt better prepared for teaching in practice. Furthermore, regarding technological affordances, system usability was considered between acceptable and good. Concerning social affordances, PSTs appreciated collaboration in the virtual internships. As an educational affordance, it appeared that learning from videos with authentic classroom events is a good preparation for the professional teaching context. According to the PSTs, the scenarios in virtual internships could be improved in terms of authenticity and personalisation by offering more details and background information. The results of this study imply that virtual internships can be useful assets for teacher education.

2.1 Introduction

During internships, PSTs are often confronted with feelings of stress and anxiety (Murray-Harvey et al., 2000). For example, classroom management issues are a major stress factor (Pillen et al., 2013). Bridging the gap between lessons learned at the teacher education institute and entering the professional teaching practice appears to be difficult (Darling-Hammond, 2006).

This paper presents an exploratory study about the use of virtual internships in teacher education to familiarise PSTs with the teaching profession, and whether these can ease the transition from teacher training courses to the professional practice at internship schools. This study investigates whether virtual internships can lower PSTs' professional anxiety and how PSTs evaluate this experience.

2.2 Theoretical background

Preservice teachers' professional anxiety

Teachers often experience their work as stressful because of students' lack of motivation, time and work pressure, continuous reforms, troublesome relationships with colleagues, increasing administrative activities, and classroom management problems (Alontaga & Durban, 2013). We define stress related to teachers' professional actions that manifests itself in feelings of fear and anxiety as *professional anxiety*. An important part of teachers' professional anxiety concerns classroom management and interpersonal teacher behaviour (the ability to create positive teacher-student relations) (Pillen et al., 2013). Difficulty with classroom management is one of the main reasons for PSTs to leave educational practice (Evertson & Weinstein, 2006).

PSTs experience professional anxiety, in particular, during internships (Murray-Harvey et al., 2000). Often, PSTs perceive interruptions in their teaching practice, such as students' chatter and absence of teaching materials, as stressful moments. Their most pressing stress factor is the dilemma of "wanting to care for students versus being expected to act tough" (Pillen et al., 2013). This stress relates to PSTs' interpersonal behaviour because PSTs struggle with simultaneously taking charge of their class and building a good relationship with their students.

On top of these, PSTs experience the prospect of assessment by supervising teachers as an extra source of stress (Morton et al., 1997). Evaluation by supervising teachers can be stressful because of inconsistencies in the evaluation process, different and/or unclear expectations concerning PSTs' performances and a lack of constructive feedback (MacDonald, 1993).

Preservice teachers' internships

PSTs' anxiety can be reduced through successful teaching experiences during their internships (Morton et al., 1997). Darling-Hammond (2006) argued that teacher education programmes should extend the duration of these internships. This was confirmed by Silvernail and Costello (1983), who reported that PSTs' professional anxiety decreased after an extensive internship, while PSTs' professional anxiety in a shorter internship remained high. Despite feeling professional anxiety, PSTs reported internships as the most valuable teaching experience during teacher education (MacDonald, 1993).

However, it appears difficult for PSTs to bridge the gap between teacher education lectures and professional practice during their internships (Darling-Hammond, 2006). This is caused by a lack of an automatic transfer from theory to workplace. In addition, PSTs experience tension while changing their role from student to teacher (Pillen et al., 2013). Consequently, three challenges confront PSTs during internships (Darling-Hammond, 2006). First, PSTs should understand that being a teacher differs from their own experience with teachers when they were students. Second, PSTs not only have to think but also act as teachers. Third, PSTs need to develop an understanding of the complexity of classrooms.

Computer-based classroom simulations

We argue that the transition from theory to practice (and from institute to internship school) can be improved with *computer-based classroom simulations*. The last decade saw a growing trend in classroom simulations to prepare PSTs for educational practice (e.g., Dalgarno et al., 2016; Rayner & Fluck, 2014). However, none of the studies in a recent literature review on computer-based classroom simulations and PSTs' well-being has reported effects of these simulations on PSTs' professional anxiety (Theelen et al., 2019a, see chapter 3).

Simulations for learning are popular and effective in all domains and levels of education and other disciplines (Mayer & Mastik, 2007). Examples are learning how to build seaports (Bekebrede & Mayer, 2006), how to install residential electrical wiring (Liu & Su, 2011) and how to bridge the gap between entrepreneurial theory and practice (Westera, Sloep, & Gerissen, 1999). Specifically, for teacher education, computer-based classroom simulations support the improvement of PSTs' classroom management competence and increase practical knowledge on how to manage classroom disruptions (Dalgarno et al., 2016).

Computer-based classroom simulations are often simplified versions of real classroom situations (Clark & Mayer, 2011). In these simulations, PSTs and teacher educators can have control of content, training structure, and timing of events. These simulations offer safe learning environments for PSTs to experiment before entering the actual teaching

context (Rayner & Fluck, 2014). Therefore, PSTs can make mistakes without harming their relationship with students. In addition, a supervising teacher is physically absent in a computer-based simulation, which possibly reduces the prospect of assessment as a source of stress. Furthermore, classroom simulations appear attractive for teacher education because they provide PSTs with authentic tasks and real-life experiences (Herrington & Oliver, 2000). Also, simulations are increasingly accessible due to the rise of ICT (Brown, 1999). PSTs benefit from classroom simulations when they support self-efficacy, locus of control and specific teaching skills (Knezek, Christensen, Tyler-Wood, Fisser, & Gibson, 2012).

Virtual internships

Virtual internships are an example of computer-based classroom simulations. They offer learning tasks that require students to think and act as professionals and simultaneously familiarise them with the culture and community of (teaching) occupation (Shaffer, 2007). We define virtual internships in teacher education as online environments in which PSTs think and act as teachers through assignments based on authentic classroom contexts. Virtual internships are based on the theory of situated learning (Sadler, 2009), which can be defined as the nature of knowing and learning in relation to being situated in a specific environment. Situated learning assumes that students learn best in authentic contexts, where consequences follow actions.

Since PSTs often experience difficulties when acting as teachers (Darling-Hammond, 2006), virtual internships could be useful in teacher education. It is suggested to include these virtual internships a part of blended courses (Beckem & Watkins, 2012). Blended learning combines online materials with face-to-face instruction and support (Driscoll, 2002). The main advantages of blended learning are improved pedagogy, learning in any place, at any time, and reduced costs (Graham, 2006).

Designing virtual internships

When designing virtual internships or simulations, the *affordances* of ICT are important. These affordances can be defined as the perceived and actual properties of the virtual internship that determine how it could be used (Salomon, 1993, as cited in Conole & Dyke, 2004). Discussion forums and chat functions are examples of affordances that can be used to stimulate PSTs to engage with each other (Conole & Dyke, 2004). Three types of affordances can be distinguished: technological, which relate to the system itself; social, which offer opportunities for social interaction; and educational, which determine how learning takes place using ICT (Kirschner et al., 2004).

Furthermore, it is important to focus virtual internships on learning outcomes. To focus online tool development on learning outcomes, Kearney, Schuck, Burden, & Aubusson (2012) created a pedagogical framework that consists of three features: personalisation, authenticity, and collaboration. Personalisation implies that ownership, agency, and autonomous learning are important aspects when designing online tools. Authenticity highlights the opportunities for contextualised, situated learning. Collaboration captures the connected aspects of online tools. Use of time and space are central elements of the pedagogical framework. Online tools offer opportunities to learn in a variety of "spaces," using virtual environments, which makes learning time and place independent (Kearney et al., 2012). Hence, learning is not restricted to classrooms or teaching periods, as is the case in traditional learning during internships. The virtual internships in this study were designed along the framework of Kearney and colleagues (2012).

Evaluating virtual internships

For a virtual internship to contribute to PSTs' professional development, it requires a purposefully designed system (Brooke, 1996). Design of educational ICT systems is evaluated by three different concepts: *system usability* (Brooke, 1996), *learner community satisfaction* (Wang, 2003), and *content satisfaction* (Wang, 2003). To assess the design, it is desirable to evaluate the design in terms of the three affordances. We argue that system usability can be considered as an evaluative measure for technological affordances. Social affordances can be evaluated by the satisfaction with the learner community facilitated by the system, because this addresses the extent to which learners communicate and collaborate with each other in the virtual internship. Lastly, satisfaction with the content offered in the system can give more insights into the educational affordances.

Aim and research questions

The focus of this study is on PSTs' learning experiences while engaging in virtual internships and the effects of these virtual internships on PSTs' anxiety. To explore the use of virtual internships, we evaluated the effect on PSTs' learning experiences and anxiety with two different types of online virtual internship environments, each featuring different characteristics. The purpose of these virtual internships was to make PSTs familiar with different aspects of teaching before PSTs enter the teaching context, rather than to substitute the real-life work situation with a virtual internship. Instead of using a whole-task approach, each virtual internship focused on familiarising PSTs with one sub-aspect of teaching (differentiation and observing interpersonal behaviour, respectively). This is also known as the decomposition of practice, which means that PSTs' learning process is focused on only one element of teaching which enables them to identify and use elements of teaching more effectively (Grossman et al., 2009).

The main research question is: *How can virtual internships in blended learning environments support PSTs' preparation for their work as teachers?* The following sub-questions were examined:

1. *What is the effect of virtual internships in blended learning environments on PSTs' professional anxiety?*
2. *How are virtual internships in blended learning environments evaluated by PSTs in terms of technological, social, and educational affordances?*

2.3 Design of virtual internships

In this exploratory study, two different types of virtual internships were implemented at a teacher education programme in the Netherlands, during the courses: "Diversity in the classroom" (Virtual Internship 1) and "Classroom management" (Virtual Internship 2). Virtual Internship 1 (further: VI-1) and Virtual Internship 2 (further: VI-2) were variants of the concept "virtual internships," rather than VI-2 an iteration on VI-1. When interpreting the results, some caution needs to be taken as the virtual internships differed in multiple ways. For example, the contents of VI-1 and VI-2 differed because they were offered as part of two different, yet related courses. Table 2.1 provides an overview of the characteristics of VI-1 and VI-2. The aim was to investigate and evaluate the two virtual internships separately to explore how the aspects of virtual internships are evaluated by PSTs. The discussed pedagogical framework (Kearney et al., 2012) was used for the internships' design.

Virtual Internship 1

VI-1 was designed in the Syntern web application (Shaffer, Ruis, & Graesser, 2015), consisting of email functionality, notebooks, and chat function (Figure 2.1). Syntern was used to simulate a virtual internship. To create authenticity, VI-1 took place at the fictitious school "Eindhoven college." The virtual internship was text-based following a fixed path with all virtual characters pre-designed.

The activities in VI-1 were integrated with lectures of the course "Diversity in the classroom", creating a blended environment, in which PSTs were instructed to differentiate for a student with special educational needs at Eindhoven college. PSTs could personalise their internship by choosing between two cases: Duane, an autistic student, or Bryan, a highly gifted student. PSTs received emails from a fictitious principal of Eindhoven college, containing the student's background information, assignments for PSTs and additional resources.

Table 2.1
Characteristics of VI-1 and VI-2

	VI-1	VI-2
system	Syntern	Canvas
collaboration tool	chat function	discussion forum
authenticity (context)	scenario-driven: Eindhoven college	scenario-driven: Eindhoven college
personalisation	choice between two cases	choice in order of assignments per week
feedback	standardized feedback e-mails	rubrics
number of assignments	6	9
cohesion between assignments	non-corresponding assignments	corresponding assignments
number of videos in the internship	1	8
content	diversity in classrooms	classroom management
duration of internship	6 weeks	4 weeks
language	English	Dutch
participants	PSTs with prior teaching experience	PSTs with no or little prior teaching experience

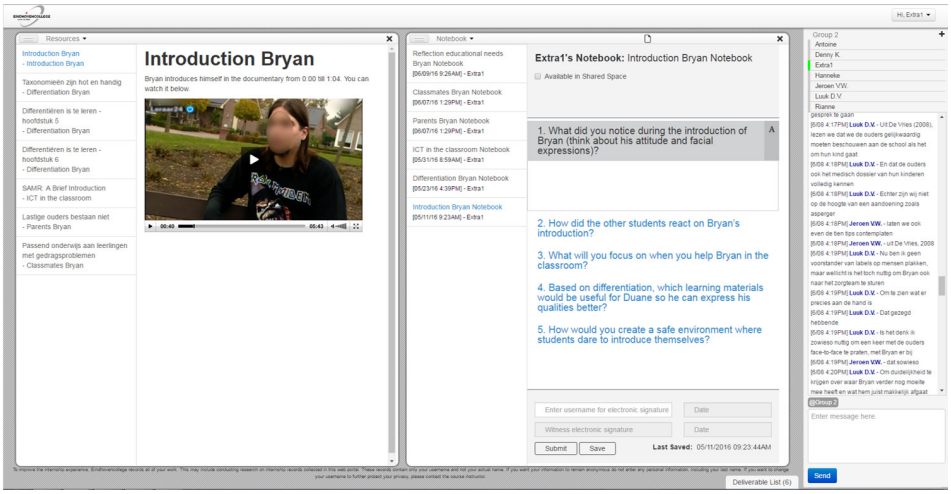

Figure 2.1 Screenshot of Syntern

PSTs received weekly assignments in English by email, for a period of six weeks. The first assignment asked PSTs to make a differentiation plan. Each new assignment was a reaction to this plan, for example by complaining parents. Although VI-1 was scenario-driven, the system did not allow to make changes in the assignments during the internship. As a result, not all assignments corresponded exactly with the development of PSTs' individual scenarios. Collaboration was facilitated by the chat function, which enabled groups of two up to five students to discuss assignments. Guided by the group discussions, PSTs completed each assignment individually in a digital notebook. The teacher educator gave graded feedback per assignment: insufficient, sufficient, or excellent. Subsequently, PSTs received a new assignment.

Virtual Internship 2

VI-2 was conducted in the university's learning management system "Canvas" (Figure 2.2). PSTs were already familiar with this system, and therefore no additional system for the virtual internship was needed. Authenticity was created similar to VI-1, by providing assignments in the context of "Eindhoven college." VI-2 was integrated in the lectures of the course "Classroom management" creating a blended environment.

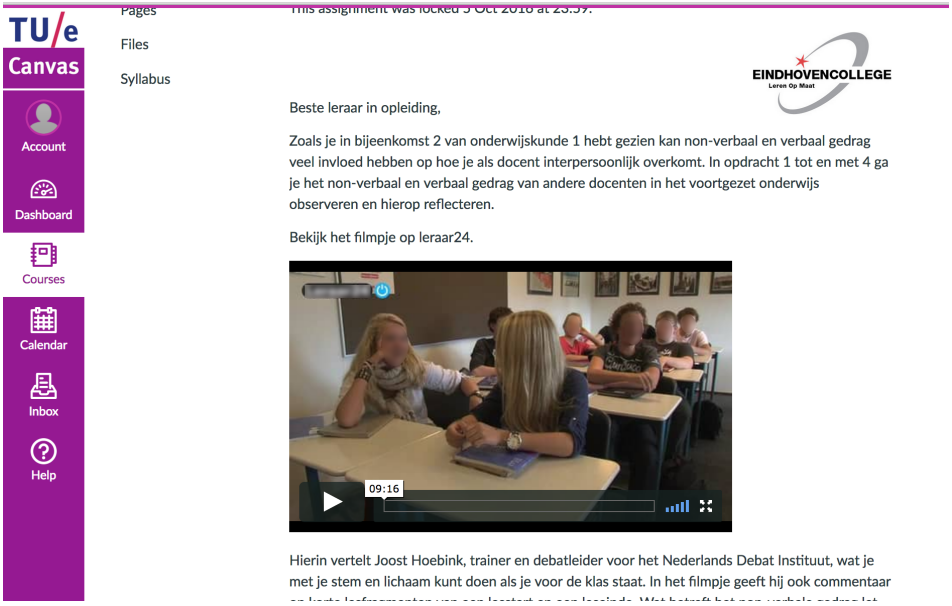

Figure 2.2 Screenshot of Canvas

VI-2 consisted of nine assignments in Dutch, which asked PSTs to evaluate video fragments of experienced teachers (e.g., videos with authentic classroom events) regarding interpersonal teacher behaviour. These videos contained classroom events which PSTs perceive as stressful (e.g., disruptive students, lesson start) (Admiraal et al.,1996). To stimulate collaboration, PSTs could discuss their evaluations in groups of two up to four peers in the discussion forum. These tasks were based on the observation model of Baeten and Simons (2014), which provides that observing another teacher and discussing about these observations is one way for PSTs to gain an understanding about effective teaching behaviour. Furthermore, PSTs also experienced the difficulty of noticing and interpreting relevant classroom events. The decomposition of the teaching practice (Grossman et al., 2009) and the use of videos with authentic classroom events (Seidel & Stürmer, 2014) enabled PSTs to develop this professional vision. PSTs received two or three assignments per week. Afterwards, PSTs handed in their assignments individually online. The teacher educator gave graded feedback for all assignments at once with an assessment rubric, using the criteria: completeness, accurateness and quality of the assignments, relevance for teacher practice and profoundness of the discussions.

2.4 Method

Participants

Participants in this study were PSTs of two cohorts of a teacher education programme for secondary education in the Netherlands (*N* = 43; Table 2.2). VI-1 PSTs already had previous teaching experience in real-life internships, contrary to VI-2 PSTs who had no prior teaching experience. The virtual internships were conducted as part of the first cohort's course "Diversity in the classroom" (*N* = 27; spring 2016) and the second cohort's course "Classroom management" (*N* = 16; fall 2016). This study followed the research guidelines of social scientific studies from Eindhoven University of Technology (2014), and the Association of Universities in the Netherlands (2018). Participants took part voluntarily and gave informed consent.

Table 2.2
Participants

	pre- and post-test	focus group	interviews
VI-1	27; 10♀	6; 1♀	-
VI-2	16; 8♀	-	9; 3♀

Questionnaires

To gather insight into PSTs' experiences, data from a questionnaire with 46 statements about professional anxiety (Teacher Anxiety Scale; Parsons, 1973) and affordances (Systems Usability Scale - Brooke, 1996; E-learner Community Satisfaction - Wang, 2003; Content Satisfaction - Wang, 2003; Task Satisfaction - self constructed) of the virtual internships were analysed. Table 2.3 gives an overview of the questionnaires, for each scale sample items and its internal consistency, which was good. Items were measured using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). High scores imply positive experiences, except for the Teacher Anxiety Scale, where high scores indicate a high level of anxiety. In addition to these questionnaires, PSTs answered two open-ended questions about affordances and hindrances of the virtual internship.

Focus group and individual interviews

To gather more insight into PSTs' experiences with the virtual internships, a focus group was organised after VI-1 (n = 6), and semi-structured individual interviews were conducted after VI-2 (n = 9). The number of respondents met the minimal requirement for theoretical saturation (Guest, Bunce, & Johnson, 2006) and respondents were selected via convenience sampling. The focus group was recorded on video, and the interviews were recorded on audio. The focus group and individual interviews consisted of 11 questions about technical, social and educational affordances, and professional anxiety. Example questions include: *"What did you think about collaboration in the virtual internship?"* and *"To what extent did the virtual internship influence your professional anxiety?"*

Analysis

A mixed methods design was used for this study. Questionnaires were analysed with IBM SPSS Statistics 22. Regarding the Teacher Anxiety Scale (Parsons, 1973), the results of the pre- and post-tests for each virtual internship were compared using a paired samples t-test. Because of the small sample size, the non-parametric Wilcoxon signed-rank test was used to determine the difference between pre- and post-scores. Descriptive statistics were calculated for system usability, learner community, content and task satisfaction.

Table 2.3
Questionnaires

Questionnaire	Theoretical concept	Sample item
Teacher Anxiety Scale (Parsons, 1973)	Teacher anxiety	I feel uncomfortable when I speak before a group
System Usability Scale** (Brooke, 1996)	Technological affordances	I thought the system was easy to use
e-learner community satisfaction (Wang, 2003)	Social affordances	The e-learning system makes it easy for you to discuss questions with other students
content satisfaction (Wang, 2003)	Educational affordances	The e-learning system provides useful content
task satisfaction***	Educational affordances	Assignments in the system exactly fits your needs

* This questionnaire originally consisted of 25 items. The item 'I'm less happy teaching than I thought I'd be' was excluded for further analysis because PSTs without prior teaching experience could not answer this question.

With respect to the analysis of the qualitative data, sensitising concepts (professional anxiety, technical, social, and educational affordances) were derived from the theoretical background and used to categorise answers from interviews, focus group, and open-ended questions in an analysis matrix. The categorisation was validated by four of the authors, by continuous discussion and evaluation. For example, if the statements concerned the discussion forum or the chat function, they were categorised as a social affordance because such functionalities are used to collaborate. If statements concerned learning or activities on collaboration or the desire to work independently, they were coded as social affordances. When statements by PSTs were made about, for example, the compatibility with internet browsers or the video and audio quality, they were categorised as a technological affordance because these kinds of statements are related to the technological aspects of the virtual internship environments. To increase the reliability of this qualitative analysis, the authors collaborated closely in the process. Points of debate and uncertainty were discussed until consensus was reached.

Language	Number of items	α pre-test VI-1	α post-test VI-1	α pre-test VI-2	α post-test VI-2
Dutch (verified via back-translation)	24*	.83	.88	.86	.83
Translated into Dutch by Sauro (2012).	10		.80		.87
Dutch (verified via back-translation)	4		.72		.83
Dutch (verified via back-translation)	4		.84		.79
Dutch	4		.73		.64

** The output of the survey is a score between 0-100 (SUS-score); high scores relate to high system usability and vice versa.
*** The task satisfaction scale was self-constructed based on e-learner community and content satisfaction questionnaires.

2.5 Results

Professional anxiety

The first aim of this study was to investigate if PSTs' professional anxiety could be reduced using virtual internships.

Table 2.4
Mean score and standard deviations on professional anxiety

	pre-test		post-test				
	M	*SD*	*M*	*SD*	*t(df)*	*p*	*d*
professional anxiety VI-1 (*n* = 27)	2.28	0.42	2.27	0.46	0.14*(26)*	.89	ns.
professional anxiety VI-2 (*n* = 16)	2.46	0.36	2.35	0.35	2.45*(15)*	.03*	0.6

* $p < 0.05$

Table 2.4 shows no significant difference between the pre- and post-test scores on PSTs' professional anxiety of VI-1. Note that these PSTs already gained previous teaching experience in real-life internships. Table 2.4 does show a significant difference in

professional anxiety between the pre- and post-test scores for VI-2 (PSTs with no prior teaching experience) with an average effect size (d = 0.6). The Wilcoxon signed-rank test confirmed these outcomes for VI-1 (Z = −0.819, p = .41) and for VI-2 (Z = −2.276, p = .02).

Concerning PSTs' professional anxiety, the qualitative data revealed that especially VI-2 PSTs felt better prepared for the professional teaching context by watching other teachers, which was also highly appreciated. Fourteen VI-2 PSTs reported in the open-ended questions and the interviews (nine and five PSTs, respectively) that they gained a better and more realistic impression of the teaching practice. For example, one VI-2 PST said: *"Not all classes resemble each other, the teacher's behaviour makes a difference."* Watching other teachers gave these VI-2 PSTs peace of mind because they felt better prepared to teach themselves. The virtual internship caused some PSTs to know better what to expect from teaching practice, which made them feel more relaxed. In the interviews, four VI-2 PSTs noted that after observing other teachers, they knew much better to which classroom events attention should be paid. It also made them more conscious about their own attitude in front of the classroom. Furthermore, one VI-2 PST reported that it was easier to analyse the behaviour of other teachers than your own. Two VI-2 PSTs even reported that after the virtual internship their enthusiasm for teaching increased. Finally, VI-1 PSTs believed that the virtual internship is especially interesting for PSTs with little or no teaching experience to familiarise them with the teaching practice.

Affordances of virtual internships

The second aim of this study was to determine how PSTs evaluate virtual internships in blended environments in terms of technological (system usability), social (learner community satisfaction) and educational (content and task satisfaction) affordances (Table 2.5).

Table 2.5

Mean scores and standard deviations of the System Usability Scale, Learner community, content, and task satisfaction

	VI-1 (n = 27)		VI-2 (n = 16)	
	M	*SD*	*M*	*SD*
system usability scale (SUS-score)	63.43	14.20	64.69	13.35
learner community satisfaction	3.03	0.84	3.19	0.76
content satisfaction	3.12	0.84	3.77	0.57
task satisfaction	2.98	0.72	3.56	0.47

Technological affordances

Table 2.5 shows the SUS scores for both virtual internships (63.43 and 64.69). Bangor, Kortum, and Miller (2008) offer guidelines for interpreting these SUS scores. SUS scores below 70 are considered suitable for improvement. However, the acceptability of the SUS scores of both internships was, considering these guidelines, between acceptable and good, even though they do suggest the need for further improvement (Bangor, Kortum, & Miller, 2008). Overall, the results suggest that PSTs from both internships experienced the learning environment sufficiently user-friendly.

The qualitative analysis provided more in-depth information about the technological affordances. Two VI-1 and three VI-2 PSTs appreciated the possibility to complete tasks in the internship in their own pace and place. Furthermore, one VI-1 and three VI-2 PSTs reported that the virtual internship enabled them to be already engaged in the school context without a real-life internship.

Although five VI-1 PSTs were satisfied with the online environment, eight PSTs reported technical hindrances in the open-ended questions. For example, one PST noted hindrances with the compatibility of the virtual internship with different types of Internet browsers. Eleven VI-I PSTs reported that for virtual internships, online systems with good working video, email, discussion functions, and multiple screens are necessary. Furthermore, in the focus group, all six VI-1 PSTs disliked the standardised feedback offered by the system and preferred more personalised feedback. This was adopted in VI-2 by using assessment rubrics. In the second internship, all PSTs were satisfied with the feedback functionality.

Social affordances

PSTs in both internships found collaboration beneficial for their learning outcomes, which was also reflected in the outcomes of the sub-scale, learner community satisfaction (Table 2.5). Yet the standard deviations show a high variation in scores between the PSTs.

After completing VI-1, twelve PSTs reported that collaborating through the chat function was beneficial. Responses to the open-ended questions showed that these PSTs appreciated working together without being at the same place by sharing good examples of assignments with peers and being able to read back their discussions. Eight VI-1 PSTs disliked the chat function because it was inconvenient to find a moment to meet online, and it appeared difficult to exchange experiences intensively. Two VI-2 PSTs also reported to appreciate sharing their findings with peers. However, in this internship, five PSTs reported in the interviews they disliked the discussion forum because it did not function as a chat. Discussions did not take place real-time, and these five PSTs sometimes had to wait hours before peers responded. In addition, it appeared difficult to navigate through the

discussion forum. As a result, the discussion forum was not lively. After both internships, five VI-1 and three VI-2 PSTs reported in the open-ended questions that they preferred face-to-face discussions that offered more in-depth discussions and enabled them to see their peers' emotions, allowing for faster communication verbally in comparison to typing on a computer.

Educational affordances

Table 2.5 shows that PSTs of both virtual internships were satisfied with the content and the tasks in the internship. Yet the standard deviations of both scales measured after VI-1 show a high variety in answers between the PSTs.

Several advantages in relation to the content of virtual internships were identified, such as the content of the assignments, learning experiences, and video fragments. Seven VI-1 PSTs perceived the authentic cases as an advantage because this made the course content realistic, which they believed to be a better method to prepare themselves for a professional teaching context. However, three VI-1 PSTs thought that the cases were not realistic because of limited details and context information, rendering the internship somewhat shallow. These PSTs felt a need for more in-depth cases, and suggested doing this by sharing more background information, describing situations more extensively and using more video fragments. Furthermore, two VI-1 PSTs had difficulties with the language (English) of the assignments. PSTs reported to prefer assignments in their mother tongue (Dutch). Despite this dissatisfaction, one PST reported the link with theory from the lectures as a positive learning experience. Finally, two VI-1 PSTs reported that assignments were not logically aligned. This was because the Syntern system did not give the option to adjust assignments during the internship. These issues were addressed in the design of VI-2.

After VI-2, all PSTs reported in the open-ended questions and the interviews satisfaction with the content of the internship, and that there was a good match between the lecture topics and the assignments in the virtual internship. Eight VI-2 PSTs reported in the open-ended questions that it was a good learning experience to watch other teachers. These PSTs learned from mistakes the teachers made in the video fragments, and from being confronted with different teaching styles. An added advantage reported by one VI-2 PST was that the virtual internship gave PSTs the opportunity to engage in the course, even when they did not have real internships.

What is noteworthy is that six VI-2 PSTs in the interviews reported that the scenario-driven context of the internship (Eindhoven college), such as emails from the principal, did not add value. Most of them did not read the email messages entirely, but only read the actual assignment, implying they missed a part of the context.

In conclusion, PSTs found that virtual internships improved their teaching skills, and that they were a good preparation for educational practice. PSTs considered it useful to watch other teachers, and that virtual internships especially offered added value for PSTs with little or no teaching experience. PSTs appreciated that they could practice in a safe setting and were able to gain teaching experience before entering the real workplace.

2.6 Conclusion and discussion

This study attempted to gather insight into how different types of virtual internships in blended environments could support PSTs' preparation for educational practice. The present study was designed to investigate the effect of virtual internships on PSTs' professional anxiety, and to determine how virtual internships in blended environments were evaluated by PSTs in terms of technological, social, and educational affordances. Virtual Internships 1 and 2 were developed in two different online systems. Although VI-1 and VI-2 were variations of the concept "virtual internship," they were evaluated individually because of the importance of context in relation to the usability of virtual internships (Brooke, 1996). Both virtual internships took place in different settings, used different systems, and were followed by different groups of users. Therefore, the two virtual internships were investigated and evaluated separately as two exploratory variations of the same tool (virtual internship).

The first aim of this study was to identify whether PSTs' professional anxiety reduced after virtual internships. A significant decrease was found in PSTs' professional anxiety for VI-2, consisting of PSTs with little or no teaching experience. However, no significant differences were found in VI-1 PSTs' professional anxiety, who were PSTs with some previous teaching experience. These results partially support the theory of MacDonald (1993), which assumes that teaching experience reduces PSTs' anxiety. The inconsistency between differences in professional anxiety for both virtual internships may be due to the differences in the online learning environments. VI-1 PSTs reported many technical hindrances, which possibly distracted from the virtual internships' content. Our findings suggest that a higher degree of personalisation (e.g., mother tongue, a familiar learning environment, personalised feedback) and video content used to observe other teachers teach VI-2 contributed positively to reducing PSTs' professional anxiety. It is noteworthy that both the quantitative and the qualitative data from VI-2 reveal that a virtual internship is especially interesting for PSTs with little or no teaching experience. These PSTs reported that the virtual internship contributed to a more realistic image of educational practice and feeling better prepared. We can thus infer that virtual internships can be a useful method for teacher education to reduce PSTs' professional anxiety provided that they have little or no teaching experience.

The second aim of this study was to determine how virtual internships in blended environments were evaluated by PSTs, in terms of technological, social, and educational affordances. Regarding technological affordances, system usability was considered between acceptable and good, following the guidelines of Bangor and colleagues (2008). However, these guidelines also suggest that further improvements are needed for SUS scores lower than 70, as was the case in our study. Improvements to the used tools are needed to minimalize the experienced hindrances, especially for VI-1. Due to the small sample size, it is not possible to generalise to the population at large (Bangor et al., 2008).

Although there were technical hindrances in VI-1, PSTs in both courses reported the virtual internship as sufficiently user-friendly. The stated usefulness of flexible time and space in virtual internships, as reported in the pedagogical framework of Kearney and colleagues (2012), was supported by PSTs in this study. Virtual internships can engage PSTs in a course about teaching strategies and make PSTs familiar with the teaching context without a real-life internship. Furthermore, PSTs appreciated learning without being physically present, in their own pace and place.

In both systems, PSTs appreciated the social affordance of collaboration, which is one of the key features in the pedagogical framework for learning with online tools (Kearney et al., 2012). Collaboration was attractive because of the opportunity to share examples and discuss with peers. Since data sharing and conversation are important elements of collaboration in the pedagogical framework, it contributes positively to learner experiences. However, PSTs were also facing technical hindrances during their virtual internship. Because learning was time and place independent, it was difficult for PSTs to meet at the same time online, which led to PSTs preferring face-to-face discussions instead. Furthermore, PSTs experienced technical hindrances related to online collaboration. For example, VI-2 PSTs disliked the discussion forum because it did not function as a chat. PSTs experiencing both social advantages and disadvantages possibly led to the high variation in scores between the PSTs on the learner community satisfaction questionnaire.

As an educational affordance, PSTs appreciated the connection between the lectures and the virtual internships in the blended environment. Furthermore, online tools made it possible to learn from authentic and personalised cases (Kearney et al., 2012). Both virtual internships had two components which made the internship authentic: a scenario-driven case and the use of videos. It appeared that learning from videos with authentic classroom events was a good preparation for educational practice (Blomberg, Sherin, Renkl, Glogger, & Seidel, 2014). However, scenario-driven cases in the virtual internships did not come entirely to life. A lack of details and background information created a realism deficiency. In addition, due to non-corresponding assignments in VI-1, the opportunity of personalisation

was also missing. Cases can become more authentic and personalised if they offer enough details and background information. It is important to give clear coherent assignments in PSTs' mother tongue; otherwise, it may lead to confusion as demonstrated in the study results.

Contrary to expectations, PSTs in this study reported that the scenario-driven cases of the virtual internships did not add value for some PSTs. Some PSTs even overlooked the context of the case and only read the actual assignments. This can be explained possibly from a neuropsychological view: irrelevant details can distract beginners from the actual task and cause cognitive overload (Gulikers, Bastiaens, & Martens, 2005). It seems that beginner learners can learn, without an authentic case, if only the task itself is authentic.

Despite different types of virtual internships, it stands out that VI-2 PSTs had higher scores on learner community, content and task satisfaction. A possible explanation for this is that VI-2 used Canvas, a familiar LMS to students. Furthermore, VI-2 provided a higher degree of personalisation (e.g., use of mother tongue, using a familiar learning environment, personalised feedback) which contributed positively to reducing PSTs' professional anxiety. In addition, the topic of VI-2 (classroom management) appealed possibly more to PSTs because of their struggles with classroom management issues and the use of videos made the course content more realistic.

Where prior studies about classroom simulations mainly focused on cognitive outcomes, the present study contributed to the field by showing that virtual internships can decrease PSTs' professional anxiety and which characteristics of virtual internships supported a positive evaluation of technological, social and educational affordances. PSTs felt better prepared for the teaching context and their professional anxiety reduced. Due to the virtual internships, PSTs had a better impression of teaching as a profession as they could learn from authentic cases, developed a more realistic image of the teaching context and could benefit from collaborating with peers. Virtual internships appear suitable in a blended environment as PSTs can learn in their own pace at home. Furthermore, it is highly recommended to use online systems with good working video, email, discussion functions and multiple screens.

Virtual internships are context related. However, some aspects are transferable to other contexts: general design principles, such as the use of first language, usefulness of video fragments and the use of discussion forums. Furthermore, the reliability of these findings may be limited by the relatively small group of participants. Due to limited generalisability, a follow-up study with more participants is recommended. However, our results do serve as an illustration for the use of virtual internships in teacher education. Finally, it is important

to bear in mind that virtual internships are not isolated activities. The virtual internships in the present study were conducted in blended environments and therefore other aspects of these blended environments could have influenced the results as well.

Our study gained more insights about virtual internships in blended environments for supporting PSTs' preparation for their work as teachers. Virtual internships can already be a valuable addition to PSTs' preparation during their study. There are, however, still many unanswered questions regarding the specific elements of virtual internships that help prepare PSTs for educational practice. With the findings and recommendations from PSTs in this study, further research will eventually lead to more effective virtual internships to prepare PSTs for their work as teachers.

Chapter 3

Classroom simulations in teacher education to support preservice teachers' interpersonal competence: A systematic literature review

This chapter was published in adapted form as:
Theelen, H., van den Beemt, A., & den Brok, P. (2019). Classroom simulations in teacher education to support preservice teachers' interpersonal competence: A systematic literature review. *Computers & Education, 129*(1), 14-26.
doi:10.1016/j.compedu.2018.10.015

Abstract

Computer-based classroom simulations have been argued to be a promising way to practice preservice teachers' (PSTs') interpersonal competence and to ease the gap between teacher education and educational practice. The systematic literature review presented in this paper examined existing research on the links between PSTs' interpersonal competence, well-being, and simulations. Furthermore, this review mapped learning experiences, affordances, and hindrances of simulations. Fifteen studies were found eligible for inclusion. Most of these studies reported positive effects of simulations on PSTs' classroom management and teaching skills in general, rather than specifically on interpersonal competence (e.g., professional interpersonal vision, professional interpersonal knowledge, professional interpersonal repertoire). Concerning PSTs' well-being, four studies did show positive effects of simulations on PSTs' self-efficacy. However, none of the studies reported PSTs' anxiety. Reported affordances were mostly educational (e.g., receiving teacher feedback, available resources) or social (e.g., peer observation, discussions), while the reported hindrances were mainly of a technical nature (e.g., lack of a user-friendly interface, malfunctioning audio or video). Positive learning experiences depended on the degree of realism and authenticity in the simulation. The results of this study provide suggestions for future research on how computer-based simulations in teacher education could contribute to PSTs' interpersonal competence and well-being.

3.1 Introduction

Preservice teachers' (PSTs) ability to create positive teacher-student relationships via behavioural strategies is referred to as PSTs' interpersonal competence, which is an important element in classroom management (Stough & Montague, 2015) and a major concern for PSTs (Friedman, 1995). Difficulties with classroom management and teacher-student interpersonal relationships are among the main reasons for PSTs to leave teacher education (Evertson & Weinstein, 2006). Computer-based classroom simulations are considered a safe way to practice and improve PSTs' interpersonal competence (Dalgarno et al., 2016; Rayner & Fluck, 2014), which in turn contributes to preservice teachers' well-being (Wubbels et al., 2015).

A recent literature review found promising learning outcomes in the cognitive, intrapersonal, and interpersonal domains for games and simulations in education (Clark, Tanner-Smith, & Killingsworth, 2016). For example, digital games were found to be more effective for learning outcomes than non-game instructional conditions. However, this review focused primarily on games rather than simulations, and on K-16 students, rather than PSTs. Moreover, prior reviews on simulations in education (e.g., Vogel, et al., 2006; Wouters, van Nimwegen, van Oostendorp, van der Spek, 2013) refrained from addressing aspects that afforded or hindered the effective use in teacher education. Furthermore, PSTs' feelings that arise through simulations were unaddressed, while these feelings can determine the quality of the learning experience (Sansone & Thoman, 2005).

This paper offers a systematic review to map all relevant literature about computer-based classroom simulations, PSTs' interpersonal competence, and important indicators of PSTs' well-being. Additionally, our review explores learning experiences, affordances, and hindrances of simulations. It serves as a starting point for more in-depth research about simulations and PSTs' interpersonal competence. Below, we first operationalize the main concepts of this review: Figure 3.1 shows an overview of these concepts and their assumed underlying concepts and their mutual relations.

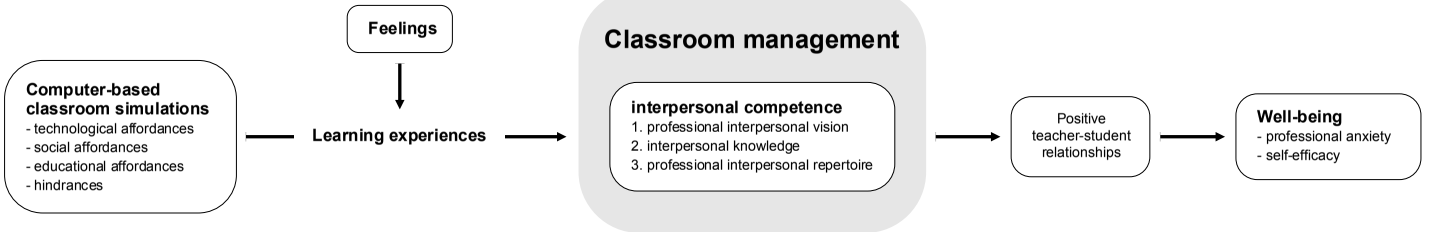

Figure 3.1 Main concepts and their assumed interrelations

3.2 Theoretical background

Preservice teachers' well-being

Well-being encompasses, among other things, how PSTs feel at school, and whether they are free of school related psychological or psychosomatic problems (van der Want, 2015). Following van der Want (2015) we distinguish two central aspects of PSTs' well-being: *professional anxiety* and *self-efficacy*. Teachers often experience emotions such as anxiety, as teaching is characterized by intensive social relations, fast decision making, unmotivated students, and constant change (Alontaga & Durban, 2013). When anxiety of teachers relates to their professional actions, it is considered professional anxiety. PSTs experience anxieties from (minor) disruptions in their daily classroom routine, such as students' off and on task behaviour (Admiraal et al., 1996). Likewise, 'classroom discipline' and 'motivating students' are reported as the two most important problems that PSTs and beginner teachers face (Veenman, 1984).

PSTs have a lower chance of experiencing professional anxiety caused by disruptions in their daily classroom routine, if they have a strong sense of self-efficacy (Friedman, 2003). Self-efficacy is known as teachers' belief that they can influence student behaviour and achievements (Friedman, 2003). Three subcomponents of self-efficacy can be distinguished: self-efficacy for classroom management, for instructional strategies, and for student engagement (Tschannen-Morran & Woolfolk Hoy, 2001).

Preservice teachers' interpersonal competence

The actions teachers undertake to create positive learning environments, and the meaning students and teachers give to their interactions can be defined as interpersonal competence (Wubbels et al., 2015; Wubbels et al., 1985). We perceive interpersonal competence as the combined set of abilities to notice, interpret and anticipate on classroom events, aiming to influence the teacher-student relationship. We distinguish three important components of interpersonal competence: *professional interpersonal vision*, *professional interpersonal knowledge*, and *professional interpersonal repertoire*.

Teachers' professional interpersonal vision consists of the combination of noticing and interpreting classroom events from an interpersonal perspective (Goodwin, 1994; van Es & Sherin, 2002). The 'Learning to Notice Framework' (van Es & Sherin, 2002), distinguishes three key aspects of PSTs professional interpersonal vision. The first aspect in professional interpersonal vision is to notice a relevant classroom event. Second, after PSTs notice a relevant classroom event, they should interpret this event by connecting it to theories about interpersonal teaching behaviour. Through interpreting noticed interpersonal events, PSTs develop insight in interpersonal classroom events. Lastly, PSTs have to apply knowledge about the specific teaching context to the noticed event.

The second component of interpersonal competence involves interpreting classroom events, where interpretation depends on PSTs' knowledge about interpersonal behaviour. We refer to this as professional interpersonal knowledge. We define professional interpersonal knowledge as practical knowledge about how to develop and support a healthy teacher-student relationship. This knowledge includes the roles students and teachers have, as well as the larger classroom system that they are a part of. Practical knowledge is defined as PSTs' knowledge and beliefs related to their own teaching practices, for example about classroom management strategies (van Tartwijk, den Brok, Veldman, & Wubbels, 2009). Knowledge of strategies before starting a lesson, such as shaking hands to create positive and trustful teacher-student relationships, is an example of professional interpersonal knowledge.

The third component of interpersonal competence involves anticipating on classroom events. This consist of the range of possible actions PSTs undertake to create positive teacher-student relationships, which we define as PSTs' professional interpersonal repertoire. This repertoire is influenced by professional interpersonal knowledge (Verloop, van Driel, & Meijer, 2001; Wubbels et al., 2015). A relation exists between PSTs' professional interpersonal knowledge on teacher-student relationships, and the quality of these relationships (Wubbels et al., 2015). This quality increases when PSTs are more knowledgeable of factors that improve teacher-student relationships, and when they can apply this knowledge into practice.

Computer-based classroom simulations

Since PSTs practice their interpersonal competence mainly in the classroom, this may restrict their teacher education (Brekelmans, 2010). *Computer-based classroom simulations* offer the opportunity to improve teacher education and educational practice as it can smoothen the transition from teacher education to practice. This way, before they assume full responsibility over a real classroom, PSTs can experience rich learning opportunities by engaging in a safe environment (Rayner & Fluck, 2014). Classroom simulations in teacher education are intended as an additional resource for developing interpersonal competence, rather than a replacement of the teacher educator. Simulations offer dynamic, rule-based and often simplified imitations of classroom events. They give teachers (educators) control of content, training structure and timing of classroom events (Clark & Mayer, 2011). Simulations differ from games, since games result in a quantifiable outcome (Salen & Zimmerman, 2004). In other words, contrary to simulations, players can either win or lose a game or receive a numerical score.

A common way of simulating classrooms is role playing (Clapper, 2010): simulating realistic classroom events and confronting PSTs with realistic problems in their role as teachers. By taking part in role plays, PSTs are able to actively develop new skills. The focus in this

literature review is on classroom simulations that use role play enhanced by technology. Role play simulations can be enhanced by technology in two ways via non-immersive simulations and immersive simulations (Dalgarno et al., 2016). Non-immersive simulations represent classroom scenarios through text and static graphical output. Examples of this kind of simulations include: ClassSim (Ferry, Kervin, Cambourne, Turbill, & Hedberg, 2005), the Cook District School (Girod & Girod, 2006), and simSchool (Gibson, 2007). Immersive simulations are designed with visual representations of realistic classroom events (Dalgarno et al., 2016). Avatars are used to represent students and teachers. Examples of these kind of simulations are Second Life (Cheong, 2010; Mahon, Bryant, Brown, & Kim, 2010), or The VirtualPREX Classroom Simulation (Dalgarno et al., 2016).

A recent literature review (Clark et al., 2016) demonstrated that cognitive, intrapersonal and interpersonal learning outcomes from students in grade K-16 increased after applying simulations. However, not all learners were motivated by simulations (van den Beemt, Akkerman, & Simons, 2010). Learners who were unfamiliar with simulations were demotivated by the complexity of these applications. Additionally, it has been argued that elements of simulations can be so motivating that they distract from learning goals (Clark & Mayer, 2011). Hence, it is important to investigate how simulations contribute to learning and how a balance can be achieved between learning and maintaining student motivation (Clark et al., 2016). Therefore, this review also focuses on affordances and hindrances for simulations in teacher education.

Affordances are the perceived and actual properties of objects that determine how they could possibly be used (Salomon, 1993; as cited in Conole & Dyke, 2004). For example, a potential affordance of ICT is the exposure to experiences of others (Conole & Dyke, 2004). Three types of affordances can be distinguished: technological, social, and educational (Kirschner et al., 2004). Technological affordances relate to system usability, social affordances give the opportunity for social interaction, and educational affordances determine how learning takes place using ICT. Hindrances are the counterpart of technological affordances. Not being able to see facial expressions of avatars is an example of a hindrance when focusing on interpersonal competence (Kim & Blankenship, 2013).

Learning experiences from simulations

While PSTs are engaged in learning experiences using computer-based classroom simulations, they experience different types of feelings (Sansone & Thoman, 2005). Feelings of engagement and motivation, as well as feelings of uncertainty and stress were reported to be caused by classroom simulations (Stavroulia, Makri-Botsari, Psycharis, & Kekkeris, 2016). Particularly for classroom simulations PSTs reported negative feelings including anxiety, embarrassment, nervousness, disappointment, insecurity, inability to deal with

the various classroom management issues, feeling dissatisfied about oneself during the simulated activities, fatigue, fear, stress, and confusion (Stavroulia et al., 2016). Feelings such as embarrassment, insecurity, and stress were found to be similar to feelings novice teachers experience in classrooms (Stavroulia et al., 2016).

Van den Beemt and Diepstraten (2016) argued that besides feelings, attitudes towards ICT are based on a relation between teachers' self-efficacy, learning experiences, relevant others, beliefs, and their adoption of ICT. In this context, the concept of ICT minded teachers and non-ICT minded teachers is introduced. ICT minded teachers are able to set limitations of new technologies aside whereas non-ICT minded teachers experience these limitations as a foundation for their aversion towards technology.

Aim and research questions

This paper presents a systematic literature review in an effort to gather and analyse existing research about interrelations between computer-based classroom simulations, learning experiences, interpersonal competence, and well-being as discussed above in our theoretical model (Figure 3.1). Simulations serve to increase interpersonal competence, which is speculated to increase PSTs' well-being through decreasing their professional anxiety and increasing PSTs' self-efficacy. Furthermore, this review aims to understand learning experiences, affordances, and hindrances of computer-based classroom simulations when applied to enhance PSTs' interpersonal competence. The main research question that guides this review is: *What main issues regarding computer-based classroom simulations, affordances, hindrances, learning experiences, interpersonal competence, and well-being have emerged in the field of empirical research on teacher education?*

3.3 Method

Search process

A systematic review was conducted to answer the research question. Studies were found in the databases Scopus, ERIC, PsycINFO, and Web of Science. Studies had to be peer reviewed to be included. Table 3.1 provides an overview of keywords and corresponding synonyms that were used to select relevant studies. These keywords were based on relevant literature about interpersonal competence, well-being, and simulations. Based on the argued increase in digital games for learning from 2000 and later (Clark et al., 2016), the search period of this systematic review was limited to 2000 until 2016.

Table 3.1

Keywords and synonyms used in the query

Keywords	Synonyms
simulation	"virtual reality", "game*", "role play*", "virtual internship*", "simulated environment*", "virtual environment*"
interpersonal competence	"classroom management", "teacher-student relationship*", "teacher beliefs", "teacher cognition*", "interpersonal communication*", "teacher-student interaction*"
professional interpersonal vision	"withitness", "awareness", "visual perception*", "learning to notice", "cognitive representation*"
professional interpersonal repertoire	"teacher attitude*", "teacher skill*", "teacher value*", "interpersonal knowledge", "teacher knowledge", "pedagogical knowledge"
self-efficacy	"teacher concerns", "work engagement"
teachers' well-being	"teachers' well-being", "teachers' wellbeing", "teachers' well-being"
teacher education	"teacher training"

* after a keyword denotes that variations of the keyword, such as plurals, were also included as search terms

Figure 3.2 shows the selection process of this literature review. The first search resulted in 594 hits in Scopus, 11 hits in ERIC, four hits in PsycINFO and 19 hits in Web of Science. Twenty articles appeared to be duplicates.

Initially, the abstracts were screened by applying the following inclusion criteria:

1. The study investigated the use of computer-based classroom simulations;
2. The study discussed one of the following terms: interpersonal competence, professional interpersonal vision, professional interpersonal repertoire, professional interpersonal knowledge, well-being, professional anxiety, and professional efficacy;
3. Participants in the study were PSTs;
4. Studies could be qualitative or quantitative;
5. The article was written in English with an available full-text version.

After reading the abstracts, thirty-eight studies remained for full reading. Studies that did not met one or more of the above criteria were excluded for analysis.

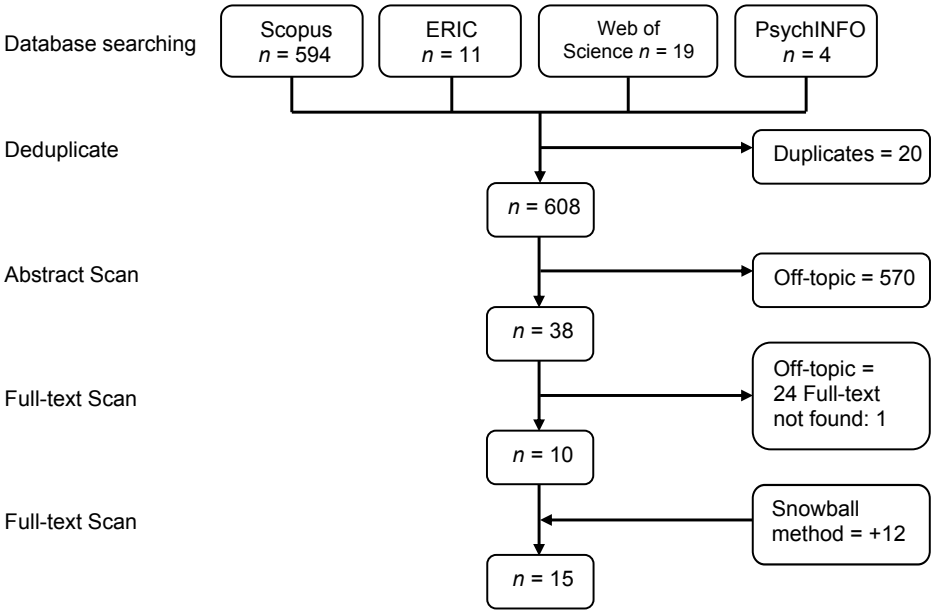

Figure 3.2 Flowchart selection process

Reading full articles

In the next phase, full texts were analysed using the inclusion criteria explained above. However, one full text could not be retrieved, even after contacting the authors, and was therefore excluded. Ten studies were eventually included. Snowballing the references of included articles yielded another twelve studies. After reading the abstracts and full texts of these twelve studies, five studies remained. Eventually, fifteen studies met the inclusion criteria. Main reasons to exclude articles during the selection process were that they were conducted in contexts other than teacher education (such as nursery), they were not about computer-based simulations, or no reference was made to one of the keywords in the abstract.

Process of analysis

The following theoretical coding scheme was applied to describe and categorise the included studies:

1. General information: authors, title, year of publication, database, journal, abstract, keywords, country;
2. Research design: aims and research questions, theoretical background, method, instruments, information about the participants, length of intervention;

3. Operationalisation concepts: definitions of the used computer-based classroom simulations and keywords;
4. Overall results: findings and conclusions related to research question of this review. Results were organized using keywords from the query, such as interpersonal competence, well-being, and affordances.

The coding scheme revealed similarities and dissimilarities between results of the included studies. During the process of analysis, the first author applied the coding scheme, the second and third authors monitored the process, and advised about the method.

Quality appraisal

Finally, quality appraisal was employed. Criteria for evaluating studies suitable for qualitative research synthesis (Table 3.2) were adapted from Savin-Baden and Major (2007, p. 838) and used for quality appraisal of included qualitative studies (N = 2). Criteria for quality appraisal of the quantitative studies (N = 8) were adapted from the checklist for quantitative intervention studies (NICE, 2012) as shown in Table 3.2. Mixed-method studies that were equally quantitative and qualitative (N = 5) were subjected to both quality appraisals. Two mixed-method studies were mostly quantitative and hence included in the quantitative quality appraisal. For each of the criteria, studies received a score between 0 and 3. A score of 0 represents no mention of the topic, where 3 represents an excellent description of the criteria's topic. The scores 1 and 2 respectively represent touching the topic only briefly and substantial description of the topic.

A few studies scored high on multiple (e.g., most) quality aspects: Rayner and Fluck (2014), Mirliss, May, and Zedeck (2015), Girod and Girod (2006), and Christensen, Knezek, and Tyler-Wood (2011). For the mixed-method studies, one study scored low on the quality appraisal. Other studies scored across the remaining range of the quality appraisal scale. Because the research field of this literature review is in its nascent state, only a few (15) articles were found about this topic and was decided to include all studies to obtain a substantial body of literature. Because the found studies scored across the full range of the quality appraisal scale, conclusion will be drawn with caution.

Table 3.2

Criteria for quality appraisal

	0 no mention	1 some mention	2 good mention	3 extensive mention
Criteria for qualitative studies				
Study methodologically is clear		6	1	
Study theoretically substantiated		2	2	3
Ethical process transparent	3	2	2	
Researcher(s) relation to participants are clear	5	1	1	
Researchers(s) relation to the data are clear	7			
Researcher(s) take a critical stance towards own research	1	4	2	
Congruence between methodology and methods used for data collection, analysis, and interpretation	1	2	4	
Participant involvement in data interpretation	7			
Limitations voiced	1	3	3	
Criteria for quantitative studies				
Is the source population or source area well described?		3	6	3
Were interventions and comparisons) well described and appropriate?		3	6	3
Were outcome measures reliable?		4	6	2
Were outcomes relevant?		2	7	3
Were the analytical methods appropriate?		4	4	4
Are the study results internally valid (i.e., unbiased)?	2	4	5	1
Are the findings generalizable to the source population (i.e., externally valid)?	7	1	3	1

3.4 Results

Characteristics

The search period for this systematic review was between 2000 and 2016. Distribution over years, countries, type of methodology, and discussed theoretical concepts of the included articles are presented in Table 3.3. None of the included articles reported studies about the theoretical interrelation between concepts of the theoretical model (Figure 3.1) as discussed above in the

theoretical background. The included studies focused only on individual interrelations of the theoretical model, for example simulations and self-efficacy. In the result section of this study, we describe these individual interrelations in the sequence of our theoretical background.

Well-being

None of the included studies reported effects of computer-based classroom simulations on PSTs' professional anxiety. Concerning PSTs' self-efficacy, four studies showed that computer-based classroom simulations increased PSTs' self-efficacy, however, not specifically efficacy for classroom management. Cheong (2010), Bautista and Boone (2005), and Christensen et al. (2011) reported significant increase in teaching self-efficacy through using respectively Second Life, TeachME™, and simSchool. Studies conducted by Bautista and Boone (2005) and Cheong (2010) measured science teaching efficacy beliefs using two scales: personal science teaching efficacy and science teaching outcome expectancy. Both scales had increased in the study of Bautista and Boone (2005). In contrast, Cheong (2010) reported that only the personal science teaching efficacy had increased after using the simulation. Christensen et al. (2011) measured an increased instructional self-efficacy. Dalgarno et al. (2016) showed that after using a simulation PSTs reported increased self-confidence as a teacher, however, this study did not specifically examine self-efficacy.

Overall, the results of these studies suggest a positive contribution of computer-based classroom simulations to PSTs' self-efficacy.

Interpersonal competence

The conceptual framework of this article stated that interpersonal competence consists of PSTs' professional interpersonal vision, repertoire, and knowledge. None of the included studies focused specifically on interpersonal competence. However, we did find six studies looking at the broader concept of classroom management.

Bautista and Boone (2015) used an immersive classroom simulation (TeachME™) in which PSTs practiced instructional strategies. In this simulation, PSTs in science education entered a classroom with five students (avatars), which represented typical middle school students. Students or hired professionals controlled the five avatars. PSTs were standing in front of a screen facing the avatars and practiced pedagogical skills and knowledge. The teacher educator first demonstrated classroom management strategies in the simulation. PSTs learned strategies for classroom management by mimicking the teacher educator. In another study, PSTs could make decisions about classroom management (Dalgarno et al., 2016). After using an immersive simulation (VirtualPREX) with Second Life as a virtual classroom environment, PSTs felt that they could better manage student behaviour. This study, however, did not investigate whether classroom management competence had actually improved.

Table 3.3

Characteristics of included studies

Authors	Simulation	Theoretical concepts
Bautista & Boone	TeachME™	Interpersonal competence Learning experiences
Cheong	Second Life	Self-efficacy
Christensen, Knezek, & Tyler-Wood	simSchool	Self-efficacy
Dalgarno et al.	VirtualPREX	Interpersonal competence Professional interpersonal vision Professional interpersonal repertoire Self-efficacy Hindrances Learning experiences
Dawson & Lignugaris/Kraft	TLE TeachLivE™	Interpersonal competence
Deale & Pastore	simSchool	Professional interpersonal repertoire Learning experiences
Ferry et al.	ClassSim	Professional interpersonal vision Affordances
Girod & Girod	The Cook Simulation	Professional interpersonal repertoire
Hummel et al.	Mastership game (online and face-to-face version)	Interpersonal competence Affordances Learning experiences
Kim & Blankenship	Second Life	Hindrances Learning experiences
Mahon et al.	Second Life and Role Play	Interpersonal competence Hindrances

	N	Method	Type of data collection	Country	Year
	62	Mixed-method	Written journals	United States	2015
	110 Condition 1: 59 Condition 2: 51	Quantitative	Questionnaire	Korea	2010
	Trial 1: 62 Trial 2: 104 (47 PSTs)	Quantitative	Questionnaires	United States	2011
	Phase 1: 72 Phase 2: 21	Mixed-method	Questionnaire	Australia	2016
	4	Quantitative	Video Assessments Questionnaire	United States	2016
	13	Quantitative	Questionnaire	United States	2014
	Trial 1: 24 Trial 2: 24	Qualitative	Observations Interviews PSTS' entries	Australia	2005
	Experimental group: 33 Control group: 38	Quantitative	Questionnaire Teacher work sample scores Lesson evaluation scores	United States	2006
	19 Online version: 9 Face-to-face: 10	Mixed-method	Questionnaire Written reports	The Netherlands	2015
	12	Qualitative	Vignettes Reflective statements Observations Debriefings	United States	2013
	20	Qualitative	Questionnaire Observation Written notes	United States	2010

Table 3.3
Continued

Authors	Simulation	Theoretical concepts
Mirliss et al.	Seton Hall's Simulation (Second Life software)	Interpersonal competence Professional interpersonal repertoire Affordances Hindrances Learning experiences
Quintana & Fernández	TYMMI (in Second Life and Open Sim virtual worlds)	Professional interpersonal repertoire Affordances Hindrances Learning experiences
Rayner & Fluck	simSchool	Professional interpersonal knowledge Affordances Learning experiences
Yeh	Computer Simulation for Teaching	Professional interpersonal knowledge

In the immersive Seton Hall's Simulation, one group of PSTs practiced classroom management competence while another group functioned as the audience (Mirliss et al., 2015). This study showed a significant difference between the actors and the audience for PSTs' ability to formulate classroom rules. PSTs reported that concepts they learned were suitable to apply at the workplace. Hummel, Geerts, Slootmaker, Kuipers, and Westera (2015) used 'The Mastership Game' which, in our opinion, is a simulation because it missed a quantifiable outcome. Together with peers PSTs discussed classroom dilemmas (i.e., 'How to deal with a pupil that does not want to get coached?'. In the end, PSTs elaborated a solution for a problem in an advisory report. This study concluded that PSTs could learn classroom management in simulated environments, through collaboration and without support of a teacher.

Furthermore, PSTs who practiced classroom management in another Second Life environment reported learning classroom management through simulations to be creative and intriguing (Mahon et al., 2010). They also reported an increased understanding of classroom management competence. Finally, Dawson and Lignugaris/Kraft (2016) reported that PSTs improved their delivery of specific praise, praise around (simultaneously ignoring misbehaviour and praising desired behaviour), and error correction after using the non-immersive TLE TeachLivE™. This simulation was projected on a big screen, using an Xbox Kinect system. An interactor manipulated virtual students and observed through a camera PSTs' actions.

	N	Method	Type of data collection	Country	Year
	23	Mixed-method	Questionnaires	United States	2015
	18	Mixed-method	Log book Questionnaire Observation	Chili	2015
	15	Mixed-method	Questionnaire	Australia	2014
	149	Quantitative	Questionnaire	Taiwan	2004

Overall, these results indicate that computer-based classroom simulations contribute to PSTs' classroom management skills and therefore are assumed to enhance interpersonal competence. However, direct empirical evidence for the effect on interpersonal competence was absent in all of the included studies.

Professional interpersonal vision

Although two studies studied simulations and awareness, which is only part of PSTs' professional interpersonal vision, none of the studies reported specific results about professional interpersonal vision. Ferry et al. (2005) used a non-immersive computer-based classroom simulation ClassSim. In this simulation, PSTs took on the role of kindergarten teacher. Participants were confronted with sets of authentic classroom teaching episodes in which PSTs took classroom management decisions. Afterwards, the participating PSTs reported increased awareness of the challenges they might face in an actual classroom. Dalgarno et al. (2016) reported that PSTs became more conscious about unexpected circumstances in classrooms after observing their peers.

Professional interpersonal knowledge

None of the included studies reported effects of simulations on professional interpersonal knowledge. However, three studies showed that computer-based simulations could increase PSTs' pedagogical knowledge about teaching in general.

Drawing from Shulman (1986), Yeh (2004) found that using the non-immersive Computer Simulation for Teaching General Critical-Thinking Skills caused a significant effect on content knowledge (PSTs' understanding of the concept critical thinking) about effective instruction of critical thinking. However, PSTs pedagogical content knowledge (PSTs' knowledge about designing a curriculum to improve students' critical thinking) did not increase significantly. Mirliss et al. (2015) found a positive correlation between the immersive Seton Hall's Simulation and applying teaching knowledge and learning about characteristics of classrooms. Furthermore, PSTs reported to have gained more insight in special educational needs of students (Rayner & Fluck, 2014) after they were engaged in simSchool.

The results of these studies demonstrate inconsistent effects of computer-based classroom simulations on PSTs' pedagogical knowledge. All three studies found positive results on gaining knowledge after simulating, yet Yeh (2004) only found increased content knowledge rather than pedagogical content knowledge. Moreover, none focussed explicitly on professional interpersonal knowledge.

Professional interpersonal repertoire

The included articles did not specifically address professional interpersonal repertoire. However, four studies reported positive contributions of simulations on PSTs' teaching skills in general. Professional interpersonal repertoire can be seen as part of PSTs' teaching skills (Shagrir, 2010). Since the included studies did not define teaching skills, it is assumed that PSTs' professional interpersonal repertoire improved as part of more general improvement in teaching skills.

First, in the study of Dalgarno et al. (2016), PSTs reported an increased ability to handle unexpected occurrences in the classroom as result of to the simulation (Dalgarno et al., 2016). Second, Girod and Girod (2006) used the non-immersive Cook Simulation. In this simulation, students were simulated, and PSTs had the opportunity to control variables such as instructional strategy or curriculum area. Girod and Girod (2006) suggested that teaching skills increased after simulated classrooms. Third, Deale and Pastore (2014) used the non-immersive simulation simSchool. This simulation models learner behaviour and gives PSTs opportunities to practice their teaching skills, which increased after simulating. Finally, Quintana and Fernandez (2015) reported that PSTs believed that an immersive simulation supported them in their teaching practice as it increased their professional skills (Quintana & Fernandez, 2015). In this simulation, using an immersive computer-based classroom simulation, using Second Life, and the learning management system Open Sims virtual worlds, PSTs were confronted with classroom scenarios in which they acted like teachers.

Although definitions of teaching skills were sometimes unclear, and data were collected via PSTs' self-reports, overall, these results suggest that computer-based classroom simulations have a positive influence on PSTs' teaching skills. Therefore, it stays unclear to what degree these skills encompass professional interpersonal repertoire.

Affordances and hindrances

Affordances and hindrances of computer-based classroom simulations reported by PSTs were derived from the included studies. In the study by Quintana and Fernandez (2015) PSTs reported the following educational affordances of the simulation: co-assessment, receiving teacher feedback, and available resources. These affordances helped PSTs to improve their teaching practice and to gain more insight into their strengths and weaknesses. PSTs using the simulation ClassSim experienced thinking spaces, which provided opportunities to reflect on occurrences as an educational affordance (Ferry et al., 2005). These thinking spaces allowed PSTs to reflect on and evaluate the decisions they made in the simulation. Furthermore, PSTs reported social affordances about working with simulations on the following characteristics: collaboration (Hummel et al., 2015), peer observation, and discussions (Rayner & Fluck, 2014). PSTs could learn from each other through these affordances.

PSTs also reported technical hindrances, such as malfunctioning audio and videos (Mahon et al., 2010; Mirliss et al., 2015; Quintana & Fernandez, 2015). These technology-related hindrances impacted their learning throughout the simulation. PSTs also experienced problems with chat/conversation functions. Furthermore, PSTs indicated that simultaneous reading and writing was not very convenient (Quintana & Fernandez, 2015), and that they perceived typing, instead of talking, as difficult (Dalgarno et al., 2016). As a consequence, PSTs were not always able to follow and contribute to the conversations in the simulation, which led to less lively conversations. PSTs using Second Life reported that it was difficult to see facial expressions of avatars, which made it difficult to interpret interactions (Kim & Blankenship, 2013).

Learning experiences

Learning experiences in terms of PSTs' feelings towards computer-based classroom simulations were examined. Five studies showed that PSTs found learning with simulations enjoyable (Bautista & Boone, 2015; Hummel et al., 2015; Kim & Blankenship, 2013; Mirliss et al., 2015; Quintana & Fernandez, 2015). Furthermore, PSTs felt engaged as they were psychologically involved and could enjoy the simulation's content. Providing that the simulation was realistic and authentic, PSTs were able to engage more efficiently with the content of the simulation. (Mirliss et al., 2015). This can be contrasted with two other studies in which PSTs were unable to engage with the content because the simulation was unrealistic due to the simulation being dissimilar to an actual classroom (Dalgarno et al., 2016; Rayner & Fluck, 2014).

The TeachME™ simulation and ClassSim were experienced as relatively safe learning environments (Bautista & Boone, 2015) as PSTs could explore interactions without damaging their relationship with students (Ferry et al., 2005). Since the simulation felt like a real classroom (Bautista & Boone, 2015), PSTs reported that these simulations helped prepare them for their work in actual classrooms (Bautista & Boone, 2015; Dalgarno et al., 2016; Deale & Pastore, 2014; Quintana & Fernandez, 2015; Rayner & Fluck, 2014). Finally, PSTs perceived the simulations as relevant (Quintana & Fernandez, 2015).

Alongside positive feelings and experiences with classroom simulation, PSTs of two studies also experienced negative feelings. Due to the unfamiliarity of the simulation as they did not know what to expect, as well as being evaluated by their peers, some PSTs believed this contributed to their negative feelings (Bautista & Boone, 2015). Furthermore, they found the pupil behaviour in the simulation unrealistic and thought the pupils in the simulation were overreacting. PSTs also perceived the simulation to be difficult as there were too many activities happening at the same time. On the other hand, some PSTs even felt boredom because pupils' off-task behaviour was taking all playing time (Dalgarno et al., 2016). For these reasons, some PSTs did not appreciate the simulation at all.

3.5 Conclusion and discussion

This literature review aimed to map research about computer-based classroom simulations, PSTs' interpersonal competence, and aspects of PSTs' well-being. Furthermore, affordances and hindrances of simulations, and how PSTs experienced simulations aimed at their (interpersonal) teaching skills were explored.

It was found that simulations can contribute to PSTs' professional development and are a potential asset for teacher education by bridging the gap between teacher education and educational practice. However, our literature review did not find studies that directly and specifically investigated the interrelations between PSTs' well-being, interpersonal competence, learning experiences, and computer-based classroom simulations as visualized in figure 3.1. Although the theoretical background advocated the importance of studying these interrelations as a whole (increasing well-being via interpersonal competence through positive learning experiences with simulations), included studies only focused on individual interrelations of the model.

A closer look at the individual interrelations revealed little evidence about the contribution of computer-based classroom simulations on PSTs' professional anxiety and interpersonal competence. However, studies did report effects of simulations on

the broader domain of classroom management skills, teaching skills and self-efficacy. We also found studies that reported about the specific aspect awareness as part of professional (interpersonal) vision.

Concerning PSTs' well-being, none of the included studies reported effects of computer-based classroom simulations on professional anxiety. Yet, included studies did show positive effects of simulations on PSTs' self-efficacy. These results are consistent with data obtained in a study of Knezek and colleagues (2012) who indicate that PSTs' self-efficacy improved significantly after using simSchool. Increased self-efficacy can be explained by Bandura's (1977) self-efficacy theory, which assumes that self-efficacy increases through vicarious experiences. The results of our literature review demonstrate that simulations can strengthen PSTs' beliefs in their teacher abilities and add value to teacher education.

None of the included studies focused specifically on interpersonal competence as element of classroom management, however, six studies investigated the influence of simulations on the broader concept of classroom management. Findings suggest that PSTs can learn classroom management through computer-based classroom simulations. These studies reported that PSTs' felt as though they were able to manage their classrooms better. However, whether they actually improved their classroom management skills, was not observed in the studies. Other studies focused only on an aspect of classroom management, such as formulating rules. The lack of attention to interpersonal competence is possibly a consequence of current teacher education programs. PSTs often experience a shortage in reality-based preparation on how to manage classrooms (Eisenman, Edwards, & Cushman, 2015). The attention teacher education gives to classroom management is mainly focused on how to manage misbehaviour, instead of on how to create positive teacher-student relationships (van Tartwijk & Hammerness, 2011). However, research indicates that interpersonal competence is important for teachers as part of their classroom management skills (Wubbels et al., 2015). We argue that future research should focus on particular effects of classroom simulations on PSTs' interpersonal competence.

Furthermore, we examined PSTs professional interpersonal vision, as part of their interpersonal competence. Two studies demonstrated that after using a simulation, PSTs were more conscious and aware of the challenges that teachers face and the unexpected circumstances in classrooms. These studies concluded that noticing important classroom events can be improved with simulations. However, professional interpersonal vision includes not only awareness of important classroom events, but also interpreting these events based on professional interpersonal knowledge (van Es & Sherin, 2002). Regarding professional interpersonal knowledge, three studies reported inconsistent results about

increased (pedagogical) content knowledge. Consequently, we conclude that little is known about simulations and professional interpersonal knowledge. Studies argue that PSTs' professional vision is important for PSTs classroom management skills (van den Bogert, 2016; Wolff, 2015). Therefore, it can be inferred that further research into whether classroom simulations could help PSTs develop their professional vision beyond the aspect of awareness and professional interpersonal knowledge, necessary for professional vision, would be considered as valuable and necessary.

Another part of PSTs' interpersonal competence distinguished in this review was professional interpersonal repertoire, which was not specifically examined in the included studies. Most of these studies reported improved general teaching skills caused by computer-based classroom simulations. However, the included studies did not operationalize the concept of teaching skills very clearly, and data were collected via PSTs' self-reports. The positive results of simulations on self-reported teaching skills are consistent with the study of Knezek et al. (2012), which showed that teachings skills improved significantly after using simSchool. However, several studies suggest that there may be differences between self-perceived behaviour and behaviour as observed by others, such as the students of a PST (den Brok, Bergen, & Brekelmans, 2006). Thus, there is a clear need for more specific research on simulations and interpersonal repertoire, not only using self-reports, but also student perceptions or observations.

Overall, the results of this literature review strengthen the idea that simulations are promising tools to contribute to improving PSTs' teaching skills. However, we understand that simulations can never replace teacher educators to teach PSTs complex topics such as interpersonal competence. The interest of our study was to investigate whether simulations can additionally contribute to PSTs' development of interpersonal competence. Although the included studies mainly provided information about teaching skills in general, findings of these studies are promising, and in many cases interpersonal competence can be assumed to be part of these more general skills. As a result, it is relevant to assess the effects of simulations on PSTs professional interpersonal vision, professional interpersonal knowledge, and professional interpersonal repertoire as part of PSTs' interpersonal competence. This assessment would offer more specific insights into how simulations can support interpersonal competence, and as a result, it would aid in the development of classroom management skills. In fact, studies have already demonstrated a positive influence of simulations on teaching and classroom management skills. In addition, it would be interesting to investigate if classroom simulations can also reduce PSTs' professional anxiety.

Furthermore, this study asked whether there are any affordances and hindrances when using computer-based classroom simulations for PSTs. The educational affordances of these simulations perceived by PSTs were co-assessment, receiving teacher feedback, available resources, thinking spaces, active learning, and the ability to take the role of a teacher. Reported social affordances were peer observation, discussions, and collaboration. Most reported affordances appeared to be educational, which can be explained by the limited possibilities to collaborate or work together in simulations. At the same time, reported hindrances were primarily technical. The lack of a user-friendly interface, malfunctioning audio or video, not being able to see facial expressions, lack of realism, and problems with chat/conversation functions were reported as a hindrance of simulations.

This review extends our knowledge about affordances and hindrances of computer-based classroom simulations and could contribute to further development of these kind of simulations. For simulations to be effective, a well-designed interface is necessary, as well as a high level of realism. Although this conclusion appears obvious, many included studies regarded this as an important aspect for using simulations.

Finally, this literature review investigated how learning experiences with computer-based classroom simulations are influenced by PSTs' feelings. Although some PSTs felt anxiety, were nervous, or did not appreciate simulations, in general, PSTs appreciated the simulations, felt engaged, and enjoyed the experience. These feelings correspond with results found by Stavroulia et al. (2016), who conclude that feelings of both enjoyment or engagement, as well as anxiety and nervousness, are similar to emotions novice teachers experience in classrooms. The included studies did not report whether participating PSTs were ICT minded or not. This is important for previous positive or negative experiences with ICT could influence future experiences with simulations (van den Beemt & Diepstraten, 2016). As it was not investigated whether ICT mindedness contributed to these differences in the PSTs experience, it is not clear whether a lack of ICT mindedness had negatively influenced their experience with simulations. One possible explanation could be that non-ICT minded PSTs were nervous due to their unfamiliarity with the technology of simulations. Continuing, non-ICT minded PSTs could have perceived the simulations as less useful, because of the technical nature of the hindrances. Nevertheless, the majority of PSTs felt better prepared for jobs in education by using classroom simulating as they perceived simulations as a safe learning environment to practice in before they entered a real classroom. These findings support arguments by Rayner and Fluck (2014) who suggest that computer-based classroom simulations are a safe way to prepare PSTs for educational practice because PSTs are able to practice their role as a teacher without the fear of making mistakes in front of real students. Therefore, we argue that simulations improve PSTs' interpersonal competence and well-being as they are potential assets for teacher education, provided that simulations are realistic.

Limitations and future research

Findings of this review may be limited by the small number of included studies. Numerous studies used quantitative data gathering from self-reports and refrained from providing in-depth information about simulations in teacher education. Effects of computer-based classroom simulations were reported, such as positive effects on PSTs' teaching skills and self-efficacy. However, none of the studies reported which elements of simulations contributed to PSTs' professional development. Most results found in the studies only provided a limited insight. Moreover, ten of the included studies were case studies, and most of them were conducted locally. Most studies also had only a small number of participants, which further limited their results. For that reason, the results are less generalizable. Finally, it is important to bear in mind that the quality appraisal showed differences in quality of the included studies. To preserve a substantive body of literature we decided not to exclude studies from our literature review. Therefore, not all results appeared equally reliable which could lead to an overly positive bias. When analysed as a whole, we should be cautious with extrapolating our findings to the population at large.

By mapping existing research about computer-based classroom simulations in teacher education, this review study serves as a starting point for more in-depth research about classroom simulations and their effects on PSTs' interpersonal competence and well-being. Due to a limited number of studies on computer-based classroom simulations and professional anxiety, further research could usefully explore how these simulations contribute to PSTs' professional anxiety. To determine the interrelations between simulations, well-being, interpersonal competence, and learning experiences in relation to each other, further research is also required.

Chapter 4

Enhancing authentic learning experiences in teacher education through 360-degree videos and theoretical lectures: Reducing preservice teachers' anxiety

This chapter was published in adapted form as:
Theelen, H., van den Beemt, A., & den Brok, P. (2020). Enhancing authentic learning experiences in teacher education through 360-degree videos and theoretical lectures: reducing preservice teachers' anxiety. *European Journal of Teacher Education*. doi:10.1080/02619768.2020.182739

Abstract

Preservice teachers (PSTs) often experience professional anxiety when managing their classrooms. These feelings of anxiety can be reduced, and their feelings of self-efficacy increased by training PSTs' interpersonal competence. This study used authentic learning experiences combining theoretical lectures and 360-degree videos watched with virtual reality headsets, to train their interpersonal competence. Participants of this study were 141 first year PSTs of a teacher education institute in the Netherlands. Results showed that the video-lecture combination led to a reduced professional anxiety and increased self-efficacy. PSTs' self-perceptions of their own expected interpersonal behaviour indicated that PSTs thought they would be more in control in the actual classroom after the intervention. PSTs attributed these results to exemplary teacher behaviour shown in the 360-degree videos.

4.1 Introduction

Imagine standing in front of a classroom with approximately 25 to 30 adolescents. Some students are chatting with each other, some students are unmotivated to join the lesson, some students are waiting for you to start while other students are walking through the classroom. You have to attract their attention to start your lesson. However, you are just a beginning teacher – still a student yourself at a teacher education institute. You lack the experience and the tools (yet) to maintain order in the classroom. This is a difficult task and frightening for many preservice teachers (PSTs). Feelings of fear and anxiety are common for PSTs and are often related to classroom management issues (Murray-Harvey et al., 2000; Pillen et al., 2013; Akmal, Razali, Ningshi, & Rosdiana, 2019). In this study, we define PSTs' stress manifested in feelings of fear and anxiety, as PSTs' professional anxiety.

PSTs' beliefs in their own capacities to influence student behaviour, also known as their self-efficacy (Friedman, 2003), is an important coping resource to handle classroom management issues and can be increased by training PSTs in classroom management (McCarthy et al., 2015). However, when entering internship schools, PSTs feel ill-prepared for the difficult task of teaching, and especially for managing their classrooms (Keppell, 2006; Korthagen, 2010; McCarthy et al., 2015). PSTs often experience a gap between theory offered at the teacher education institute and educational practice, also referred to as the 'practice shock' (Keppell, 2006; Korthagen, 2010; Voss & Kunter, 2019).

Exposing PSTs to real-world, complex problems and their solutions using realistic cases, creates authentic learning experiences which may help PSTs to bridge the gap between theory learned at the teacher education institute and educational practice, and smoothen the practice shock (Keppell, 2006). Videos can be used to deliver these realistic cases (Herrington & Herrington, 2006; Cho, Mansfield, & Claughton, 2020). Furthermore, interpersonal competence, as part of classroom management, can be successfully developed using 360-degree videos in combination with theoretical lectures (Theelen et al., 2019b, see chapter 5). The current paper presents a mixed-method study about authentic learning experiences for PSTs using 360-degree videos in combination with theoretical lectures and evaluates if these authentic learning experiences lead to a reduction in PSTs' professional anxiety and increase in their self-efficacy.

4.2 Theoretical background

Preservice teachers' feelings of stress and professional anxiety

Although PSTs perceive internships during teacher education as valuable learning experiences, many PSTs experience their school internship as particularly stressful (Murray-Harvey et al., 2000; MacDonald, 1993; McCarthy et al., 2015). Sources of stress for PSTs appear to be twofold: (1) PSTs experience teacher stress in their role transition from student to intern at their internship school (MacDonald, 1993; Pillen et al., 2013; Voss & Kunter, 2019) and (2) they are confronted with demanding situations in the class and school context in their internship (Alontaga & Durban, 2013; Admiraal, et al., 1996; Veenman, 1984).

Stressful aspects in PSTs' role as an intern are related to role clarification, expectations, conformity, time, evaluation, assignments, peer discussions, and feedback (MacDonald, 1993). Stressful aspects in the class and school context consist of dealing with intensive social relations, troublesome relationships with colleagues, fast decision making, time and work pressure, constant change, unmotivated students, disruptive student behaviour, students' off and on task behaviour, classroom discipline, and classroom management issues (Harmsen, Helms-Lorenz, Maulana, & van Veen, 2018; Alontaga & Durban, 2013; Admiraal et al., 1996; Veenman, 1984; Pillen et al., 2013).

This teacher stress leads to negative emotions characterised by feelings such as professional anxiety and fear, which makes PSTs vulnerable for reduced well-being and even burnout (Chang 2009; McCarthy et al., 2015). According to Chang (2009), especially classroom management issues evoke PSTs' *professional anxiety*, and are therefore PSTs' most pressing concern (Pillen et al., 2013).

Classroom management issues are not only a source of PSTs' professional anxiety, but also a consequence (Chang, 2009; McCarthy et al., 2015). In other words, a PST who experiences anxiety, is potentially not capable to manage disruptive student behaviour in an effective way, which may lead to more disruptive behaviour and eventually higher levels of anxiety. Furthermore, PSTs experiencing anxiety are more likely to use negative classroom management techniques such as yelling at students, which increases disruptive student behaviour (Sutton, Mudrey-Camino, & Knight, 2009). Problematic for PSTs is that they cannot leave the classroom when they feel anxious. Instead, they instantly have to deal with the classroom management issues at hand (McCarthy et al., 2015).

Preservice teachers' self-efficacy

Self-efficacy can be defined as teachers' beliefs that they can influence student behaviour and achievements (Friedman, 2003). Self-efficacy can be an important coping resource for PSTs when dealing with professional anxiety (McCarthy et al., 2015). PSTs with a strong sense of self-efficacy are less vulnerable for experiencing professional anxiety when they are confronted with classroom management issues (Friedman, 2003; Zee & Koomen, 2016). Creating successful classroom management experiences helps PSTs gaining self-efficacy for classroom management (Brouwers & Tomic, 2000; Marlow et al., 2015). Developing PSTs' classroom management competence could be an effective and important strategy to gain self-efficacy for classroom management and consequently reduce or even prevent PSTs' professional anxiety (McCarthy et al., 2015).

Practice shock

When confronted with classroom management issues, PSTs often experience a gap between the training they received at the teacher education institute about classroom management and the actual teaching practice. This gap between theory and practice is also known as 'practice shock' (Keppell, 2006; Korthagen, 2010; Voss & Kunter, 2019).

As Korthagen (2010) advocates, practice shock is a well-known phenomenon for teacher education worldwide throughout the twentieth century. Lessons learned at teacher education institutes seem to be forgotten when entering the educational practice (Veenman, 1984; Korthagen, 2010). Beginner teachers experience discrepancies between their personal preferences and teaching methods they feel forced into by their school practice (Brouwer & Korthagen, 2005). Consequently, PSTs feel insufficiently prepared by teacher education institutes (Stokking, Leenders, de Jong, & van Tartwijk, 2003).

Due to the complexity of classrooms, it is difficult for teacher education institutes to prepare PSTs for the educational practice (Korthagen, 2010). In general, teacher education institutes are guided by generalised, theoretical principles and skills, instead of genuine practices of professionals in authentic contexts (Herrington & Herrington, 2006).

Authentic learning experiences

Providing PSTs with authentic learning experiences at teacher education institutes, possibly bridges the gap between teacher education institutes and educational practice (Keppell, 2006). 'Authentic learning typically focuses on real-world, complex problems and their solutions, using role-playing exercises, problem-based activities, case studies, and participation in virtual communities of practice' (Lombardi & Oblinger, 2007, p.2).

Videos can deliver authentic cases with realistic complex problems and real-world relevance (Herrington & Herrington, 2006; Cho, Mansfield, & Claughton, 2020). Videos expose PSTs to classroom events in which expert teachers function in real-world contexts. This way, PSTs are given models to observe and are enabled to explore different perspectives on teaching (Herrington & Herrington, 2006).

360-degree videos

In the current study, 360-degree videos are used, because previous studies showed that 360-degree videos in teacher education can be used to develop classroom management (Theelen et al., 2019b, see chapter 5; Theelen et al., 2020b, see chapter 6). With 360-degree videos one can view situations all around the viewpoint, which is also known as a spherical view. This spherical view makes it possible for viewers to drag the video up, down, left, right, and to decide themselves where to focus attention to (Reyna, 2018). For classroom videos, this entails that PSTs can view classroom interactions from both a teacher and student perspective. Using YouTube as an online platform, 360-degree videos can be watched with a virtual reality headset (Figure 4.1), disconnecting viewers from their surroundings (Aguayo et al., 2017; Olmos et al., 2018; Olmos-Raya et al., 2018). This way, 360-degree videos provide viewers with a sense of presence and immersion in a realistic and authentic situation that cannot be realised with traditional 2D videos (Reyna, 2018; Martín-Gutiérrez, Mora, Añorbe-Díaz, & González-Marrero, 2016; Yoh, 2001).

Figure 4.1 VR headset

Although sometimes frustrated by technical hindrances, 360-degree videos are slowly finding their way into education (Aguayo et al., 2017). In education, 360-degree videos can be used to show learners complex scenarios (Reyna, 2018). In the context of teacher education, only a few exploratory studies and projects have been conducted on the use of 360-degree videos (e.g., Roche and Gal-Petitfaux 2017; Loewus 2017; Pea et al., 2004; Theelen et al., 2019b). For example, Roche and Gal-Petitfaux's study (2017) illustrates the benefits of PSTs watching 360-degree videos on helping them understand classroom events during physical education lessons.

Preservice teachers' interpersonal competence

Because PSTs' professional anxiety concerns classroom management issues the most, the 360-degree videos in the current study covered classroom management issues. Classroom management can be conceptualised in terms of the teacher-student relationship, PSTs manage their classrooms with all the actions they undertake to create a positive learning environment via teacher-student relationships, the so-called PSTs' *interpersonal competence* (Wubbels et al., 2015; Stough & Montague, 2015). Positive teacher-student relationships are associated with higher levels of self-efficacy (Mashburn, Hamre, Downer, & Pianta, 2006; van der Want, Beijaard, & den Brok, 2019), are important for PSTs' well-being (Wubbels et al., 2006), and contribute to PSTs' job satisfaction (Chang, 2009). Positive teacher-student relationships are also positively correlated with better student achievement and attitudes (den Brok, Brekelmans, & Wubbels, 2004).

A commonly used approach to describe and understand teacher-student relationships is the dynamic systems approach (Watzlawick et al., 1967; Wubbels & Brekelmans, 2005; Wubbels et al., 2015). In this approach classes are seen as social systems in which teachers and students continuously interact, in both a verbal and non-verbal way (Wubbels & Brekelmans, 2005). These interactions between teachers and students consist of a content and a relational aspect. Teachers' non-verbal behaviour plays an important part in the relational aspect of communicating content from a students' perspective (Wubbels et al., 2006).

Teacher-student interactions are reciprocal, which means that teacher and students affect each other mutually (Horowitz & Strack, 2011). This mutual interaction can be described through two independent dimensions that together form a circumplex structure: agency, the level of influence teacher and students have, and communion, the warmth of the teacher-student relationship (Horowitz & Strack, 2011). Both are visualised in the Teacher Interpersonal Circle (TIC) (Figure 4.2) (Pennings et al., 2018). Underlying the two dimensions are eight types of teacher behaviour that can be distinguished: directing, helpful, understanding, compliant, dissatisfied, uncertain, imposing, and confrontational

(den Brok & van Tartwijk, 2015). The TIC visualises, for example, that directing teacher behaviour is characterised by high levels of teacher influence on the agency dimension, in combination with a warm teacher-student relationship on the communion dimension. This is also the case for helpful teacher behaviour, although for this type the communion dimension dominates (Wubbels & Brekelmans, 2005). Teacher behaviour that scores high on both communion and agency is related to positive teacher-student relationships (Wubbels et al., 2006).

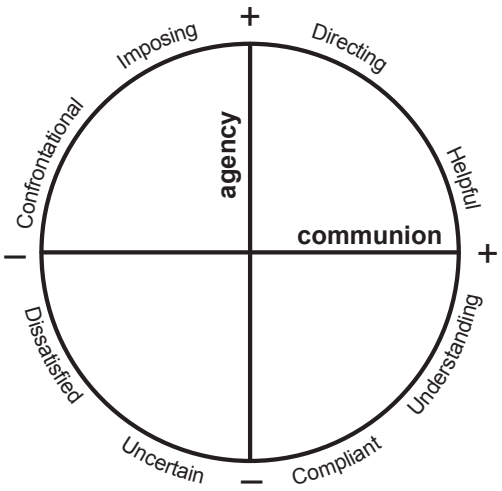

Figure 4.2 Teacher Interpersonal Circle (Pennings et al., 2018; Figure is used with permission of the authors)

Aim and research questions

The aim of this study was to decrease PSTs' professional anxiety and increase PSTs' self-efficacy by developing their interpersonal behaviour by exposing them to authentic learning experiences using 360-degree videos, in combination with, theoretical lectures (The video-lecture combination will be explained in section 2.) Previous studies indicated a relation between PSTs' professional anxiety and self-efficacy, suggesting that PSTs' with high feelings of self-efficacy were less vulnerable for professional anxiety (e.g., McCarthy et al., 2015; Friedman, 2003). In the present study we investigated the concepts 'professional anxiety' and 'self-efficacy' separately. Although we assume a relation between the two concepts and in the interpretation of the results of this study, we will take the presumed relation between professional anxiety and self-efficacy into account. This leads to the first two research questions:

1. *What is the effect of authentic learning experiences in teacher education (video-lecture combination) focusing on teachers' interpersonal behaviour on PSTs' professional anxiety?*
2. *What is the effect of authentic learning experiences in teacher education (video-lecture combination focusing on teachers' interpersonal behaviour on PSTs' self-efficacy?*

Previous research has also shown the relation between classroom management, including PSTs' interpersonal behaviour, and PSTs' professional anxiety and self-efficacy (e.g., Chang, 2009; Brouwers & Tomic, 2000). PSTs' poor interpersonal behaviour can lead to higher professional anxiety and self-efficacy can be gained by successful experiences managing a classroom. Because PSTs in the present study were not yet involved in real-life internships, PSTs' self-perceptions towards their own anticipated interpersonal behaviour were investigated. This leads to the third research question:

3. *What is the effect of authentic learning experiences in teacher education (video-lecture combination) on PSTs' self-perception of their (anticipated) interpersonal behaviour?*

Because (preservice) teachers differ in their sense of self-efficacy (Friedman, 2003) and cope differently with feelings of anxiety (Sutton et al., 2009), this study also investigates if different clusters of PSTs can be distinguished regarding PSTs' self-efficacy and professional anxiety. We assumed to find four clusters of PSTs differing in their professional anxiety and self-efficacy when looking at the start of the intervention (see Table 4.1).

Table 4.1
Assumed clusters of PSTs regarding professional anxiety and self-efficacy at the start of the intervention

	Cluster			
	1	2	3	4
professional anxiety	high	low	high	low
self-efficacy	high	low	low	high

After establishing the clusters, we were also interested to see whether PSTs from various clusters developed their professional anxiety, self-efficacy, and self-perceived interpersonal behaviour differently. This leads to the last two research questions:

4. *Which meaningful clusters can be distinguished among PSTs concerning their professional anxiety and self-efficacy before the start of the intervention?*
5. *In what way do the various clusters concerning PSTs' professional anxiety and self-efficacy before the intervention differ from each other in their development of professional anxiety, self-efficacy, and self-perceived interpersonal behaviour after authentic learning experiences (video-lecture combination)?*

4.3 Design authentic learning experiences: The Virtual Classroom

To create authentic learning experiences in the teacher education institute, theory lectures in a regular teacher education setting were combined with watching 360-degree videos in three two-hour sessions, referred to as the Virtual Classroom. The aim of the 360-degree videos was exposing PSTs to model behaviour of expert teachers providing PSTs opportunities to observe real-world classroom situations from different perspectives.

Each session started with a theoretical lecture about interpersonal teacher behaviour, which gave PSTs a perspective to watch the 360-degree videos. Theory included the systems approach to communication (Watzlawick et al., 1967; Wubbels et al., 2006), the TIC (Wubbels et al., 2006; den Brok & van Tartwijk, 2015; Pennings et al., 2018), and teachers' verbal and non-verbal behaviour (van Tartwijk, 1993) with increasing complexity in succeeding sessions. After each theoretical instruction, all PSTs watched 360-degree videos and were encouraged to observe systematically by doing assignments while watching the video (e.g., What do you notice about the teacher's non-verbal behaviour? How does the teacher in the video correct the disruptive student?) The sessions ended with PSTs discussing their interpretations of observed classroom events together with their fellow PSTs in the classroom setting. These discussions gave PSTs the opportunity to learn from their peers' interpretations (Star & Strickland, 2008), to analyse classroom interactions (Sherin & van Es, 2005), and to reflect and reason about teacher and student behaviour (Santagata & Guarino, 2011).

Using their mobile phones with a virtual reality headset playing 360-degree YouTube videos, PSTs watched a total of fifteen 360-degree videos of ten experienced secondary education teachers. All videos contained one or more classroom events that are considered important for the teacher-student relationship: (1) the beginning of a lesson, (2) a moment of instruction, (3) stimulating students to work, (4) disruptive behaviour, (5) comments of students, (6) insufficient students' performances, (7) questions or feedback from students, and (8) the transition between two different

phases of the lesson (e.g., from instruction to work independently on the teaching materials) (Admiraal, 1994; Admiraal et al., 1996; Wubbels et al., 2006). Video length averaged three minutes and 8 seconds with extremes of 47 seconds and four minutes and 48 seconds.

4.4 Methods

Participants

Participants in this study were first year PSTs of a teacher education programme in the Netherlands (*N* = 141; 81♀) with little or no teaching experience. This teacher education program prepares PSTs for the secondary education context. This study followed the research guidelines for social scientific studies from the Association of Universities in The Netherlands (2018). Participants took part voluntarily and gave their informed consent.

Questionnaires

To gather insight in PSTs' experiences with the video-lecture combination, data from a questionnaire with 69 statements about professional anxiety, self-efficacy, and self-perceptions of interpersonal teacher behaviour were analysed. Table 4.2 gives an overview of the questionnaires, with a sample item for each scale and its internal consistency. All scales had a good internal consistency. Items were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). High scores imply positive experiences with the video-lecture combination for the self-efficacy scale. For the Teacher Anxiety Scale, high scores mean a high level of anxiety, which implies a negative experience. Because participants of this study had little or no teaching experience, they could only score their self-perceptions regarding their anticipated interpersonal behaviour on the Questionnaire on Teacher Interaction (van Tartwijk et al., 2014), for example from the perspective of the kind of teacher they believe they would be in the future.

Interviews

To gather more insight in PSTs' experiences with the video-lecture combination, semi-structured individual interviews were conducted after the video-lecture combination (*n* = 12; 7♀). Interviewees were selected with convenience sampling resulting in five PSTs from cluster 1 and seven PSTs from cluster 2 (see results cluster analysis section 4.3). This number of participants met the minimal requirement for theoretical saturation (Guest et al., 2006). The interviews were audio recorded and consisted of six questions about professional anxiety and self-efficacy (See Appendix A). A sample question is *'Did the video-lecture combination influence your professional anxiety? How?'* The interviews did not gather information about PSTs' self-perceived interpersonal behaviour.

Table 4.2

Questionnaires

Questionnaire	Theoretical concept
Student Teacher Anxiety Scale (Morton, Vesco, Williams & Awender, 1997)	Teacher anxiety
Teacher Self-Efficacy Scale - the classroom context (Friedman & Kass, 2002)	Self-efficacy in the classroom context
Questionnaire on Teacher Interaction (van Tartwijk et al., 2014)	Interpersonal behaviour

Data-analysis

This study used a mixed-method design with a pre-test, an intervention (the video-lecture combination), and a post-test. Data from the questionnaires were both gathered at the pre- and post-test. The interviews were conducted after the intervention, at the post-test. Results of the questionnaires for PSTs' professional anxiety, self-efficacy, and interpersonal teacher behaviour at the pre- and post-test were compared using a paired samples *t*-test and analysed with IBM SPSS Statistics 22.

Regarding the qualitative data retrieved from the interviews, the sensitising concepts (Charmaz, 2006) professional anxiety, self-efficacy, interpersonal teacher behaviour, and 360-degree videos were derived from the theoretical background. These four concepts were used to categorise the interviewees' answers in an analysis matrix. Three sub-categories were distinguished for the category interpersonal teacher behaviour: teachers' verbal behaviour, teachers' non-verbal behaviour, and interpersonal teacher styles. Concerning the reliability of the qualitative analysis, the second author validated the categorisation of the first author by discussing and evaluating the categorisation. For example, if the interviewees' statements concerned feelings of confidence to create positive teacher-student relationships, they were categorised as self-efficacy. The qualitative part of this study was relatively small and there were no points of debate when categorising the statements.

To obtain a deeper understanding about PSTs' professional anxiety and self-efficacy at the pre-test, a hierarchical cluster analysis on the cases was conducted using IBM SPSS Statistics 22, identifying different clusters of PSTs regarding PSTs' professional anxiety and self-efficacy in our dataset. The hierarchical cluster analysis was chosen above discriminant or assignment methods because no classification was known a-priori (Everitt,

Sample item	Number of items	α pre-test	α post-test
I am anxious about possible problems in the class with individual disruptive children.	26	.94	.96
I see myself as an interesting and motivating teacher.	19	.87	.87
I think that as a teacher I will have a pleasant atmosphere in the classroom	24	Dimensions: influence: .68 proximity: .85	Dimensions: influence: .64 proximity: .76

1995). The hierarchical cluster analysis starts with treating all cases as a cluster on its own. Then clusters are merged based on similarity using Euclidean Distance (geometric distance between two cases) (Field, 2017). Because this process is hierarchical, final clusters will depend on the cases that are used as a starting point (Field, 2017). For this reason, we repeated the cluster analysis several times with different cases as starting point. Ward's method was used to include cases into clusters in such a way that the variance within clusters were minimised. To determine if PSTs from different clusters developed their interpersonal behaviour differently, analysis of variances (one-way ANOVAs) were conducted. For this analysis, the cluster-solution was used as an independent variable, the pre-and post-test of the two dimensions agency and communion and the eight sectors of teacher behaviour of the TIC were used as dependent variables.

To determine if the two clusters differed by background variables, an analysis of variance (one-way ANOVA) was conducted. The background variables included teaching domain, age, gender, previous education, previous teaching experience, and the device used for watching the videos (e.g., mobile phone, tablet, laptop). The one-way ANOVA revealed that the clusters did not differ in terms of background variables.

4.5 Results

Preservice teachers' professional anxiety and self-efficacy

For research questions 1 and 2, this study examined the effect of authentic learning experiences using 360-degree videos in combination with theoretical lectures on PSTs' professional anxiety and self-efficacy. Table 4.3 shows negative and statistically significant

differences for PSTs' professional anxiety, and positive and statistically significant differences for PSTs' self-efficacy between the pre-and post-test, with small effect sizes (Cohen, 1988). This indicates that the video-lecture combination contributed to PSTs experiencing a slightly reduced anxiety and gain in their self-efficacy.

Table 4.3

Mean score and standard deviations on PSTs' professional anxiety and self-efficacy

	pre-test		post-test				
	M	*SD*	*M*	*SD*	*t(df)*	*D*	*p*
professional anxiety (*n* = 141)	3.11	0.61	2.92	0.70	3.951*(140)*	0.3	< 0.01
self-efficacy (*n* = 141)	3.77	0.38	3.86	0.36	-2.595*(140)*	0.2	< 0.05

1 = *strongly disagree*, 2 = *disagree*, 3 = *neutral*, 4 = *agree*, 5 = *strongly agree*

The qualitative data revealed that all twelve interviewees agreed that the video-lecture combination was useful in reducing PSTs' professional anxiety. This was because of the exemplary behaviour of experienced teachers in the videos they observed as it made PSTs familiar with the actual teaching practice. As one PST quoted: *'You learn what behaviour you can display in different situations.'* Another PST stated: *'I learned on which aspects in the classroom I have to focus when teaching.'* Furthermore, two PSTs reported that they paid more attention to the non-verbal behaviour of the experienced teachers. This made them more conscious about their own non-verbal behaviour. Finally, one PST reported: *'I have learned that you do not have to be strict to be in control in the classroom.'* This was an important lesson for her.

Although all interviewees experienced authentic learning experiences using a video-lecture combination as a useful method to reduce PSTs' professional anxiety, only seven PSTs reported that the video-lecture combination reduced their own professional anxiety. This was because three of them did not experience anxiety at all before the intervention. The other two stated that they still experience some anxiety, and they hoped their anxiety would be reduced after their actual internships at the internship schools.

After the video-lecture combination, ten interviewees were convinced about their own ability to create positive teacher-student relationships. These ten PSTs attributed their feelings of self-efficacy to the video-lecture combination. Two PSTs still felt somewhat insecure about their own interpersonal behaviour.

Self-perceived interpersonal competence

For research question 3, this study examined the effect of authentic learning experiences using 360-degree videos in combination with theoretical lectures on PSTs' self-perceptions of their anticipated interpersonal behaviour. First, PSTs' self-perceptions on the two dimensions of the TIC (agency and communion) were examined. Second, we took a closer look at PSTs' self-perceptions on the eight sectors of teacher behaviour of the TIC. Table 4.4 shows positive and statistically significant differences for PSTs' self-perceptions regarding the communion dimensions between the pre- and post-test, with a small effect size (Cohen, 1988). No statistically significant differences were found for the agency dimension. This data suggests that after authentic learning experiences, PSTs perceived themselves as teachers with higher levels of communion, which means they think they would have a more warm, positive relationship with their students.

Table 4.4

Mean score and standard deviations on the agency and communion dimension

	pre-test		post-test				
	M	*SD*	*M*	*SD*	*t(df)*	*D*	*p*
agency (*n* = 141)	0.49	0.38	0.52	0.35	-.67*(140)*	0.1	.51
communion (*n* = 141)	0.75	0.47	0.85	0.43	-2.54*(140)*	0.2	.01*

* $p < 0.05$, Z-scores

Table 4.5 shows a positive and statistically significant difference for PSTs' self-perceptions regarding directing teacher behaviour, and negative and statistically significant differences for imposing teacher behaviour between the pre- and post-test, with small effect sizes (Cohen, 1988). No statistically significant differences were found for helpful, understanding, compliant, uncertain, dissatisfied, and confrontational types of teacher behaviour. This is in line with the positive difference on the communion dimension, because imposing teacher behaviour entails less communion than directing teacher behaviour.

Preservice teachers' anxiety and self-efficacy clusters

Regarding research questions 4 and 5, this study examined if PSTs differed in their sense of self-efficacy and feelings of anxiety, and whether PSTs from various clusters developed their professional anxiety, self-efficacy, and self-perceived interpersonal behaviour differently. The cluster analysis resulted in two meaningful clusters of PSTs at the pre-test, differing in professional anxiety and self-efficacy (see Table 4.6). These results indicated that PSTs from cluster 1 scored high on both professional anxiety and self-efficacy at the pre-test. PSTs from cluster 2 scored average on professional anxiety and high on self-efficacy at the pre-test. Because of the hierarchical process of cluster analysis (Field, 2017), the cluster analysis

was repeated several times with different cases as starting point. This led to comparable cluster solutions. Beside the two-cluster solution, various cluster solutions were explored. However, no other interpretable cluster solutions were found. Additional clustering led to new clusters containing only small numbers of student teachers (e.g., containing four PSTs), with otherwise minimal differences compared to the two-cluster solution.

Table 4.5
Mean score and standard deviations on the eight types of teacher behaviour

	pre-test		post-test				
	M	*SD*	*M*	*SD*	*t(df)*	*d*	*p*
directing (*n* = 141)	0.70	0.33	0.74	0.11	-2.99*(140)*	0.3	.00*
helpful (*n* = 141)	0.80	0.14	0.81	0.11	-3.82(140)	0.0	.70
understanding (*n* = 141)	0.71	0.14	0.73	0.12	-1.46(140)	0.1	.15
compliant (*n* = 141)	0.42	0.16	0.42	0.18	0.29(140)	0.0	.78
uncertain (*n* = 141)	0.26	0.18	0.23	0.16	1.67(140)	0.1	.10
dissatisfied (*n* = 141)	0.23	0.17	0.23	0.17	0.00(140)	0.0	1.00
confrontational (*n* = 141)	0.37	0.15	0.36	0.15	0.72(140)	0.1	.47
imposing *(n* = 141)	0.43	0.15	0.39	0.16	2.22*(140)*	0.2	.03**

* $p < 0.01$, ** $p < 0.05$, Z-scores

Table 4.6
Clusters and mean scores on professional anxiety and self-efficacy at the pre-test

	cluster 1 (n = 69)		*cluster 2 (n = 72)*	
	M	*SD*	*M*	*SD*
professional anxiety pre-test	3.57	0.37	2.67	0.44
self-efficacy pre-test	3.60	0.37	3.95	0.31

n = 141; Cluster analysis: Ward's method, Squared Euclidian distances
1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

The qualitative data revealed that all PSTs from cluster 1 indeed experienced high feelings of professional anxiety and self-efficacy at the same time. As one PST stated: *'Although my anxiety is reduced, I recognise feelings of anxiety. You do not know how the students are doing and how your lesson is going to be.'* Two PSTs reported that their feelings of anxiety were mostly related to classroom management issues; how to be in control during the lesson. Another PST reported he even had physical reactions regarding his anxiety: *'After every lesson, I could put on a new t-shirt because of my sweating.'* Concerning PSTs'

self-efficacy of cluster 1, two of the five interviewees reported that they, contrary to the quantitative data, were a little bit insecure to teach. This insecurity was mainly about their own teaching skills. As one PST put it: *'It is mainly in teaching, I am concerned about that.'* With respect to PSTs from cluster 2, the qualitative data confirmed that all seven interviewees had average feelings of anxiety and experienced high self-efficacy. For example, one PST reported: *'I do not feel anxiety at all. […] I have many good experiences in building relationships.'*

To determine how the two clusters influenced PSTs' professional anxiety, self-efficacy, and development of interpersonal behaviour after authentic learning experiences using a video-lecture combination an analysis of variance (one-way ANOVA) was conducted. For professional anxiety, the one-way ANOVA revealed that PTSs from both clusters differed statistically significant at the post-test ($F(1,140) = 45.014$, $p < .01$). PSTs from both clusters experienced less anxiety after the video-lecture combination, for PSTs from cluster 1 the reduction of anxiety was the largest. A statistically significant difference was found between the two clusters for self-efficacy at the post-test ($F(1,140) = 8.743$, $p < .01$). PSTs from cluster 1 gained self-efficacy after the video-lecture combination, whereas self-efficacy of PSTs from cluster 2 stayed almost the same as at the pre-test. Noteworthy is that six of the seven interviewees from cluster 2 experienced that their self-efficacy positively changed after the intervention because of the exemplary behaviour they saw on the videos. For example, one PST stated: *'It did contribute to my feelings of being certain. You have more experience, that is always good.'*

Regarding PSTs' interpersonal behaviour, the two clusters differed statistically significant at the pre-test for the dimension agency ($F(1,140) = 8.023$, $p < .01$). PSTs from cluster 1 perceived themselves low on agency, PSTs from cluster 2 estimated their agency between average and high. At the post-test, no statistically significant differences between PSTs from the two clusters were found. Furthermore, PSTs from both clusters differed statistically significantly for two types of teacher behaviour: dissatisfied ($F(1,140) = 4.241$, $p < .05$) and imposing ($F(1,140) = 5.226$, $p < .05$). PSTs from cluster 1 perceived themselves after the video-lecture combination as less dissatisfied and more imposing. For PSTs from cluster 2 this was the other way around; more dissatisfied and less imposing.

4.6 Conclusion and discussion

The aim of the current study was to examine if PSTs' professional anxiety decreased and PSTs' self-efficacy increased by developing their interpersonal behaviour through exposing them to authentic learning experiences using 360-degree videos in combination with theoretical lectures. This study assumed a relation between PSTs' professional anxiety, self-

efficacy, and PSTs' interpersonal behaviour based on previous research (e.g., McCarthy et al., 2015; Friedman, 2003; Chang, 2009; Brouwers & Tomic, 2000). Less developed interpersonal behaviour could lead to professional anxiety, while positive classroom management and interpersonal behaviour experiences could lead to PSTs with higher feelings of self-efficacy. Authentic learning experiences in this study, using a video-lecture combination, focused on teachers' interpersonal behaviour providing PSTs with exemplary interpersonal teacher behaviour. It was expected that if the authentic learning experiences contributed positively to a reduction in PSTs' anxiety, PSTs' self-efficacy would increase. Although PSTs professional anxiety, self-efficacy, and self-perceived interpersonal behaviour were examined separately, conclusions drawn in this study should be seen in the light of the assumed connections between these concepts.

With respect to research questions 1 and 2, this study found that PSTs' professional anxiety decreased, and PSTs' self-efficacy increased statistically significantly after being exposed to authentic learning experiences using a video-lecture combination. Data from the interviews revealed that the reduction of PSTs' professional anxiety and their increased self-efficacy was mainly because of the exemplary behaviour of experienced teachers in the 360-degree videos. It helped PSTs becoming familiar with the actual teaching practice. The presumed relation between PSTs' professional anxiety and self-efficacy was confirmed in the current study and supported Brouwers and Tomic (2000), who found that successful classroom management experiences increase PSTs' self-efficacy. Consequently, higher self-efficacy leads to less anxiety (McCarthy et al., 2015).

Concerning research question 3 our results showed that PSTs perceived themselves as teachers with higher anticipated levels of communion after authentic learning experiences using a video-lecture combination. Although the cluster analysis showed PSTs differed in their perceived agency at the pre-test, no significant differences were found for the agency dimension between the pre- and post-test, implying that watching videos of experienced teachers was not useful to influence PSTs' self-perceived agency. The reason for this could be that the PSTs perceived themselves already relatively high on the agency dimension before the intervention. Regarding the eight sectors of teacher behaviour of the TIC, only positive differences were found on PSTs' self-perceptions for directing teacher behaviour, and negative differences for imposing teacher behaviour. This led to teacher behaviour that combines relatively high communion and agency. It is possible that PSTs perceived their own anticipated teacher behaviour as more directing and less imposing because they have learned in the video-lecture combination that students appreciate the class climate with this teacher behaviour (Wubbels et al., 2006). Previous research also showed that experienced teachers display behaviour that scores higher on the communion dimension than PSTs (Brekelmans, Wubbels, & van Tartwijk, 2005). Because PSTs observed experienced

teachers in the video-lecture combination, and the 360-degree videos of the current study contained exemplary teacher behaviour combining high levels of communion and agency, it is possible that PSTs perceived teacher behaviour characterised by combining high communion and agency on the TIC as ideal teacher behaviour.

The current study indicated that successful classroom management experiences could be accomplished in authentic learning experiences to simulate a realistic context using 360-degree videos and virtual reality headsets. After authentic learning experiences PSTs characterised their own interpersonal behaviour with higher dimensions of communion, meaning more directing and less imposing teacher behaviour. This implies that these experiences help PSTs to form self-perceived interpersonal behaviour that is in line with interpersonal teacher behaviour that students perceive as 'ideal'. The attention given to interpersonal teacher behaviour in the video-lecture combination also seemed to influence PSTs' professional anxiety and self-efficacy. PSTs became more confident with their own abilities to manage classrooms from an interpersonal perspective and felt less anxious. As difficulties with classroom management issues are among the main reasons for PSTs to leave (teacher) education (Evertson & Weinstein, 2006), it is important that teacher education institutes invest in classroom management competence including interpersonal behaviour. McCarthy and colleagues (2015) stress the importance of a preventive approach as used in the current study for teacher education institutes to prepare PSTs for stressful moments in the actual classroom and with this, prevent burnouts and dropout. In conclusion, authentic learning experiences using 360-degree videos containing experienced teachers showing interpersonal teacher behaviour in classroom events, combined with theoretical lectures about interpersonal behaviour are useful for teacher education institutes to prepare PSTs for the actual teaching practice. With this approach PSTs develop a better image of their own ideal interpersonal teacher behaviour. Even more important, PSTs experience less anxiety for the actual teaching practice and will enter this teaching practice with more self-efficacy. Because of the differences between PSTs in their sense of self-efficacy (Friedman, 2003) and feelings of anxiety (Sutton et al., 2009), this study also investigated if different clusters of PSTs could be distinguished regarding PSTs' self-efficacy and professional anxiety. Consequently, it was examined whether PSTs from different clusters differed in their professional anxiety, self-efficacy, and self-perceptions of their interpersonal behaviour after the intervention. Regarding research questions 4 and 5, there were assumed to be four clusters of PSTs differing in their professional anxiety and self-efficacy at the pre-test (see Table 4.1). However, only two meaningful clusters of PSTs could be distinguished. PSTs from cluster 1 scored both high on professional anxiety and self-efficacy. This was quite a remarkable result for PSTs from cluster 1, because literature suggests that, in general, PSTs with high feelings of professional anxiety have a lower self-efficacy (e.g., Brouwers & Tomic, 2000; McCarthy et

al., 2015; Friedman, 2003). This indicated that many first year PSTs, with little or no teaching experience, were feeling anxious when they thought about managing a classroom. At the same time, they were also confident that they could handle classroom management issues. PSTs from cluster 2 scored average on professional anxiety and high on self-efficacy.

A closer look at the effect authentic learning experiences using a video-lecture combination had on these two clusters of PSTs' professional anxiety and self-efficacy, it was revealed that PSTs from both clusters experienced reduced anxiety. However, this reduction differed statistically significant between clusters, with the largest decrease for PSTs from cluster 1. Furthermore, PSTs from cluster 1 gained in their self-efficacy while the self-efficacy of clusters evolved to the normal pattern where self-efficacy is a counterpart of professional anxiety. In other words, the video-lecture combination enables PSTs to have a more realistic understanding and appraisal of themselves. Finally, it is noteworthy that PSTs from both clusters differed statistically significant on the dissatisfied and imposing teacher behaviour. After authentic learning experiences PSTs from cluster 1 perceived themselves as less dissatisfied and more imposing, which was opposite to PSTs from cluster 2. Imposing teacher behaviour is characterised by teachers being in the lead and cooperative (Wubbels & Brekelmans, 2005). That PSTs from cluster 1 scored perceived themselves as more dissatisfied is in line with their gain in self-efficacy. Having confidence in your own abilities to handle classroom management issues makes teachers feel more in control to take the lead in their classroom. The reason why PSTs from cluster 2 perceived themselves as more dissatisfied and less imposing is not as clear. These results indicate that PSTs from cluster 2 perceived themselves lower on agency. Before the video-lecture combination they perceived themselves relatively high on agency. Possibly, their self-perceptions became more realistic after the video-lecture combination. The cluster analysis provided interesting insights into the relation between PSTs' professional anxiety and self-efficacy for PSTs with no or little teaching experience. Almost half of the PSTs experienced anxiety before the intervention, but at the same time they had high self-efficacy and believed in their own abilities to influence student behaviour. For teacher education institutes it is valuable to know that PSTs' professional anxiety and self-efficacy evolved in a normal pattern because of the video-lecture combination. Furthermore, this study showed that authentic learning experiences are useful for all PSTs to reduce professional anxiety and increase self-efficacy, however PSTs with high levels of anxiety and self-efficacy profit the most from the video-lecture combination.

The current study did not include students' perceptions of PSTs' interpersonal behaviour. For this study PSTs' self-perceptions about their own expected teacher behaviour were used. The question is whether PSTs have an accurate perception of their own interpersonal behaviour, since they lack teaching experience and because students have a different

perception of teacher behaviour. Previous research (Brekelmans et al., 2011) has shown that teachers tend to overestimate their own behaviour on the communion and agency dimension. Further research could provide more insights in whether the video-lecture combination also influences PSTs' interpersonal competence as perceived by students in the classroom.

In conclusion, the current study investigated authentic learning experiences using a combination of theoretical lectures and 360-degree videos watched with a virtual reality-headset about expert interpersonal teacher behaviour in order to reduce PSTs' professional anxiety and increase their self-efficacy. This study showed that these experiences may be an asset for teacher education institutes to smoothen the transition from the teacher education institute to the actual teaching practice, decreasing the practice shock, by reducing PSTs' professional anxiety and increasing their self-efficacy with behalf of exemplary teacher behaviour. Furthermore, PSTs perceptions of their own interpersonal behaviour tended towards more to 'ideal' interpersonal teacher behaviour after authentic learning experiences.

Chapter 5

Using 360-degree videos in teacher education to improve preservice teachers' professional interpersonal vision

This chapter was published in adapted form as:
Theelen, H., van den Beemt, A., & den Brok, P. (2019). Using 360-degree videos in teacher education to improve teachers' professional interpersonal vision. *Journal of Computer Assisted Learning, 35*(5), 582-594.
doi:10.1111/jcal.12361

Abstract

Noticing and interpreting classroom events (professional vision) is an important element of preservice teachers' (PSTs) interpersonal competence. This paper presents a mixed-method study about a classroom simulation using 360-degree videos combined with theoretical lectures in teacher education, intended to improve PSTs' interpretations of noticed events. Furthermore, this study examined how PSTs evaluate technological and educational affordances of 360-degree videos. Results indicate that participating PSTs improved in noticing classroom events and in applying a more theory-based terminology to describe these events. PSTs perceived observing other teachers teach as an educational affordance for mastering theory and for developing insights about interpersonal teacher behaviour. Concerning technological affordances, mainly physical discomforts and technical hindrances, was reported by PSTs. The results of this study imply that 360-degree videos can be useful for teacher education to improve PSTs' interpretation of noticed events.

5.1 Introduction

Preservice teachers (PSTs) need the ability to create positive teacher–student relationships to improve student achievement and attitudes (den Brok et al., 2004). Positive teacher–student relationships also contribute to PSTs' well-being (Wubbels et al., 2015). PSTs' actions to create positive teacher–student relationships are referred to as PSTs' *interpersonal competence* (Wubbels et al., 2015). Managing a positive relationship is a major concern for PSTs (Pillen et al., 2013), and an important reason for leaving the teaching profession (Evertson & Weinstein, 2006). Training interpersonal competence mainly takes place in the classroom during internships (Brekelmans, 2010) but can also be practiced in teacher education using *computer-based classroom simulations* (e.g., Dalgarno, Gregory, Knox, & Reiners, 2016; Rayner & Fluck, 2014). One way of simulating is using 360-degree videos of actual classes in order to familiarize PSTs with the professional teaching context (Beck, King, & Marshall, 2002).

This paper presents a mixed-method study about the use of 360- degree videos as an example of computer-based classroom simulations in teacher education to improve PSTs' professional interpersonal vision, and specifically the interpretations of noticed events. Interpersonal vision is an aspect of PSTs' interpersonal competence (see Section 1.1). Furthermore, this study examines how 360-degree videos are evaluated by PSTs in terms of technological and educational affordances. In the introduction of this paper, we first operationalize the concept of professional interpersonal vision as part of PSTs' interpersonal competence. Second, we describe the use of 360-degree videos and virtual reality. Lastly, the importance of affordances of ICT will be explained.

5.2 Theoretical background

Preservice teachers' professional interpersonal vision

Classroom management is a major concern for PSTs (e.g., Friedman, 1995; Pillen et al., 2013) and can be one of the main reasons for PSTs to stop teaching (Evertson & Weinstein, 2006). Examples of PSTs' concerns include managing unmotivated students (Alontaga & Durban, 2013), or students' off and on task behaviour (Admiraal et al., 1996). One of the goals of classroom management is to create positive teacher–student relationships (Stough & Montague, 2015). Teachers' actions to create a positive learning environment via teacher–student relationships and the meaning both students and teachers give to their relationships in the classroom are also known as teachers' interpersonal competence (Wubbels et al., 2015). Noticing and interpreting what occurs in a classroom is an important skill for classroom management in general (van Es & Sherin, 2002) and can be considered

as an important element of PSTs' interpersonal competence. In this study, we refer to the combination of noticing and interpreting classroom events from an interpersonal perspective as PSTs' professional interpersonal vision. This study utilizes conceptually an adapted version of the "Learning to Notice Framework (van Es & Sherin, 2002), in which PSTs professional interpersonal vision consists of three key aspects, as visualized in Figure 5.1.

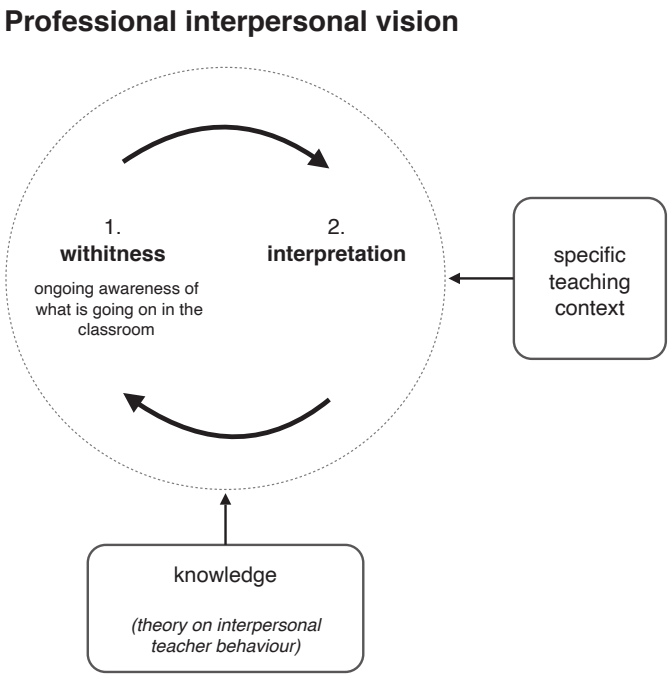

Figure 5.1 Aspects of professional interpersonal vision and their underlying relations

First, PSTs have to be aware of relevant interpersonal classroom events and maintain an ongoing awareness of what occurs in a classroom (Kounin, 1970 as cited in Wolff, 2015). Previous research has shown that experienced teachers, in contrast to PSTs, are continuously scanning the classroom, which gives them the opportunity to notice relevant classroom events at an early stage (van den Bogert, 2016). This also gives experienced teachers the opportunity to intervene before events escalate. Furthermore, it is suggested that experienced teachers have a better overview of the classroom, which allows them to not only notice disruptive students but also to be aware of other students who are influenced by this disruption (van den Bogert, 2016).

Second, to make sense of a noticed interpersonal classroom event, PSTs need to interpret

a noticed event, which in turn requires knowledge (van Es & Sherin, 2002). In other words, PSTs have to apply theory on interpersonal teacher behaviour to their observations. For example, when an experienced teacher notices a disruptive student, (s)he likely knows from interpersonal behaviour theory that teacher dominance evokes submissive student behaviour (Wubbels et al., 2006). Previous research has shown that experienced teachers mostly use theoretical teaching and learning principles when they interpret noticed classroom events, whereas PSTs mainly use literal descriptions to interpret an event (Copeland, Birmingham, DeMeulle, D'Emidio-Caston, & Natal, 1994; van Es & Sherin, 2002).

Third, noticing relevant classroom events takes place in a specific teaching context. For example, a history teacher makes more sense of events in a history lesson than a biology teacher (van Es & Sherin, 2002).

Van Es and Sherin (2002) suggest that when interpretations of noticed events are on a higher level in the Learning to Notice Framework, this allows PSTs to use more theory for their interpretations and be less judgmental, as well as, to also learn to notice and discriminate relevant classroom events. Therefore, we argue there is an ongoing interaction between noticed classroom events and interpretations. When PSTs notice and interpret a relevant classroom event, they can use their interpretations to inform pedagogical decisions (van Es & Sherin, 2002).

Computer-based classroom simulations

Computer-based classroom simulations can be used to enable PSTs to become more aware of relevant classroom events (Dalgarno et al., 2016; Ferry et al., 2005). However, awareness is only one aspect of professional interpersonal vision. It is yet to be determined whether computer-based classroom simulations can stimulate PSTs' application and retrieval of knowledge for interpretations of noticed classroom events as part of their professional interpersonal vision (Theelen et al., 2019a, see chapter 3). Computer-based classroom simulations provide representations of real classroom events in which PSTs and teacher educators have control over content, training structure, and timing of classroom events (Clark & Mayer, 2011). Using classroom simulations, PSTs can learn safely from performing tasks in an authentic learning environment (Rayner & Fluck, 2014). These authentic tasks offer PSTs real-life experiences before entering a real classroom (Herrington & Oliver, 2000). Therefore, we argue that classroom simulations can ease the transition from teacher education to professional teaching contexts.

One type of content in simulations is video, which can provide PSTs with real-life authentic cases (Beck et al., 2002). Compared with traditional assignments in teacher education, videos can capture the richness and complexity of classrooms and appear to be useful in bridging the gap between teacher education and the professional teaching context (Gomez

et al., 2008). Previous studies have reported the usefulness of videos in teacher education to prepare PSTs for the professional teaching context (e.g., Asan, 2003; Blomberg, Sherin, Renkl, Glogger, & Seidel, 2014; Santagata & Guarino, 2011).

PSTs can use videos to reflect on their own teacher behaviour, using for example the video-stimulated recall method (e.g., Muir, 2010; Pirie, 1996; Powell, 2005). In this method, PSTs watch videotaped passages of their own lessons to reflect on a dialogue between the PST and a researcher. These dialogues are focused on thinking about aspects of the teaching practice (Powell, 2005), which provides opportunities to relive the classroom event and to verbalize the original thought processes in retrospect (Pirie, 1996).

Besides being used as a reflective tool, videos also appear useful for watching other teachers teach (Star & Strickland, 2008). Videos provide illustrations of teaching and learning theories and provide PSTs the opportunity to watch videos together and discuss their observations (Star & Strickland, 2008). By watching videos, PSTs can learn from examples of different teachers, students, settings, and pedagogies (Star & Strickland, 2008). This way, PSTs can reflect on classroom interactions and learn about teacher behaviour (Sherin & van Es, 2005). Videos appear to be useful to notice, analyse, and reason teacher and student behaviour (Santagata & Guarino, 2011).

Regarding PSTs' professional vision, watching and discussing videos can influence which classroom events PSTs notice and how PSTs discuss these classroom events over time (Sherin & van Es, 2005). For example, in one study (Sherin & van Es, 2005) PSTs focused at the beginning of the study on every classroom event they noticed. Later on, they only focused on classroom events that were relevant to react on. Furthermore, PSTs' discussions became more interpretative instead of evaluative. Likewise, Star and Strickland (2008) found that PSTs significantly improved their ability to notice important classroom events. These PSTs specifically noticed classroom management events while watching videos, which is not surprising because problems related to classroom management are one of the most pressing concerns for PSTs (Pillen et al., 2013) and consequently attract PSTs attention.

360-Degree videos

Recent technological developments enable video simulations to be enriched using 360-degree cameras (Aguayo et al., 2017). 360-degree cameras are becoming more affordable (Aguayo et al., 2017), and mobile devices (e.g., smartphone and tablet) have become powerful enough to play 360-degree videos (Martín-Gutiérrez et al., 2016). We argue that 360-degree videos are more useful in teacher education than traditional video for watching experienced teachers teach, because 360-degree videos enable PSTs to

continuously choose their own perspective when observing classroom interactions rather than viewing from a fixed perspective, which can help PSTs to understand classroom dynamics. Studies in other domains that compared 360-degree videos with traditional videos showed promising results in favour of 360-degree videos (e.g., Schöne, Wessels, & Gruber, 2017; Yoganathan, Finch, Parkin, & Pollard, 2018). Participants in the study of Schöne et al. (2017) watched either a 360-degree video with virtual reality (VR) or a traditional video of a motorcycle ride, followed by an unannounced recognition memory task 2 days later. VR-group participants experienced the video as more realistic and performed better in the memory task. Similarly, in the domain of surgery, doctors in the 360-degree VR condition outperformed doctors in the traditional video condition when learning surgical knot tying skills (Yoganathan et al., 2018). PSTs can watch 360-degree videos with VR headsets (Figure 5.2).

Figure 5.2 VR headset

VR headsets are becoming reasonably priced (Martín-Gutiérrez et al., 2016; Olmos et al., 2018), and online platforms such as YouTube make it possible to share 360-degree videos (Aguayo et al., 2017). Real-life classroom events can be displayed via VR and provide learners sensory and imaginary experiences similar to real-life experiences (Yoh, 2001). Watching 360-degree videos with VR headsets appear to be more attractive to learners because of the immersive user experience (Martín-Gutiérrez et al., 2016), which disconnects the user from (distracting factors of) the "real world" (Olmos-Raya et al., 2018). VR gives a feeling of presence (Yoh, 2001) and a sense of embodiment (Kilteni, Groten, & Slater, 2012) in a virtual environment. This way, the user is involved in a realistic and authentic situation

without being physically present (Martín-Gutiérrez et al., 2016). VR experiences can help bridge the gap between theory and actual teaching practice (Dede, 2009).

Information and communication technology affordances

When using technology to design simulations, information and communication technology (ICT) affordances play an important role. ICT affordances in the context of this study can be defined as the perceived and actual properties of technology that determine how the simulation possibly could be used (Salomon, 1993, as cited in Conole & Dyke, 2004). For example, simulations can provide an immersive experience (feeling of being present in an authentic situation) when watching 360-degree videos with a VR headset. Three types of affordances can be distinguished: technological, which relate to the technology itself; social, which offer opportunities for interaction; and educational, which determine how learning takes place (Kirschner et al., 2004). When designing and evaluating simulations using advanced technology, it is important to take all types of affordances into account. However, the 360-degree videos do not provide opportunities for interaction, which excludes evaluation of social affordances in this study. Our focus lies, therefore, on the remaining technological and educational affordances, both of which are distinctly relevant because the technology is new and the effect on both affordances are not or only minimally researched.

Aim and research questions

We are interested to see if PSTs' interpretations of noticed events as representations of their interpersonal knowledge, the second key aspect of professional vision, can be improved using a virtual classroom. A virtual classroom is defined in the present study as a computer-based classroom simulation containing videos.

The main research question of our study is: *How can the virtual classroom improve PSTs' level of interpretation of noticed classroom events as part of their professional interpersonal vision?* Because ICT affordances are important when evaluating 360-degree videos, we are also interested in how the videos are evaluated by PSTs in terms of technological and educational affordances. This leads to a second research question: *How is the virtual classroom evaluated by PSTs in terms of technological and educational affordances?*

5.3 Design of the Virtual Classroom

Three 2-hr sessions were created to combine theoretical lectures via a regular setting and watching 360-degree videos, which provides an addition to the regular teacher education setting. The combination of watching videos and theoretical lectures was made because it was found for simulation games that if these simulations were embedded in a program

of instruction, learners had higher knowledge levels than learners involved in simulation game without additional instruction (Sitzmann, 2011). The composition of the three sessions was adapted from the Learning to Notice Framework (see Figure 5.1). Before watching a 360-degree video, PSTs received a theoretical lecture about interpersonal teacher behaviour, which guided the PSTs on how to watch 360-degree videos. These theoretical lectures included the systems approach to communication (Watzlawick et al., 1967; Wubbels et al., 2006), the Teacher Interpersonal Circle (den Brok & van Tartwijk, 2015; Wubbels et al., 2006), and teachers' verbal and non-verbal behaviour (van Tartwijk, 1993). Guided 360-degree video watching of the entire class was conducted to encourage PSTs to observe systematically, to make PSTs aware of relevant classroom events and to activate their knowledge about interpersonal teacher behaviour. After watching a 360-degree video, PSTs discussed their interpretations of observed classroom events first in small groups, and later on with the entire class. These discussions provide PSTs with the opportunity to learn from examples of different teachers, students, settings, and pedagogies (Star & Strickland, 2008), to reflect on classroom interactions (Sherin & van Es, 2005), and to analyse and reason about teacher and student behaviour (Santagata & Guarino, 2011).

During three sessions, PSTs watched fifteen 360-degree video fragments of 10 experienced teachers in secondary education, using YouTube on their mobile phones in a VR headset. The videos each contained one or more of the following classroom events, which are important for the teacher–student relationship: (a) the beginning of a lesson, (b) a moment of instruction, (c) stimulating students to work, (d) disruptive behaviour, (e) comments of students, (f) disappointed students' performances, (g) questions or feedback from students, and (h) the transition between two different phases of the lesson (e.g., from instruction to work independently on the teaching materials; Admiraal, 1994; Admiraal et al., 1996; Wubbels et al., 2006). The length of videos varied from 47 seconds to 4 minutes and 48 seconds, with an average time of 3 minutes and 8 seconds.

5.4 Method

Participants

Participants included 141 first year PSTs of a teacher education program in the Netherlands (81♀) aged between 16 and 28 years old, with little or no teaching experience. This teacher education program prepares PSTs for the secondary education context and is representative for teacher education institutes in the Netherlands. These PSTs were from eight different domains (Table 5.1). For the intervention, they were divided into nine classes. This distribution was made based on group sizes and class schedules. The domain of English was divided into three separate classes, History was divided into two separate

classes, Dutch language and Physics were combined into one group, and Geography and Economy were combined into another group. The first author taught all groups. This study followed the research guidelines for social scientific studies from the Association of Universities in the Netherlands (2018). PSTs participated voluntarily in this study and gave their informed consent.

Table 5.1
Number of preservice teachers per domain

	number of PSTs
History	22; 3♀
Geography	10; 5♀
Economy	8; 3♀
Dutch language	17; 16♀
German language	12; 7♀
English language	47; 34♀
Mathematics	19; 13♀
Physics	6; 0♀

Procedure

This study used a mixed-method design with a pre-test, an intervention (the virtual classroom), and a post-test. The virtual classroom is a situation-based short-term classroom simulation using 360-degree videos. Because little is known about the effect of 360-degree videos in teacher education, in our study traditional videos are used before and after the simulation as pre-test and post-test to establish the level of interpretations of events. For the pre-test and post-test, the method of tagging video fragments (see Section 3.3) was used (van den Bogert, 2016) to measure the interpretation of noticed events.

After the pre-test, PSTs participated in three 2-hr sessions as described in Section 2. During the intervention, no data were collected.

For the post-test, the method of tagging was used again. Furthermore, to gather insights in PSTs' perceived affordances of the virtual classroom, a questionnaire with six closed-ended questions and three open-ended questions was conducted and analysed.

To obtain more insight in the manner in which PSTs tagged the video fragments and PSTs' experiences with the virtual classroom, semi structured individual interviews were conducted after the virtual classroom (n = 12; 7♀). Respondents were selected with convenience sampling, and their number met the minimal requirement for theoretical

saturation (Guest et al., 2006). PSTs from all teaching disciplines were involved in the interviews, which were audio recorded. The next sections describe the instruments in detail.

Tags

During the pre-test and post-test, PSTs tagged three video fragments of secondary education teachers (teacher-1, teacher-2, and teacher-3) from the video database Didiclass (Firssova, 2009). The length of these video fragments varied from 3 minutes and 8 seconds to 4 minutes and 12 seconds. These video fragments consisted of authentic classroom situations showing teachers struggling with their interpersonal teacher behaviour (e.g., disruptive students and a teacher with a lack of influence). For a description of the three video fragments, see Appendix B. After watching a video fragment, PSTs were asked to note three to five aspects related to the teacher–student relationship they considered to be important.

ICT affordances

Six closed questions were analysed to gather insights in PSTs' perceived affordances. The first five questions asked PSTs to rate the virtual classroom on the (a) quality of the content, (b) coherence between meetings, (c) added value of to the curriculum, (d) contribution to their teaching skills, and (e) technological aspects of the VR headset using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Because not all mobile phones were equipped with a gyroscope necessary for watching videos in 360-degrees and watching videos with a VR headset can cause nausea (Olmos et al., 2018), the sixth question asked about the device PSTs used to watch the videos fragments: (a) mobile phone in a VR headset, (b) mobile phone without VR headset, (c) laptop, (d) tablet, or (e) both mobile phone with and without a VR headset as well. With this information, it could be investigated if device use influenced the level of tagging (see Section 3.6).

Furthermore, three open-ended questions were used in which PSTs were asked to describe (a) what they liked and (b) disliked about the virtual classroom and (c) what they learned from the activities in the virtual classroom.

Interviews

The interviews consisted of two questions (see Appendix C) about PSTs' professional interpersonal vision. The first question was adapted from Wolff (2015): "Can you describe what you saw and how that is relevant to interpersonal teacher behaviour?" The second question asked if PSTs could distinguish differences between their tags of the pre-test and post-test.

Furthermore, the interviews consisted of six questions (see Appendix C) related to PSTs experiences with the virtual classroom. These questions were used to deepen the quantitative data about the topics of the six close-ended questions, as reported in Section 3.3. For example, *"What are your experiences with technical aspects of your mobile phone in the VR headset? Which parts worked well? Which parts didn't? How can this be improved?"*

Data analysis

Regarding professional vision, tags PSTs used to describe relevant interpersonal teacher behaviour when watching videos were first coded into four levels: (a) descriptive tags containing information about observable classroom events, (b) evaluation tags containing positive or negative appraisals about observations, (c) analytic tags containing information about underlying teaching and learning principles, and (d) prescriptive tags describing alternatives for teacher action (van den Bogert, 2016). van den Bogert (2016) based these codes on the Learning to Notice Framework of van Es and Sherin (2002). The first author (Assessor 1) and a teacher educator (Assessor 2) coded a sample survey of tags from 47 PSTs (total number was pre-test 490 tags and post-test 544 tags) to establish the interrater reliability by calculating the linear weighted Cohen's Kappa. This resulted in a value of 0.67 for the pre-test and 0.61 for the post-test. After consultation, two systematic errors were identified. First, tags related to teachers' non-verbal behaviour were coded by Assessor 1 as analytic tags and by Assessor 2 as evaluation tags. The assessors decided to code these as analytic tags, because literature distinguishes non-verbal behaviour as an important part of interpersonal teacher behaviour (van Tartwijk, 1993). Second, Assessor 2 coded some tags with judgmental terminology (e.g., much, negative, and nice), as a descriptive tag. The assessors decided that tags with judgmental terminology had to be coded as evaluation tags because objective descriptions (Level 1) are free from judgements. After correcting the systematic errors, interrater reliability was established again, which resulted in a value of 0.96 for the pre-test and 0.94 for the post-test.

Questionnaire data were entered in a database and were analysed with IBM SPSS Statistics 22. Regarding the tags, results of the pre-test and post-test were compared using a paired samples *t*-test. Descriptive statistics regarding the educational affordances and used devices were calculated for the six close-ended questions. A one-way analysis of variance (ANOVA) was used to determine if the variable "device" influenced the level of tagging for professional interpersonal vision.

With respect to the analysis of qualitative data, sensitizing concepts (Charmaz, 2006) were derived from the theoretical background and used to categorize answers from interviews, focusing group interviews and open-ended questions in an analysis matrix. The starting concepts were technical and educational affordances. The categorization was validated by

the first author and a teacher educator, by discussing and evaluating the categorization. To increase the reliability of this qualitative analysis, the first author and the teacher educator collaborated closely in the process. Points of debate and uncertainty were discussed until consensus was reached.

5.5 Results

Professional interpersonal vision

The first research question of this study was: How can the virtual classroom improve PSTs' level of interpretation of noticed classroom events as part of their professional interpersonal vision? To answer this question, tags, questionnaires, and interviews were used.

Table 5.2
Mean score and standard deviations of the level of interpretation on the tags

	pre-test		post-test				
tags	*M*	*SD*	*M*	*SD*	*t(df)*	*d*	*p*
total (*n* = 140)	1.95	0.26	2.31	0.39	-10.368*(139)*	0.8	<0.01
fragment 1 (*n* = 141)	1.88	0.38	2.34	0.46	-10.092*(140)*	0.8	<0.01
fragment 2 (*n* = 141)	1.83	0.36	2.21	0.44	-8.335*(140)*	0.7	<0.01
fragment 3 (*n* = 140)	2.13	0.37	2.39	0.46	-6.028*(139)*	0.5	<0.01

Table 5.2 shows statistically significant differences between the pre-test and post-test on PSTs' interpretations for both the individual fragments and the total of all tags (Fragments 1, 2, 3, and all fragments together), which means that after the virtual classroom PSTs interpreted the video fragments on a higher level on the Learning to Notice Framework (e.g., *"The teachers scored low on the communion dimension', 'The teacher had a closed posture"*). This implies that PSTs likely used more knowledge about teaching and learning principles for their interpretations. Table 5.2 shows medium up to large effect sizes between 0.5 and 0.8 (Cohen, 1988).

To validate the quantitative data related to PSTs' professional interpersonal vision, qualitative data were used to gather more insights in which classroom events attracts PSTs' attention when watching a video. PSTs (*n* = 12) were asked during the semi structured interviews to answer the following question for each video fragment of the post-test: *"Can you describe what you saw and how that is relevant to interpersonal teacher behaviour?"*

Fragment 1: All PSTs used Teacher Interpersonal Circle theory to report that there was less warmth in the teacher–student relationship, and for this, PSTs used words such as imposing, objecting, or non-directing. As a consequence, two PSTs stated that the relationship of the teacher in the video (teacher-1, teacher of German language) with her students was poor. Six of the 12 PSTs used non-verbal behaviour theory: Two PSTs had the opinion that her gestures came on too strong (e.g., pointing at a student), two PSTs felt that teacher-1 showed a closed posture, and three PSTs considered her tone of voice too loud and strict. Regarding the system approach theory, seven PSTs reported that teacher-1 showed a lack of authority over her students: There was a lot of noise in the classroom, students had no respect for teacher-1, it took too much time to acquire silence, rules and consequences were unclear, and students were not allowed to ask questions. However, one PST stated that teacher-1 showed enough control and another PST viewed directing students individually as a positive aspect. Two PSTs gave suggestions for alternative teacher behaviour: For teacher–student relationships, it is important to start the lesson with a friendly attitude. And to gain a positive relationship with students, it would be better if the teacher moved around the classroom instead of being in front of the classroom for the entire time.

Fragment 2: For this fragment, PSTs reported different interpretations of the teachers' behaviour (teacher-2, geography teacher). Using Teacher Interpersonal Circle and non-verbal behaviour theories, five of the 12 PSTs situated teacher-2 with a high level of communion (supporting and understanding), whereas on the other hand two PSTs thought he was sometimes hesitating, objecting, too confronting, and missing agency. This is in contrast to the opinion of one PST, who thought teacher-2 had quite a lot of authority. Three respondents confirmed this and argued that teacher-2 was in control (e.g., he gave consequences, gave warnings, used a punishment, utilized clear rules, and made eye contact), whereas seven respondents felt that teacher-2 was out of control (e.g., he gave too many warnings, students continued talking, and used bad language). One PST concluded: *"Teacher-2 had a good relationship with his students in general, but not with all students."*

Fragment 3: Interpretations of teacher-3's behaviour (history teacher) varied among PSTs, and even individual observations had changed during the lesson. Six of the 12 PSTs used Teacher Interpersonal Circle theory and reported that teacher-3 showed a lack of agency during (parts of) the lesson, was too permissive with his students, hesitated, did not give any resistance to ruling students' behaviour, and was acquiescing. Three PSTs suggested that it would be better if teacher-3 corrected misbehaviour, one PSTs stated that teacher-3 moved too often throughout the classroom instead of sitting behind his desk, and one PST emphasized that it is better to avoid frequent discussions with students. In contrast,

one PST thought he was imposing, whereas two other PSTs described him as directing, supporting, and friendly. Eight PSTs reported the use of stickers as a reward for students' good work as a positive teaching strategy, whereas one PSTs found this to be childish.

The second question regarding PSTs' professional interpersonal vision asked if PSTs could distinguish differences between their tags of the pre-test and post-test. Except for one, all PSTs stated clearly that they used more of the interpersonal behaviour theory in terms of the Teacher Interpersonal Circle and teachers' non-verbal behaviour, which made their tags more precise. One PST reported to have developed a new way of observing teachers, another PST felt he had more focus on interpersonal behaviour while observing other teachers teaching, and two PSTs said they gained more terminology to describe observed behaviour.

Overall, the results of the tags and interviews indicate that PSTs, after the virtual classroom, developed terminology to describe teacher behaviour from an interpersonal perspective and they also used more interpersonal knowledge in their tags. interviews were used.

Table 5.3
Devices PSTs used to watch the video fragments

	number of PSTs
mobile phone in a VR headset	60
mobile phone without VR headset	53
laptop	4
tablet	4
mobile phone with and without a VR headset	20

The descriptive statistics of the technical aspects of the VR headset (Table 5.3) show that PSTs had mixed opinions about these aspects. Regarding the technological aspects of the virtual classroom, 47 PSTs reported that they were hindered (more or less) by the VR headset. For 12 PSTs, the VR headset caused physical discomfort, such as headache, dizziness, and nausea. Ten PSTs experienced technical hindrances relating to difficulties with an online platform (YouTube), mobile phones without a gyroscope, and poor video and audio quality. Furthermore, 24 PSTs reported they disliked the VR headsets, and 13 PSTs thought that the VR headsets were unnecessary. Two respondents also reported that some mobile phones appeared to be too big for the VR headset. What was noteworthy is that three respondents stated that the use of a VR headset over top of prescription glasses felt uncomfortable. However, one of these respondents had mixed feelings as she also liked the immersive experience.

In contrast, a minority of seven PSTs reported the VR headset as a positive learning experience. Five PSTs reported watching videos with a VR headset as fun, instructive, and an alternative to regular teacher education sessions. Furthermore, three PSTs felt as if they were present in a real classroom due to the immersive aspect of VR. The quantitative data revealed that seven PSTs were positive about the VR headset. These PSTs appreciated the immersive aspect and thought watching 360-degree videos provided them with a different perspective of the whole classroom instead of a fixed viewpoint. Three PSTs noticed that it was difficult to look around when seated behind a desk and therefore suggested to watch the videos standing up. In the interviews and open-ended questions, five PSTs reported that they stopped using the VR headset due to technological hindrances.

Table 5.4
Descriptive statistics technological aspects of the VR headset

	1 *strongly disagree*	2 *disagree*	3 *neutral*	4 *agree*	5 *strongly agree*
technological aspects of the VR headset	10	22	43	52	14

A substantial number of PSTs experienced technological hindrances using the VR headset. To check whether the variable "device" influenced the level of tagging (professional interpersonal vision), a one-way ANOVA was conducted. Table 5.4 shows the number of PSTs per device used. A significant difference was found between devices for the level of tagging, $F(4, 135) = 2.527$, $p < .05$. We applied Fisher's Least Significant Difference post hoc test, because the overall ANOVA was significant. The post hoc test revealed that the device "laptop" outperformed all other devices, except for the device "tablet." All other differences between pairs of devices were not statistically significant. However, only four PSTs used the device "laptop." For this reason, we conclude that device did not significantly influence the level of tagging.

Overall, these results indicate that PSTs had mixed opinions about the VR headset as a technological affordance. A fair number of PSTs were hindered by technological aspects of the VR headset, whereas others perceived watching videos with the VR headset as an immersive experience. The use of devices by PSTs did not influence the level of tagging.

Educational affordances

Regarding the educational affordances of the virtual classroom, the descriptive statistics (Table 5.5) provide more insights in PSTs' ratings about the quality of the content, the coherence between meetings, the added value to the curriculum, and the contribution to their teaching skills. As Table 5.5 indicates, the majority of PSTs were positive about educational affordances.

Table 5.5
Descriptive statistics educational affordances

	1 *strongly disagree*	2 *disagree*	3 *neutral*	4 *agree*	5 *strongly agree*
content of the Virtual Classroom			12	111	18
coherence between meetings		2	4	102	33
added value Virtual Classroom to curriculum	2	6	38	80	15
contribution to PSTs' teaching skills	1	5	29	79	27

In the open-ended questions, PSTs were asked what they had learned from the virtual classroom. The results showed that 100 PSTs reported that the 360-degree videos and the theoretical lectures taught interpersonal teacher behaviour in terms of how a teacher can influence the teacher–student relationship (36 PSTs), do's and don'ts regarding interpersonal teacher behaviour (17 PSTs), different teacher styles (42 PSTs), and the meaning of communion and agency (5 PSTs). Forty-two PSTs stated that it was a good learning experience to observe other teachers teach. Through observation, PSTs gained insights on different teaching styles that influence teacher-student relationships, which helped PSTs to reflect on their own teacher behaviour. Furthermore, 31 PSTs perceived they developed more insights into non-verbal behaviour. In their responses, they focused mostly on body language and facial expressions. None of the PSTs responded negatively concerning the educational affordances.

When asked about the content of the virtual classroom during the interviews, five PSTs reported that they learned from observing other teachers teach and their interactions with students. The variety of teacher examples was especially appreciated. Not all examples were good ones, which gave PSTs the opportunity to see different sides of the teaching profession. As one PST stated: *"You learn that you can teach in different ways"*. For one PST, observing other teachers teach decreased her anxiety for classroom management. Afterwards, she was able to understand better on how to handle classroom management issues. Furthermore, three PSTs said they gained knowledge and they learned different terminology to describe interpersonal teacher behaviour. These PSTs also appreciated the structure of the meetings and how theory was spread out over the meetings.

Concerning the coherence between meetings, all interviewed PSTs felt that the coherence was good as there was repetition between the meetings, and in the end, all theory was discussed in the videos. Two respondents reported that they made progress throughout the meetings and one PST liked the variation in a meeting.

There was a consensus between all PSTs that the virtual classroom added value to the curriculum. Five PSTs argued that the virtual classroom is especially interesting for PSTs without real-life internship experiences (which was the case for them). They perceived the virtual classroom as a safe learning environment where you can observe without any pressure or making damaging mistakes. Two issues were identified: Two PSTs said it would be better if there was less time between the meetings (as meetings were sometimes 2 weeks apart) and one PST suggested that the virtual classroom could gain more added value if it was completed with a formal test.

Ten PSTs felt that the virtual classroom added value to their teaching skills. They were able to learn by observing other teachers teach, or as one PST put it: *"You notice more and more, for example facial expressions. As a beginner you do not notice these kinds of things. But now I am more aware of this."* By watching other teachers, discussion, and personal reflection, six PSTs argued they extended their teaching repertoire. In contrary, two PSTs with already minor teaching experience indicated that the virtual classroom was less useful for their teaching skills. They argued this was due to the context differing from their previous teaching experience and a difference in character traits between their own and the observed teachers. Taken together, these results suggest that PSTs experienced positive educational affordances using the virtual classroom. The majority of PSTs were positive about the quality of the content, the coherence between meetings, the added value of to the curriculum, and the contribution to their teaching skills.

5.6 Conclusion and discussion

This study set out to gather insights into how a computer-based classroom simulation using videos (the Virtual Classroom) could support the development of PSTs' interpretations of noticed classroom events as part of their professional interpersonal vision. Furthermore, this study investigated how PSTs evaluated the virtual classroom in terms of technological and educational affordances.

The virtual classroom consisted of three meetings about interpersonal teacher behaviour in which PSTs watched 360-degree videos of experienced teachers with a VR headset in combination with theoretical lectures. This study showed that participating PSTs improved

in noticing classroom events and in applying a theory-based terminology to describe these events. Furthermore, PSTs felt better prepared for teaching in practice by watching experienced teachers teach. Although some PSTs perceived watching 360-degree videos with a VR headset as an immersive learning experience, the majority of PSTs experienced physical discomfort and technical hindrances using the VR headset. These main findings will be further elaborated in detail.

Regarding PSTs interpretations of noticed classroom events, PSTs tagged three video fragments at the pre-test and post-test. These tags were coded on four levels adapted from the Learning to Notice Framework: (a) descriptive tags events, (b) evaluation tags, (c) analytic tags, and (d) prescriptive tags (van den Bogert, 2016; van Es & Sherin, 2002). A significant increase was found in the level of tags at the pre-test and post-test for all three video fragments (Table 5.2). Where PSTs at the pre-test mainly noticed tags in the first and second level, they scored more on the second and third level during the post-test. Thus, the results suggest that the 360-degree videos, added with theoretical knowledge, increased PSTs' professional vision when noticing relevant classroom events. The qualitative data also revealed that PSTs used more theoretical terminology to describe teacher behaviour from an interpersonal perspective (e.g., the interpersonal circle, aspects of non-verbal behaviour). Connecting noticed classroom events with theory is important for interpreting as it can be used to make sense of what one noticed (van Es & Sherin, 2002). Van den Bogert (2016) compared PSTs with experienced teachers in their level of tagging. This study identified that PSTs mainly use descriptive and evaluation tags, which was also the case for PSTs at our pre-test and in line with van Es and Sherin's (2002) research about the Learning to Notice Framework. However, experienced teachers also use analytic tags when noticing classroom events (van den Bogert, 2016). PSTs' level of tagging at the post-test of our study corresponded with these experienced teachers. Both PSTs from our study and the experienced teachers from van den Bogert's study (2016) did not use prescriptive tags. However, in the interviews PSTs incidentally used a prescriptive tag (they proposed alternative teacher behaviour). This indicates that a computer-based classroom simulation using (360-degree) videos, together with theoretical knowledge provided, can influence and possibly increase PSTs' capability of learning to notice. As the differences between experienced teachers and PSTs indicate that learning to notice takes time and can be developed over time, the results of our study demonstrates that teacher education institutes can accelerate this learning process using 360-degree videos in theoretical lectures. This is important because noticing and interpreting relevant classroom events are necessary to inform pedagogical decisions (van Es & Sherin, 2002). Therefore, these kinds of simulations can be an asset in teacher education to prepare PSTs for teaching in practice. However, there are still unanswered questions about whether exclusively the 360-degree videos, the theoretical lectures, or the combination of both influenced PSTs'

level of interpretations of noticed events. The study of Sitzmann (2011) already showed promising results for theoretical lectures as part of a simulation game, for 360-degree videos the influence of added theoretical lectures is still unknown.

The second aim of this study was to evaluate the technological and educational affordances by PSTs. Concerning the technological affordances, physical discomforts (headache, dizziness, and nausea) were reported by PSTs using the VR headset. Furthermore, PSTs experienced technical hindrances such as mobile phones without a gyroscope. Difficulties with an online platform (YouTube) and poor video and audio quality obstructed the immersive experience. Olmos et al. (2018) argue that these physical discomforts and low quality of VR-environments are reasons why the use of VR in education is complex, although technologies develop at fast pace. For good learning experiences with VR headsets, good usability, proper functionality, and aesthetics are necessary (Olmos et al., 2018). Due to the problems experienced with the VR headset, almost half of the participants watched the 360-degree videos without the VR headset. What is remarkable is that watching the 360-degree video with or without the VR headset did not influence the participants' level of tagging. Both conditions appeared useful to develop professional interpersonal vision. This could indicate that especially the theoretical lectures influenced PSTs' level of tagging. In conclusion, teacher educators do not have to be hindered by technical hindrances of VR when using 360-degree videos in teacher education. Solely, the use 360-degree videos in theoretical lectures is a promising combination for teacher educators to improve PSTs' interpretations of noticed classroom events and prepare them for their job as teachers.

Despite the negative experiences with the VR headset, there was also a minority of PSTs who reported that watching 360-degree videos with a VR headset was a positive learning experience. They perceived the VR headset as fun, instructive, immersive, and an alternative way of teaching. As a result of the immersive experience, some PSTs felt like they were present in a real classroom without being actually there. Yoh (2001) refers to this as the sensory experience, which can be derived from VR. These findings suggest that, in general, good working VR-environments are required for an immersive learner experience.

PSTs believed that observing other teachers teach is a positive educational affordance. Through this observation, they were able to learn theories on interpersonal teacher behaviour, develop insights about different teaching styles that influence teacher-student relationships, and could reflect on classroom events. These outcomes are in line with studies about the use of video in teacher education, which found that videos provide opportunities to learn from examples of different teachers, students, settings, and pedagogies to reflect on classroom interactions and to analyse and reason about teacher and student behaviour (Santagata & Guarino, 2011; Sherin & van Es, 2005; Star &

Strickland, 2008). This implies for teacher educators that 360-degree videos are useful to bridge the gap between theory and practice by giving PSTs opportunities to learn from experienced teachers using authentic classroom situations. Furthermore, PSTs were positive about the quality of the content and the coherence between meetings, and they had the opinion that the virtual classroom contributed to their teaching skills and added value to the curriculum. This study was, to our knowledge, the first study that investigated the use of computer-based classroom simulation using 360-degree videos to improve PSTs' professional interpersonal vision and evaluated the technological and educational affordances. Findings of this study, while preliminary, suggest that classroom simulations using 360-degree videos (with or without a VR headset) are useful for improving PSTs' professional interpersonal vision and developing theory about interpersonal teacher behaviour. This is important because the professional interpersonal vision is part of PSTs' interpersonal competence, which is a major concern for PSTs (Pillen et al., 2013). It can, therefore, be assumed that the use of classroom simulations with 360-degree videos, and theoretical knowledge can be used to strengthen PSTs' interpersonal competence and ease the transition to teaching in practice. It is also evidentiary that the use of 360-degree videos is a beneficial educational tool in general as this theory resonates with studies in other domains (e.g., Harrington et al., 2018; Krokos, Plaisant, & Varshney, 2018; Schöne et al., 2017; Yoganathan et al., 2018). Furthermore, findings of this study emphasize the importance of good quality VR-environments to improve the immersive experience.

A limitation of this study was that only PSTs' self-perceptions of affordances and hindrances were investigated. We did not measure, for example, if the simulations did contribute to PSTs' teaching skills. Another limitation is that the professional interpersonal vision was measured with tags, but whether PSTs were more accurate in their interpretations of noticed events in their actual teaching practice is still unknown. Finally, the first author taught all the classes herself which possibly caused some degree of bias.

The question raised by this study was whether 360-degree videos, in combination with lectures, added value for improving professional interpersonal vision. This study found that the combination of 360-degree videos and lectures influenced PSTs' professional interpersonal vision positively, although the added value of a VR headset was not established. Furthermore, PSTs' perceived educational affordances, which are congruent with studies on the use of "traditional" videos in teacher education. The assumed added value of 360-degree videos is that PSTs could change their viewpoint when observing classroom interactions, instead of passively viewing situations from a predefined viewpoint when watching traditional videos. However, it is unclear if PSTs of this study changed perspectives and if that was preferable over traditional videos. Although some PSTs reported that a benefit of 360-degree videos is that situations could be viewed from their

own perspective, it remains a question whether 360-degree videos are more effective to improve professional interpersonal vision than traditional video or not. However, other studies have found that there is an added value of using 360-degree videos (e.g., Schöne et al., 2017; Yoganathan et al., 2018). It would be valuable to explore those findings specifically for the current topic.

Additional research is also required to determine if the use of better quality 360-degree videos could improve the immersive experience of VR and, consequently, if a good immersive experience will improve learning experiences. What would be additionally interesting is whether the effect of reduced physical discomforts have a positive influence on the learning experience. Furthermore, this study used traditional videos for the tagging instead of 360-degree videos. It would be interesting to investigate if PSTs tag differently if 360-degree videos are used at the pre-test and post-test. Besides that, when using ICT, it is important to take PSTs' ICT mindedness into account. The level of ICT mindedness determines whether one can set aside limitations of new technological experiences for the benefit of the goal or to find a foundation for their aversion for new technological experiences in these limitations (van den Beemt & Diepstraten, 2016). Further research is required to establish if PSTs' ICT mindedness influences learning outcomes using 360-degree videos with or without a VR headset. Lastly, professional interpersonal vision is only one aspect of PSTs' interpersonal competence. Further studies regarding the influence of computer-based classroom simulations, including VR classroom situations on other aspects of PSTs' interpersonal competence, would be worthwhile to investigate, especially regarding PSTs' professional interpersonal behaviour repertoire.

Chapter 6

Developing preservice teachers' interpersonal knowledge with 360-degree videos in teacher education

This chapter was published in adapted form as:
Theelen, H., van den Beemt, A., & den Brok, P. (2020). Developing preservice teachers' interpersonal knowledge with 360-degree videos in teacher education. *Teaching and Teacher Education, 89*(1), 1-15.
doi:10.1016/j.tate.2019.102992

Abstract

Preservice teachers' (PSTs) interpersonal competence includes interpersonal knowledge. This study investigated PSTs' interpersonal knowledge structures and development of these structures via concept maps, and PSTs' knowledge application via vignettes after an intervention that combined 360-degree videos and theoretical lectures in teacher education. PSTs' concept maps were analysed with social network analysis, including measures of structure and conceptual relevance, and were compared to expert application. Results showed PSTs using more organised concept maps including more relevant concepts after the video-lecture intervention. Furthermore, PSTs were particularly capable in applying their interpersonal knowledge on vignettes focusing on high levels of interpersonal teacher control. PSTs and teacher education institutes are advised to combine theoretical lectures with 360-degree videos, using VR headsets, as this combination shows positive results on PSTs' theory-based interpersonal knowledge structures, development, and application.

6.1 Introduction

Preservice teachers (PSTs) often struggle with creating positive teacher-student relationships through behavioural strategies, also known as PSTs' *interpersonal competence* (Stough & Montague, 2015; Veenman, 1984). For interpersonal competence it is important that PSTs are able to notice and interpret relevant classroom events using *interpersonal knowledge* (van Es & Sherin, 2002). In the present study, we define PSTs' interpersonal knowledge as their knowledge to develop and sustain healthy relationships with students and a classroom environment supporting these teacher-student relationships. Healthy teacher-student interpersonal relationships combine high degrees of interpersonal control with relational proximity, and can be typified by leadership, helpful/friendly, and understanding teacher behaviour (Wubbels et al., 2006). Furthermore, as part of their interpersonal competence, PSTs need to be able to apply their interpersonal knowledge, for example by classifying observed classroom situations (Stürmer et al., 2013).

Videos appear to be a useful method for stimulating PSTs' knowledge development (e.g., Santagata & Guarino, 2011; Stürmer et al., 2013). Recent technological developments make it possible to watch videos in 360-degree (Aguayo et al., 2017). With 360-degree cameras videos can be captured with an all-around view, enabling multiple angles or viewpoints. 360-Degree videos have shown their usefulness in improving PSTs' ability to notice relevant classroom events and in applying a more theory-based terminology, describing these events as part of PSTs' interpersonal competence (Theelen et al., 2019b, see chapter 5). However, to our knowledge, little is known about the effect of 360-degree videos in teacher education, and specifically with respect to their effect on PSTs' interpersonal knowledge development.

The development of interpersonal knowledge using videos starts by observing new events or objects and linking or adjusting these observations to the theoretical concepts in a knowledge structure one already possesses (Ausubel, 2000; Novak & Gowin, 1984). In other words: new concepts are connected to familiar concepts. In this study, we define PSTs' interpersonal knowledge development as the changes in PSTs' knowledge structures and application to situations in terms of teacher-student interpersonal relationships as the result of an intervention in teacher education. Concept maps can be used to visualize knowledge structures and analysed using social network analysis (McLinden, 2013), thereby looking at measures of structural complexity, and comparisons with expert concept maps (Winitzky, Kauchak, & Kelly, 1994).

This paper presents a mixed-method study that investigated the development of PSTs' interpersonal knowledge structures and the content of PSTs' interpersonal knowledge after watching 360-degree videos combined with theoretical lectures. Concept maps were used to organize and represent PSTs' knowledge structures and these concept maps were analysed with social network analysis, also providing measures of structural complexity, and comparisons with expert maps. Furthermore, we were interested to see if PSTs could apply their interpersonal knowledge in descriptions of authentic classroom situations (vignettes).

The theoretical background of this paper firstly describes the nature of PSTs' interpersonal knowledge (section 1.1) and the content of interpersonal knowledge (section 1.2). Secondly, the use of traditional and 360-degree videos in teacher education will be explained (section 1.3). Lastly, we describe the use of concept maps for interpersonal knowledge (section 1.4). Figure 6.1 shows an overview of the above-mentioned concepts, their assumed underlying concepts, and their mutual relations. The bottom half of figure 6.1 explains data analysis and is therefore explained in the method section.

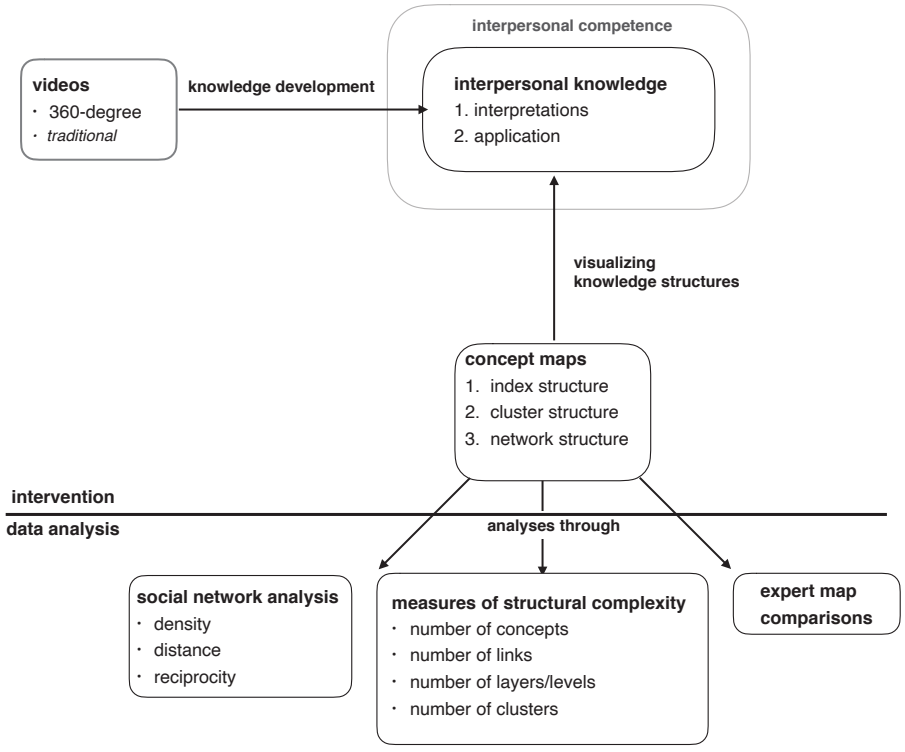

Figure 6.1 Main concepts and their assumed interrelations

6.2 Theoretical background

PSTs' interpersonal knowledge

For interpersonal competence it is important that PSTs are aware of relevant classroom events that require action (van Es & Sherin, 2002). When becoming aware of relevant classroom events, PSTs require interpersonal knowledge to give meaning to their observations by connecting theories about interpersonal teaching behaviour to their interpretations (van Es & Sherin, 2002). PSTs can acquire interpersonal knowledge at both the teacher education institute and the workplace (van Tartwijk et al., 2009).

First, knowledge acquired at the teacher education institute is based on the idea that teaching practice can be improved by knowing more about, amongst others pedagogy, and learning theories. This type of knowledge is also known as "formal knowledge," "theory-based knowledge," or "knowledge-for-practice", which is based on empirical evidence and forms the foundation of the knowledge base of teacher education institutes (van Tartwijk et al., 2009; Cochran-Smith & Lytle, 1999). Second, knowledge can be obtained at the workplace through experiences and reflecting on these experiences. This type of knowledge is also known as "practical knowledge" or "knowledge-in-practice", which can be defined as PSTs' knowledge and beliefs related to their own teaching practices, for example about interpersonal behaviour strategies. Thus, the acquisition of practical knowledge takes place in the classroom and is a result of teachers' reflections on their own classroom experiences (Cochran-Smith & Lytle, 1999; van Tartwijk et al., 2009).

Because the present study takes place at a teacher education institute, we focus on this first type of knowledge: theory-based interpersonal knowledge. Developing theory-based knowledge is an important element in teacher education institutes (Darling-Hammond, 2006). Contrary to expert teachers who already possess a certain knowledge base through experience, PSTs' knowledge is often insufficiently developed (Meijer, Zanting, & Verloop, 2002). Furthermore, differences between expert teachers and PSTs in applying theory-based knowledge when interpreting noticed relevant classroom events has also been shown in different studies (e.g., van den Bogert, 2016; Wolff, 2015).

After being aware of relevant classroom events and interpreting these events, PSTs can make pedagogical decisions about actions to undertake for creating a positive learning environment (van Es & Sherin, 2002). In other words, they can apply their knowledge in authentic classroom situations (Stürmer et al., 2013). This knowledge application includes, amongst others, the ability to explain classroom situations. This explanation contains the classification of observed situations based on their theory-based interpersonal knowledge (Stürmer et al., 2013).

Interpersonal behaviour theory

Theory-based interpersonal knowledge consists of knowledge about interpersonal processes and knowledge about the nature of interpersonal relationships and behavioural indicators that determine this nature (van Tartwijk et al., 2009). The systems approach to communication (Watzlawick et al., 1967) was used in the present study as starting point for the knowledge on interpersonal processes. One assumption of the dynamic systems approach (Watzlawick et al., 1967), is that classes can be considered as social systems in which teachers and students interact via every behaviour they display (Wubbels et al., 2006), and that they influence each other mutually (Horowitz & Strack, 2011). Knowledge on the interpersonal nature of relationships can be described in terms of the Teacher Interpersonal Circle. The Teacher Interpersonal Circle (Figure 6.2) describes this mutual influence (Pennings et al., 2018) by means of two independent dimensions: communion and agency. Communion is referred to as the extent of warmth in the teacher-student relationship. Influence of communication with students is the agency dimension (Horowitz & Strack, 2011). Teachers vary in the combination of communion and agency they use in the classroom, resulting in eight types of interpersonal teacher behaviour: directing, helpful, understanding, compliant, dissatisfied, uncertain, imposing, and confrontational (den Brok & van Tartwijk, 2015). Commonly, these eight types of interpersonal teacher behaviour are represented into four quadrants, each combining two types of teacher behaviour: (1) directing-helpful, (2) understanding-compliant, (3) dissatisfied-uncertain, and (4) imposing-confrontational (Pennings et al., 2018). For example, teacher behaviour in the directing-helpful quadrant is characterised by high levels of communion and agency. For teachers who tend to the directing type of behaviour the agency dimension dominates and vice versa for helpful teacher behaviour in which the communion dimension dominates (Wubbels & Brekelmans, 2005).

According to the systems approach of communication (Watzlawick et al., 1967), interactions between teachers and students always carry a content and a relational aspect (Wubbels et al., 2006). The relational aspect influences the interpretation of content and the perceptions of students about their teacher. For students' perception of the relational aspect of communication by the teacher (i.e., What type of interpersonal teacher behaviour does the teacher show in the student's perception?), non-verbal behaviour plays an important part (Wubbels et al., 2006). For example, students experience a smiling teacher with high communion and a teacher with an angry facial expression with low communion (van Tartwijk, 1993). Five channels of non-verbal behaviour influence students' perceptions of their teacher's interpersonal behaviour: (1) the way teachers use space in their classroom, (2) the body (position, and movements of the trunk, arms, and head), (3) facial expressions, (4) visual behaviour (e.g., how long a teacher looks at students), and (5) the non-content aspects of the voice (van Tartwijk, 1993). However, the use of voice and facial expressions are

the most important non-verbal behaviour influencing the teacher-student relationship. In the lectures as part of the intervention of the present study, all aforementioned elements and concepts were addressed.

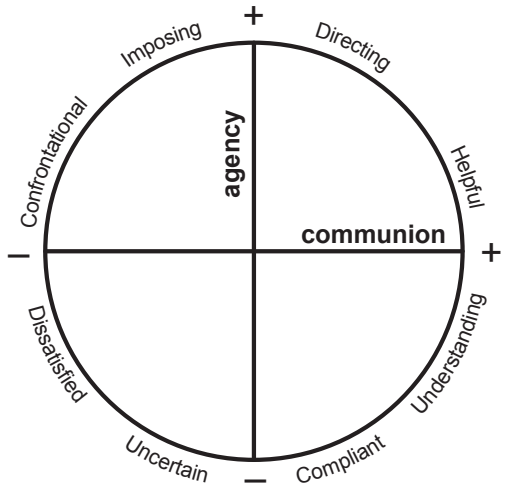

Figure 6.2 Teacher Interpersonal Circle (Pennings et al., 2018; Figure is used with permission of the authors)

Theory-based interpersonal knowledge and concept mapping

Concepts maps can be used as a graphical tool to map the structure of PSTs' theory-based interpersonal knowledge (Novak & Cañas, 2008). Concept maps consist of concepts and their interrelations linked to each other with lines (Novak & Cañas, 2008). In a concept map, interrelated concepts form a meaningful statement together (Novak & Cañas, 2008; Ruiz-Primo, Schultz, Li, & Shavelson, 2001). For example, "a bird can fly" is a meaningful statement. The two concepts "bird" and "fly" are connected to each other because the ability to fly is a characteristic of birds. However, a bird is also feathered and eats worms. In this example, the concept "bird" is involved in more meaningful statements than one. These meaningful statements together around the concept "bird" form a framework defined as a concept map (Novak & Gowin, 1984). Figure 6.3 shows an example of a concept map.

Since concepts and their interrelations concerning a subject domain are associated with an understanding of this domain (Novak & Gowin, 1984; Novak, Gowin, & Johansen, 1983), concept maps appear to be a good tool to assess students' knowledge structure (Novak, 1990). Buitink (2009) argues that there are three types of knowledge structures of concept maps based on the degree of clustering and the interconnections between clusters in the concept map: (1) index structure, (2) cluster structure, and (3) network structure (see Figure 6.4).

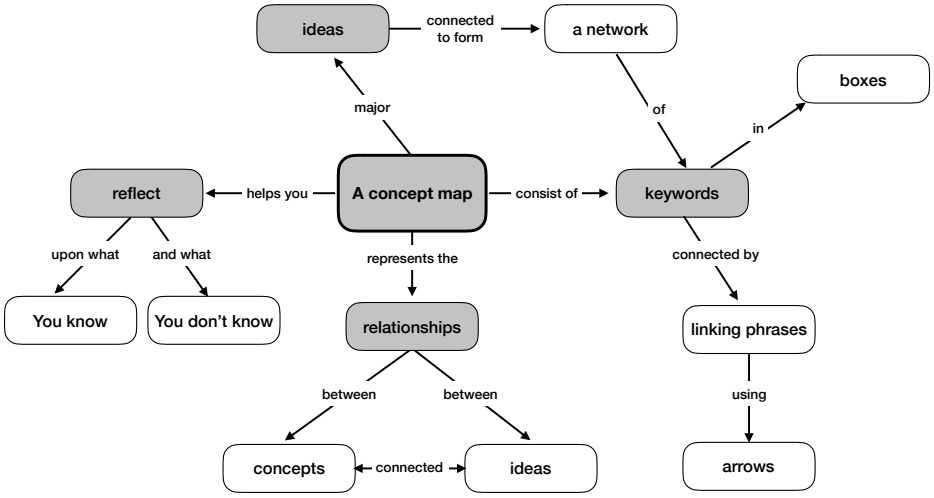

Figure 6.3 Example of a concept map about concept mapping (Morgan State University, 2019)

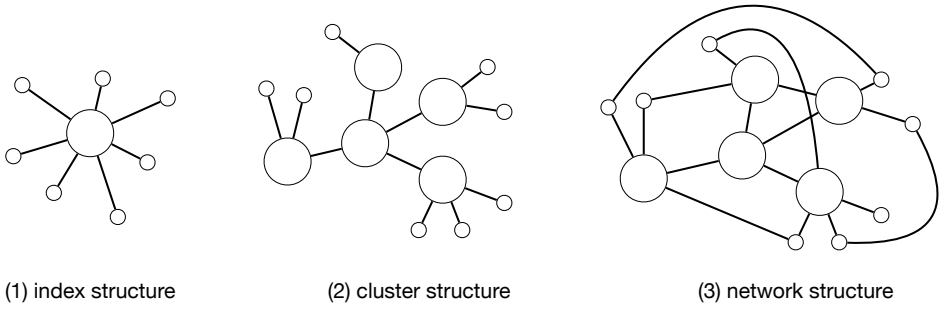

Figure 6.4 Structure of concept maps (Buitink, 2009, p. 122)

An index structure has a central concept with all other concepts directly linked to it. A cluster structure has one central concept with connected concepts each having one or more concepts connected to itself, creating clear clusters of concepts. The network structure is similar to the cluster structure, only it has (some) concepts interlinked across the whole structure, connecting concepts from the same or different clusters together (Buitink, 2009). Buitink (2009) argues that the structure of concept maps shows how well developed a knowledge structure is and that theoretical knowledge is more developed when the concept map is clearer and more coherent, as is the case for the network structure. In other words, learners with index structured concept maps have a less developed knowledge structure than learners with a cluster structure or network structure. Thus, the increasing complexity of interpersonal knowledge development can be visualised in the concept map structure.

Videos in teacher education

One way to stimulate theory-based knowledge development are videos (e.g., Santagata & Guarino, 2011; Stürmer et al., 2013). The use of videos in teacher education has already proven useful for preparing PSTs for the teaching context (e.g., Asan, 2003; Blomberg, Sherin, Renkl, Glogger, & Seidel, 2014). For example, previous studies (e.g., Theelen et al., 2019b, see chapter 5; Star & Strickland, 2008) focused on videos containing classroom management issues (e.g., disruptive students, classroom discipline, motivating students) to improve PSTs' ability to notice relevant classroom events. tar and Strickland's study (2008) demonstrate how preservice mathematics teachers improved their observational skills significantly after participating in a teaching methods course that contained videos.

Videos can provide real-life authentic cases (Beck et al., 2002) featuring the richness and complexity of classrooms (Gomez et al., 2008). For example, in the study of Beck and colleagues (2002), PSTs videotaped the lessons of their mentor teachers containing teacher strategies, student learning or understanding, teacher-student interactions, student-student interactions, and professional standards for teaching. Utilising videos, PSTs can watch experienced teachers teach, and discuss their observations grounded by teaching and learning theories (Star & Strickland, 2008). Furthermore, through videos PSTs can learn, analyse, and reason with teacher and student behaviour, and reflect on classroom interactions (Santagata & Guarino, 2011; Sherin & van Es, 2005).

As a result of recent technological developments, 360-degree cameras have become less expensive and enable enrichment of videos (Aguayo et al., 2017). Mobile devices (e.g., smartphone, tablet) are currently also powerful enough to play 360-degree videos (Martín-Gutiérrez, Mora, & Añorbe-Díaz, 2016). PSTs can see classroom interactions between teachers and students when they view experienced teachers with 360-degree videos. Furthermore, PSTs can choose their own perspective when observing classroom interactions rather than viewing from a fixed perspective. As such, 360-degree videos provide a more immersive experience giving PSTs the feeling of presence in the actual classroom (Martín-Gutiérrez, Mora, Añorbe-Díaz, & Gonzàlez-Marrero, 2016; Yoh, 2001). We therefore assume that in teacher education 360-degree videos are more useful than traditional videos.

360-degree videos can be watched using virtual reality (VR) headsets (Figure 6.5), which is becoming more affordable (Olmos et al., 2018). Online platforms such as YouTube offer easy playback and sharing of 360-degree videos (Aguayo et al., 2017). 360-degree videos can be used to display real-life classroom events to provide learners sensory and imaginary experiences resembling real-life (Yoh, 2001). The immersive user experience of watching 360-degree videos using VR headsets appears to be more attractive to learners (Martín-Gutiérrez et al., 2016), because it disconnects them from their surroundings (Olmos-Raya et

al., 2018). VR's immersiveness provides a feeling of presence (Yoh, 2001) and embodiment (Kilteni et al., 2012), offering users a realistic and authentic situation (Martín-Gutiérrez et al., 2016). However, applying VR into education is also accompanied with some difficulties, for example experiencing dizziness, nausea, disorientation, the quality of mobile virtual reality can be low, and teachers have to be properly trained to use VR in their classrooms (Olmos et al., 2018).

Figure 6.5 VR headset

Research questions

In the present study 360-degree videos are combined with theoretical lectures. We label this combination the Virtual Classroom. The Virtual Classroom is used to strengthen PSTs' theory-based interpersonal knowledge. The research questions addressed in this paper are:

1. *What is the effect of the Virtual Classroom on PSTs' theory-based interpersonal knowledge structures?*
2. *What is the effect of the Virtual Classroom on PSTs' theory-based interpersonal knowledge development?*
3. *How do PSTs apply their theory-based interpersonal knowledge after the Virtual Classroom?*

For the first research question we focus on the differences between PSTs' theory-based interpersonal knowledge structures before (pre-test) and after (post-test) the intervention. These structures are visualised using concept maps and analysed with measurements of structural complexity and social network analysis (see section 3.3 and 3.5). For the second

research question we are interested to see if what the effect is of the Virtual Classroom on PSTs' theory-based interpersonal knowledge development. For this, we will investigate if PSTs use more relevant concept after the intervention (post-test only) when comparing their concept maps with an expert concept map (see section 3.6). For the third research question we are interested to see if PSTs can apply their theory-based interpersonal knowledge in descriptions of authentic classroom situations by scoring vignettes on the Teacher Interpersonal Circle and comparing these scores with experts (see section 3.5 and 3.6).

6.3 Design of the Virtual Classroom

The Virtual Classroom consisted of three two-hour sessions combining watching 360-degree videos of experienced teachers in secondary education and theoretical lectures. For watching the 360-degree videos, PSTs used YouTube on their mobile phones and a VR headset. Every session consisted of a lecture about interpersonal behaviour theory as described in section 1.2 and five 360-degree video fragments. The theoretical lectures guided watching the videos, varying in length from 47 seconds to four minutes and 48 seconds, with an average time of three minutes and 8 seconds. For example, when the theoretical lectures were about a teacher's posture, PSTs were asked to pay specific attention to this aspect in the video. After every video, PSTs' interpretations were discussed, first in small groups then later with the entire class. This way, learning from examples of different teachers, students, settings and pedagogies was stimulated (Star & Strickland, 2008). By analysing and reasoning about teacher and student behaviour (Santagata & Guarino, 2011), PSTs could reflect on classroom interactions (Sherin & van Es, 2005).

Session 1 included the first introduction with the VR headsets. PSTs received instruction about how to watch a 360-degree video on their mobile phone using a VR headset. PSTs could practice with a non-related video to get familiar with the technological features. The goal of this introduction was to avoid technological difficulties during the Virtual Classroom, rendering the learning experience. The theoretical lectures of this session included an introduction into the systems approach to communication (e.g., the content and relational aspect of communication; interpersonal perception, levels of communication) (Watzlawick et al., 1967; Wubbels et al., 2006), teachers' verbal and non-verbal behaviour (van Tartwijk, 1993), and handling whole-class moments in the classroom where the teacher is talking and all students have to pay attention (Wubbels et al., 2006). The videos of session 1 contained one or more of the following classroom events, which are important for the teacher-student relationship: (1) the beginning of a lesson, (2) stimulating students to work behaviour, and (3) disruptive behaviour (Admiraal, 1994; Admiraal et al., 1996; Wubbels et al., 2006).

Session 2 introduced the Teacher Interpersonal Circle (Wubbels et al., 2006; den Brok et al., 2015; Pennings et al., 2018) with emphasis on the two concepts communion and agency and the five channels of non-verbal behaviour influencing the teacher-student relationship (van Tartwijk, 1993). Videos in this session displayed fragments about: (1) a moment of instruction, (2) questions or feedback from student's behaviour, (3) the transition between two different phases of the lesson, (4) disappointed students' performances, (5) comments of students, and (6) stimulating students to work behaviour (Admiraal, 1994; Admiraal et al., 1996; Wubbels et al., 2006).

Session 3 focused on teachers' verbal behaviour and steering interactions (van Tartwijk, 1993). Furthermore, this session was about punishing and rewarding student behaviour, the beginning of a lesson (Wubbels et al., 2006), and the Teacher Interpersonal Circle (Wubbels et al., 2006; den Brok et al., 2015; Pennings et al., 2018). Video fragments in this session were about: (1) disruptive behaviour, (2) a moment of instruction, (3) stimulating students to work behaviour, (4) the transition between two different phases of the lesson, and (5) questions or feedback from students' behaviour (Admiraal, 1994; Admiraal et al., 1996; Wubbels et al., 2006).

6.4 Method

Participants

Participants came from a teacher education program in the Netherlands counting 141 first year PSTs (81 female), covering all first-year students of this teacher education program. These PSTs were being prepared for the secondary education context and teach in eight different domains (see Table 6.1). Of these PSTs, 27 had little teaching experience consisting of one to two months experience at previous education programs other than the teacher education program. The remaining 114 PSTs had no teaching experience at all. This study followed the 2014 Association of Universities in the Netherlands' research guidelines for social scientific studies. All participants participated voluntarily and gave their informed consent.

Procedure

A mixed-method design was used in this study with a pre-test, an intervention (the Virtual Classroom), and a post-test. To bias the results of this study as less as possible, PSTs received no theoretical instruction about interpersonal behaviour during other courses at the teacher education program during the intervention, nor were they engaged in real-life internships. This way, other factors that could influence PSTs' interpersonal knowledge were ruled out as much as possible.

Table 6.1
Number of preservice teachers per domain

	number of PSTs
History	22; 3♀
Geography	10; 5♀
Economy	8; 3♀
Dutch language	17; 16♀
German language	12; 7♀
English language	47; 34♀
Mathematics	19; 13♀
Physics	6; 0♀

For the pre-and post-test, the method of concept mapping (see section 3.2.1) was applied to measure PSTs' conceptual interpersonal knowledge development regarding the teacher-student relationship. After the post-test, individual interviews (see section 3.2.2) were conducted (*n* 12; 7♀), to obtain more insight into PSTs' interpersonal knowledge structures and development. Meeting the minimal requirement for theoretical saturation (Guest et al., 2006), 12 interview participants were selected with convenience sampling. All PSTs came from the full range of teaching disciplines and their interviews were audio-recorded. Used instruments are described in more detail in the following sections. To measure PSTs' theory-based knowledge application, teacher behaviour vignettes on the communion and agency dimension of the Teacher Interpersonal Circle were used in the post-test (see section 3.2.3).

Concept maps

Both at the pre- and post-test, PSTs created a free recall concept map about the teacher-student relationship. Given a general topic, PSTs were asked to brainstorm about terms and organize these into a concept map (Winitzky et al., 1994). PSTs were given 50 min to develop their concept map on paper with the following instruction based on Koopman (2010):

1. *Make a list of concepts:*
    - Write down all concepts that come to your mind about the teacher-student relationship.
    - If you have an idea, ask yourself questions: Why? How? What? Where? Who? When? When you do so, you will probably get new ideas.
    - Read your list of concepts and think about which concepts are related.
    - Underline about 3 to 5 concepts that are, according to you, most important.

2. *Put the concepts in the concept map:*
    - In the middle of the concept map, you see the teacher-student relationship.
    - Around the teacher-student relationship other concepts that are related to the teacher-student relationship should be filled out.
    - Concepts that belong to each other should be put near each other.
    - The most important concepts should be close to the centre, the less important concepts should be more to the outside.

3. *Make connections:*
    - Link the concepts that are related to each other by means of lines or arrows.
    - Put a short explanation next to the links, in which you describe the relation between the two concepts that you connected to each other.

Before using the concept maps as a measurement for this study, 6 first year PSTs (3♀) from another cohort of a teacher education program in the Netherlands piloted the use of concept maps to refine the method. After this, the method underwent one minor revision. PSTs preferred that their list of concepts was on the same page as the concept map itself, instead of on the back of the same paper.

Interviews

For the interviews, the phenomenographic method was used to understand the interpretations PSTs gave to concepts (Mavers, Somekh, & Restorick, 2002). These structured interviews were designed to get a complete and open response as possible, consisting of a small number of open-ended questions. This study used the following interview questions, adapted from Mavers et al. (2002):

- I found your concept map really interesting. Please could you tell me about it?
- Is any part of your map especially important? Why?
- Can you tell me how you know all of these things?
- Are there differences between your concept maps of the pre- and post-test? If so, what are the differences?

The interview data contained no disconfirming evidence.

Teacher behaviour vignettes

At the post-test, PSTs were asked to score 20 teacher behaviour vignettes (see Appendix D) on the communion and agency dimension of the Teacher Interpersonal Circle as described in section 1.2 (Pennings et al., 2018) in order to measure PSTs' theory-based knowledge application. The vignettes contained descriptions of classroom situations with teacher

behaviour and were developed with teachers and teacher educators (de Jong, van Tartwijk, Verloop, Veldman, & Wubbels, 2012). In our study, PSTs were asked to score a vignette on the communion and agency dimension both between a range of -4 and +4. PSTs got an exemplary situation to get familiar with the vignette method: You want to start the lesson, but a few students keep talking through the classroom. You don't dare to intervene. Figure 6.6 shows the scoring corresponding with the exemplary situation.

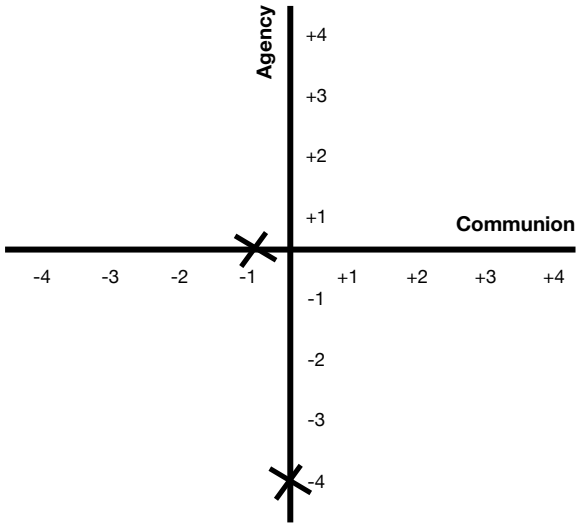

Figure 6.6 Example of scoring on the agency and communion dimension

Data-analysis

Concept maps are a network of ideas and are therefore suitable to apply social network analysis to (SNA), for a nuanced understanding of the concept map (McLinden, 2013). With SNA one can analyse networks based on visual representations of data. Using a graphical representation of concepts and how they are interlinked, SNA relies on mathematical models describing and explaining patterns (Freeman, 2004).

To further describe the social network, quantitative analyses are needed (McLinden, 2013). The quantitative measurements in SNA used in this study are density, distance, and reciprocity calculated in UCINET (Borgatti et al.,2002). Density is the statistic to quantify the number of links in the network, based on the maximum possible links between concepts in the network. The value varies between 0 (no links) and 1 (all concepts are connected) (Borgatti, Everett, & Johnson, 2013; Moolenaar, Sleegers, & Daly, 2011). Multiple concepts connected in a sequence form a path. The paths'

complete length is defined as a walk and is numerically defined by edges, which are the number of connections in a path. Concepts can be connected following multiple paths. The shortest path connecting two concepts is the geodesic distance (Borgatti et al., 2013). If links are directed, one can calculate the reciprocity. This is the number of reciprocated relationships relative to the total number of meaningful statements (Moolenaar et al., 2011).

Additional to SNA, other strategies to analyse concept maps can be used. In this study we conducted commonly used strategies when analysing concept maps: (1) measures of structural complexity and (2) comparing the concept maps of beginners with an expert on level of agreement (Winitzky et al., 1994). Measures of structural complexity contain the number of concepts, the number of links between concepts, the depth of the network by stratify the number of layers, the number of clusters, which are clusters with different topics distinguished in the concept map (Winitzky et al., 1994), and the network's structure (Buitink, 2009).

Regarding agreement with the expert map, the expert concept map functions as target of standards for scoring the beginner's concept map. PSTs' concepts maps were compared with an expert concept map made by the third author, who is an acknowledged expert in the research field of interpersonal teacher behaviour. To compare, PSTs' concepts were given a score between 1 and 3: concepts were not relevant (1), concepts were not in the expert map; however, they were relevant (2), and there was full agreement between the PST's concept and the expert's concept (3). To establish the inter-rater reliability of the agreement with the expert map, the first author (assessor 1) and a teacher educator (assessor 2) coded 10% of the total amount of concept maps as a sample survey (consisting of 28 concept maps with a total of 445 concepts), by calculating the linear weighted Cohen's Kappa. This resulted in a value of 0.72.

For analysing the above-mentioned aspects, the coding scheme (Table 6.2) adapted from Koopman, Teune, and Beijaard (2011) was used.

For analysing the teacher behaviour vignettes, firstly PSTs ratings were used to determine in which quadrant of the Teacher Interpersonal Circle PSTs scored each vignette. The model distinguishes four quadrants: (1) directing-helpful, (2) understanding-compliant, (3) dissatisfied-uncertain, and (4) imposing-confrontational (Pennings et al., 2018). Secondly, all authors of this article scored as experts on interpersonal teacher behaviour each vignette in the quadrants. Thirdly, the authors discussed their scores with each other until they reached full consensus. Fourthly, PSTs ratings correspondence with the experts' ratings were checked using IBM SPSS Statistics 22. Lastly, because PSTs' scores in an

adjacent quadrant to those from experts could be closer to the experts' scores than PSTs' scores in the same quadrant, the absolute distance between PSTs' scores and the experts' scores were also calculated, using IBM SPSS Statistics 22.

Table 6.2
Coding scheme for the analysis of the concept maps

Points of interest	Indicators	Analysis
Network cohesion	Density	UCINET
	Distance	UCINET
	Reciprocity	UCINET
Structural complexity	Number of concepts	Counts
	Number of links	Counts
	Number of layers	Maximum number of layers counts from core concept
	Clusters of concepts	Counts
	Structure of the concept maps	Rating (1 = index structure; 2 = cluster structure, 3 = network structure)
Comparison with expert map	Agreement with expert map	Rating (3 = full agreement; 2 = concepts are not in the expert map; however, they are relevant; 1 = concepts are not relevant)

Because some mobile phones were not equipped with a gyroscope necessary for watching videos in 360-degrees, and some PSTs felt nausea using the VR headset, not all 141 PSTs used the VR headset when watching the 360-degree videos. This created an extra condition to take into account when interpreting results of this study: the level of immersiveness. 60 PSTs used the VR headset every session and 81 PSTs used the VR headset very briefly or never. To determine if the level of immersiveness influenced PSTs' theory-based interpersonal knowledge structures, PSTs' theory-based interpersonal knowledge development, and the scoring of the vignettes, analysis of variances (one-way ANOVAs) were used.

6.5 Results

PSTs' theory-based interpersonal knowledge structures

For the first research question of this study, we were interested in the effect of the Virtual Classroom on PSTs' interpersonal theory-based knowledge structures by using concept maps for organizing and representing PSTs' knowledge structures, analysed using social network analysis and measurements of structural complexity.

Table 6.3
Mean scores and standard deviations on number of links, layers, clusters, network cohesion, and structure

	pre-test		post-test				
	M	*SD*	*M*	*SD*	*t(df)*	*d*	*p*
Links							
number of links (*n* = 140)	16.99	7.35	19.91	7.46	-3.912*(139)*	0.3	<.01*
Depth							
number of layers (*n* = 140)	3.29	1.63	3.07	1.36	1.426*(139)*	0.1	.16
Content							
number of clusters (*n* = 140)	3.23	2.60	4.06	2.93	-3.217*(139)*	0.3	<.01*
Network cohesion							
density (*n* = 140)	0.081	0.043	0.068	0.066	2.193*(139)*	0.2	.03**
distance (*n* = 140)	1.78	0.89	1.63	0.46	1.934*(139)*	0.2	.05
reciprocity (*n* = 140)	0.069	0.16	0.039	0.11	2.301*(139)*	0.2	.02**
Structure							
structure of the concept map (*n* = 140)	2.22	.588	2.34	.570	-1.960*(139)*	0.2	.05

* $p < 0.01$, ** $p < 0.05$

Table 6.3 shows positive and statistically significant differences in the number of links and number of clusters, and negative statistically significant differences for density and reciprocity between the pre- and post-test, with small effect sizes (respectively *d* 0.3, *d* 0.3, *d* 0.2, and *d* 0.2) (Cohen, 1988). No statistically significant differences were found in the number of layers, distance, and structure of the concept map between the pre- and post-test. These data imply that PSTs had more organised concept maps, while using more links and clusters after watching the videos and lectures. To illustrate, figure 6.7 presents an exemplary concept map from the pre-test and figure 6.8 from the post-test of the same PST (PST-a), using Netdraw in UCINET (Borgatti, 2002). As these figures show, PST-a used more links (pre-test: 9, post-test: 35), more clusters (pre-test: 2, post-test: 4), had a decreasing density (pre-test: 0.19, post-test: 0.03), and reciprocity disappeared at the post-test (pre-test: 0.27, post-test: 0). Both concept maps had a cluster structure. However, in the first concept map it was difficult to distinguish clusters, while at the post-test clusters were clearly organised and graphically visualised. The colours and shapes accompanying the concepts refer to the relevance of the concepts. Concepts in full agreement with the expert map are coloured green and have a square shape; concepts that were not in the expert map but appear relevant are coloured orange and have the shape of a circle; and concepts that were irrelevant were coloured red and have the shape of an up-triangle.

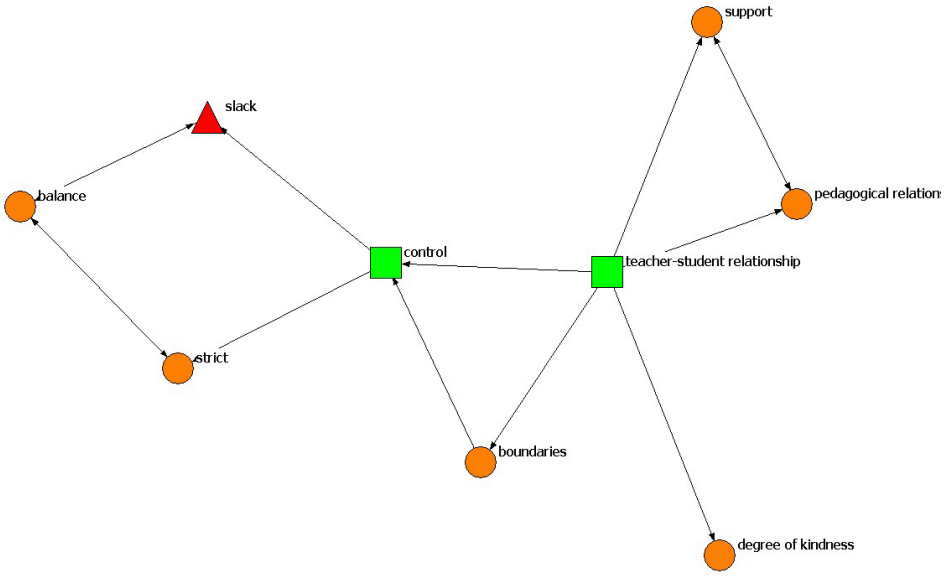

Figure 6.7 Exemplary concept map from the pre-test of PST-a

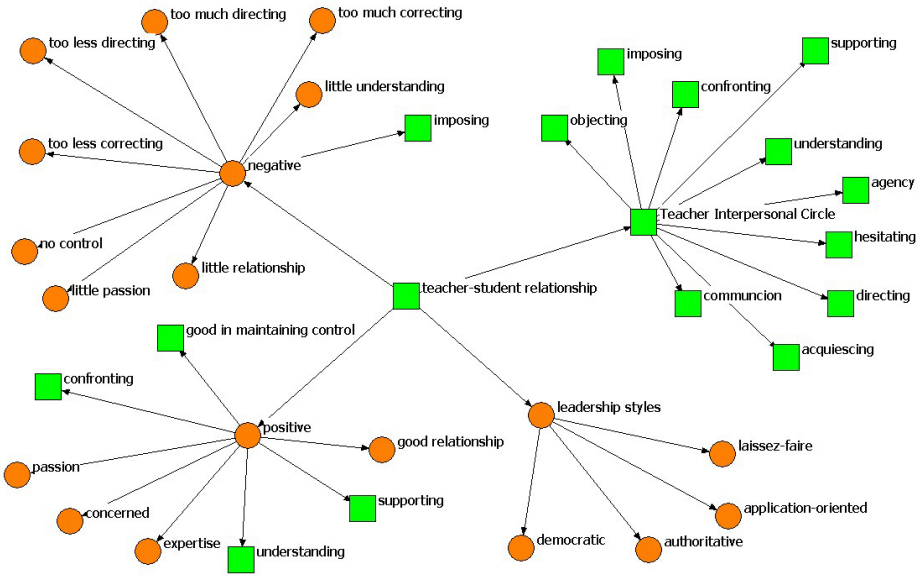

Figure 6.8 Exemplary concept map from the post-test of PST-a

To determine whether the variable 'immersiveness' influenced PSTs' theory-based interpersonal knowledge structures, an analysis of variance (one-way ANOVA) was conducted. Only a significant difference was found between immersiveness and differences between number of clusters at the pre- and post-test as part of PSTs' theory-based interpersonal knowledge development ($F(1,139)$ 9.112, $p < 0.01$). The mean scores revealed that PSTs who watched all video fragments with a VR headset outperformed the PSTs who used the VR headset sometimes or never to watch videos by showing relatively more clusters in their concept maps at the post-test.

PSTs' theory-based interpersonal knowledge development

The second research question of this study investigated the effect of the Virtual Classroom on PSTs' theory-based interpersonal knowledge development.

Table 6.4

Mean scores and standard deviations on number of concepts and relevant concepts

	pre-test		post-test				
	M	*SD*	*M*	*SD*	*t(df)*	*d*	*p*
Concepts							
Total number of concepts (*n* = 140)	16.50	6.05	19.46	6.66	-4.713*(139)*	0.4	<.001
Number of relevant concepts (*n* = 140)	2.17	0.20	2.43	0.25	-10.968*(139)*	0.9	<.001

Table 6.4 shows statistically significant differences in the total number of concepts between the pre- and post-test with a small effect size (*d* 0.4) (Cohen, 1988) and in the number of relevant concepts between the pre- and post-test with a large effect size (*d* 0.9) (Cohen, 1988). In order to provide insight into the growth of relevant concepts, as an example, figure 6.9 shows a PSTs' concept map at the pre-test, and figure 6.10 shows a concept map of the same PST (PST-b) at the post-test using Netdraw in UCINET. As figures 6.9 and 6.10 indicate, there are more green and square-shaped concepts (full agreement with the expert map) at the post-test. Figure 6.10 also illustrates that the less important concepts at the post-test were on the borders of the concept map.

To determine whether the variable 'immersiveness' influenced PSTs' theory-based interpersonal knowledge development, an analysis of variance (one-way ANOVA) was conducted. No significant differences were found between immersiveness and PSTs' theory-based interpersonal knowledge structures.

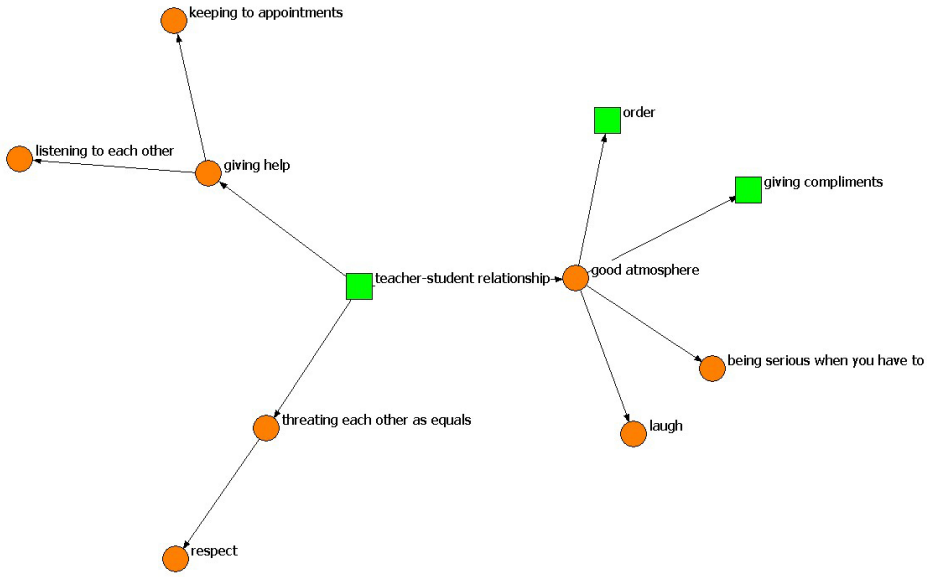

Figure 6.9 Exemplary concept map from the pre-test of PST-b

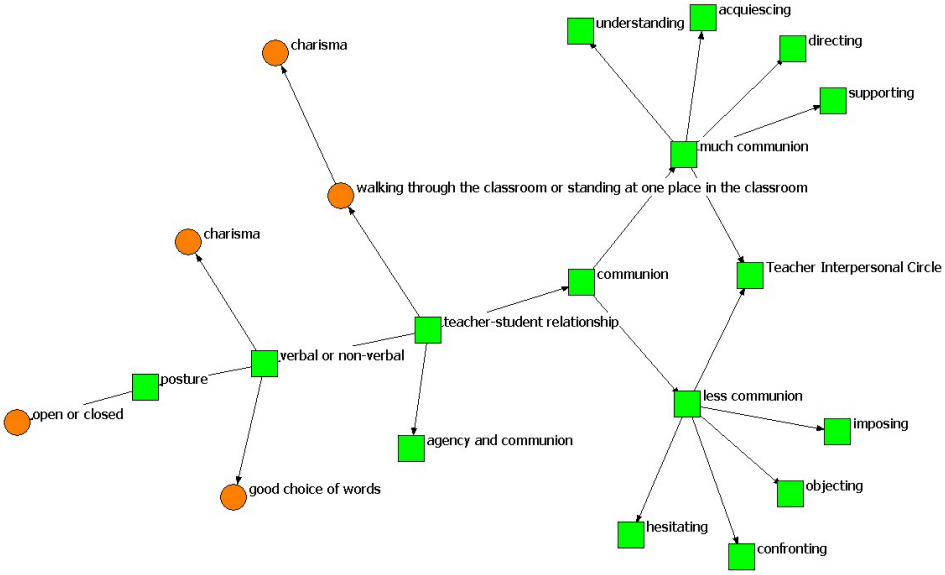

Figure 6.10 Exemplary concept map of the post-test of PST-b

Concerning the question if PSTs' theory-based interpersonal knowledge was developed by the Virtual Classroom, the interview data revealed that all interviewed PSTs reported that for their pre-test concept map, they placed everything they knew about the teacher-student relationship in the concept map. For the post-test concept map nine PSTs stated in their interviews that they relied more on the theory they learned during the Virtual Classroom. These PSTs referred to the 'Teacher Interpersonal Circle,' verbal and non-verbal behaviour, communion, agency, and different teaching styles. After they described the main concepts that were discussed during the Virtual Classroom, they described concepts that were interrelated in their opinion (e.g., positive feedback, respect, trust). Three of these nine PSTs noted that they mainly learned from connecting the theory of the lectures to classroom events in the video fragments. They had never observed other teachers teach from an interpersonal perspective, for example, by studying the non-verbal behaviour of a teacher in the video. What is his position in the classroom? What does he do with his arms? What are his facial expressions? How do students react to this non-verbal behaviour? Two PSTs added that after the Virtual Classroom they gained terminology to describe the teacher-student relationship in the concept map.

Three PSTs did not base their concept maps at the post-test on the interpersonal theory from the Virtual Classroom in the first place. One PST described the kind of teacher she wanted to be in the future. In her description she used concepts related to the teacher-student relationship, like humour, respect, and patience. Another PSTs based his concepts on his own limited teaching experience, which concepts were less related to the interpersonal theory as lectured in the Virtual Classroom. Furthermore, one PST reported that students' trust in the teacher is the most important aspect of the teacher-student relationship. From this, he described related concepts to trust. For example, not being too strict, easy to talk to.

Regarding the question which parts of the concept maps were especially important to PSTs, nine interviewed PSTs reported concepts related to the interpersonal behaviour theory, which were the same PSTs that stated they relied more on the theory they learned during the Virtual Classroom at the post-test. Three PSTs reported the 'Teacher Interpersonal Circle' as the most important part of their concept maps. Especially, being a teacher with high levels of communion and agency was important in their opinion. To them, this led to a good atmosphere in the classroom with positive teacher-student relationships. Regarding a high level of communion and agency two PSTs referred to the videos, these were the same PSTs that indicated to have never observed other teachers teach from an interpersonal perspective. One of these PSTs referred to a teacher in the video with lot of humour, but also to a teacher that was very strict. Another PST also referred to the videos of a very authoritarian teacher as an example of a teacher with less communion.

Furthermore, this PST described a teacher from the videos that was very calm and had lots of agency. Two PSTs described that teachers' personal attention towards students as the most important concept of their concept map. In their opinion, this way students have trust in the teacher and possibly put more effort in the classroom. Related to this, one PST thought that feeling safe is the most important aspect for building a relationship between a teacher and students. Furthermore, according to one PST, teaching norms and values to students is important for treating each other respectfully. Finally, talking about hobbies with students was the most important aspect in one PST's concept map. He thought that finding common ground with students based on mutual hobbies was very positive for building on a teacher-student relationship. Four PSTs stated that all concepts were equally important, and each concept was followed by another concept. The same nine PSTs who reported they relied more on the theory they learned, gained this theory about the teacher-student relationship (partly) through the lectures in the Virtual Classroom and four of these PSTs learned especially from applying theory when watching the videos in the Virtual Classroom. Six PSTs also learned about the teacher-student relationship in other educational sciences courses at the teacher training institute that were conducted at the same time as the Virtual Classroom. Five PSTs indicated to have made the concept maps purely based on their own experiences as a student.

Finally, PSTs were asked if there were differences between their concept maps at the pre- and post-test. All 12 PSTs reported that for the post-test concept map they used more interpersonal behaviour terminology derived from the theoretical lectures in the Virtual Classroom. For example, they used terms as communion, agency, Teacher Interpersonal Circle, verbal and non-verbal communication, posture, imposing, directing, helpful, compliant, dissatisfied, uncertain, imposing, and confrontational (see for an example of PST-c, figures 6.11 and 6.12). For two PSTs, the post-test concept map was more concrete, and four PSTs stated their post-test concept map was more structured. Finally, two PSTs focused at the pre-test concept map more on the content of their discipline, while they focused their post-test concept map more on teacher behaviour in general.

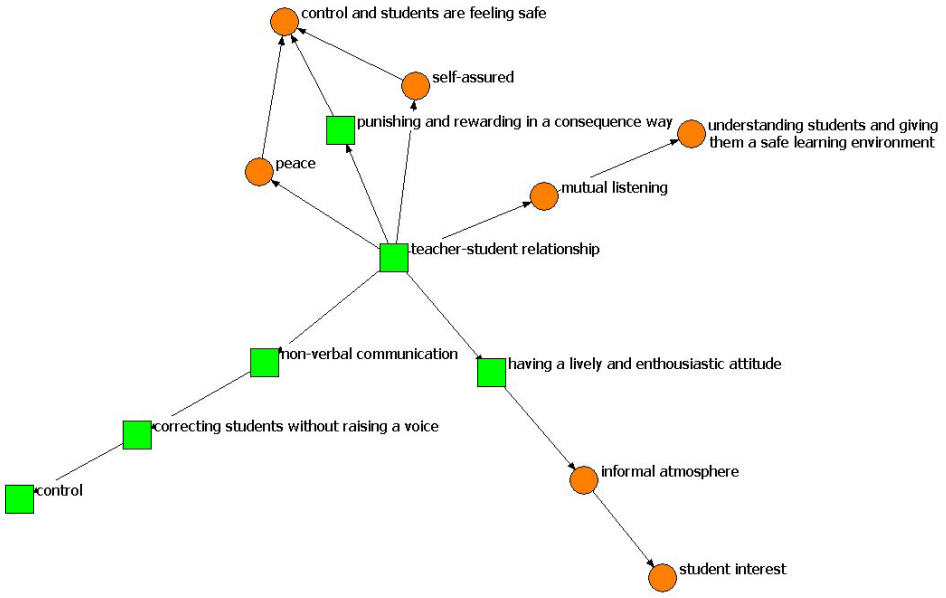

Figure 6.11 Exemplary concept map from the pre-test of PST-c

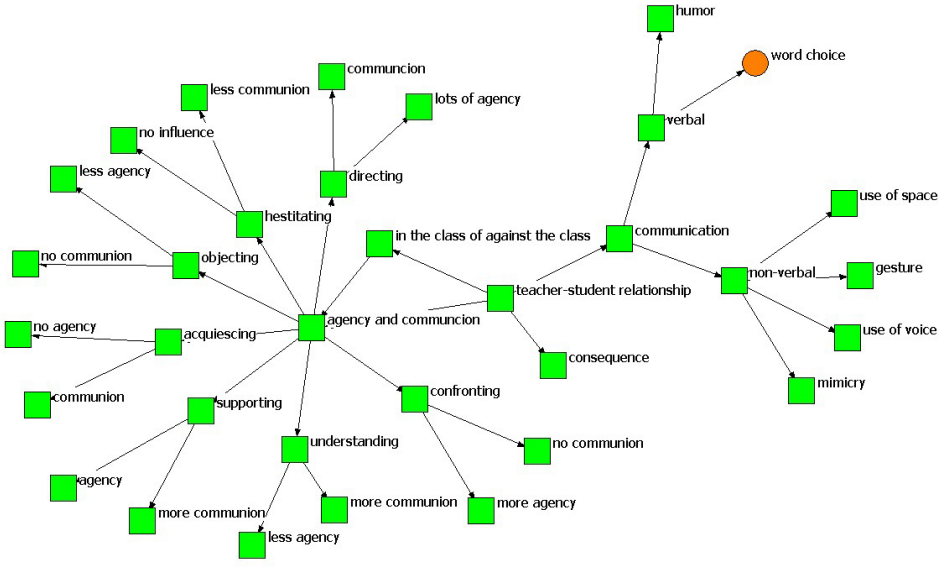

Figure 6.12 Exemplary concept map from the post-test of PST-c

PSTs' theory-based interpersonal knowledge application

For the third research question, we were interested to see if PSTs could apply their theory-based interpersonal knowledge in descriptions of authentic classroom situations.

Table 6.5 shows the percentage of agreement between PSTs and the experts when scoring the teacher behaviour vignettes in the quadrants of the Teacher Interpersonal Circle. There is a reasonable percentage of agreement for the vignettes 1, 6, 14, 18, and 19 (between 60,3% and 72,3%), and a high percentage of agreement for the vignettes 3, 7, 8, 9, 15, and 16 (between 83,7% and 97,9%). Six of the eleven above-mentioned concepts were vignettes situated in quadrant 1, three vignettes were situated in quadrant 4 and one vignette was situated in quadrant 3. This indicates that PSTs were mainly capable in applying their theory-based interpersonal knowledge for recognizing teacher behaviour situations in quadrants 1 directing-helpful and 4 imposing-confrontational, which are both quadrants where teachers showed a high level of agency. There was a relatively low percentage of agreement for the vignettes 4, 5, and 13 (between 7,8% and 24,1%). These three vignettes were the only three vignettes with situations situated in quadrant 2 understanding-compliant. This indicates that PSTs struggled the most with applying theory-based interpersonal knowledge for recognizing teacher behaviour with higher communion and lower agency.

Table 6.6 shows that the absolute distance between PSTs and the experts was relatively low for vignettes 3, 7, and 9, which is congruent with the comparisons of PSTs and the experts on the quadrant level. These results confirm that PSTs were especially capable in scoring vignettes in quadrant 1 directing-helpful. Contrary to the findings of the comparisons of PSTs and the experts on the quadrant level, the absolute distance between PSTs and the experts was relatively high for the vignettes 8, 14, and 19. This were three vignettes in which the experts scored close to the border of a quadrant.

To determine whether the variable 'immersiveness' influenced the scoring of the vignettes, an analysis of variance (one-way ANOVA) was conducted. A significant difference was found between immersiveness for scoring the vignettes ($F(1,139)$ 10.420, $p < 0.01$). The mean scores revealed that PSTs that watched all video fragments with a VR headset outperformed the PSTs that watched the videos sometimes or never with the VR headset, the absolute distance between their scores and the experts' score was lower (respectively 2.88 and 3.12). This indicates that the level of immersiveness positively influenced PSTs' theory-based interpersonal knowledge application when scoring teacher behaviour vignettes.

Table 6.5

Percentage agreement PSTs and experts in scoring vignettes in quadrants

Vignette	Quadrant expert	Percentage agreement PSTs - experts	*N*
1	1	62.4%	140
2	4	34%	138
3	1	92.2%	139
4	2	17.7%	138
5	2	7.8%	140
6	4	72.3%	141
7	1	95%	141
8	1	92.2%	141
9	1	96.4%	139
10	3	41.1%	141
11	3	60.3%	140
12	4	50.4%	140
13	2	24.1%	140
14	4	60.3%	139
15	1	97.9%	140
16	1	83.7%	139
17	1	47.5%	140
18	3	63.8%	140
19	4	64.5%	140
20	3	45.4%	140

Note: quadrant 1 = directing-helpful, quadrant 2 = understanding-compliant, quadrant 3 = dissatisfied-uncertain, quadrant 4 = imposing-confrontational

Table 6.6

Descriptive statistics mean absolute distance between PSTs and experts on vignette scores

Vignette	*N*	Minimum	Maximum	Mean	Std. deviation
1	140	.00	4.47	2.09	.89
2	138	.00	8.54	3.60	1.63
3	140	.00	7.00	1.52	1.13
4	140	.00	9.43	6.94	1.66
5	140	.00	5.10	3.25	1.43
6	141	.00	7.07	2.43	1.71
7	141	.00	5.39	1.51	.85
8	141	1.00	7.07	3.13	.93
9	139	.00	5.00	1.48	.80
10	141	.00	9.43	3.49	2.07
11	140	.00	9.43	2.80	1.48
12	140	.00	8.54	3.62	2.15
13	140	1.00	8.25	5.26	1.91
14	139	.00	7.28	3.19	1.63
15	140	.00	4.47	2.62	.72
16	139	.00	6.40	2.13	1.32
17	140	.00	7.21	2.57	1.31
18	140	.00	7.21	2.62	1.25
19	140	.00	8.54	3.14	1.81
20	140	.00	8.06	3.01	1.64

6.6 Conclusion and discussion

In this study we were interested to see if PSTs' theory-based interpersonal knowledge structures and the content of PSTs' theory-based interpersonal knowledge developed after theoretical lectures with videos (the Virtual Classroom). Furthermore, we were interested to see if PSTs could apply their theory-based interpersonal knowledge in descriptions of authentic classroom situations.

With respect to the first research question, it was found that PSTs showed more organised concept maps after the intervention. This was reflected in the statistically significant increase of links and clusters and the statistically significant decrease of density and reciprocity. Especially in concept maps of PSTs who used the VR headset throughout the whole intervention the number of clusters increased. Therefore, it seemed that providing PSTs with theoretical lectures added with observing immersive video fragments led to an increased structured concept map. Following Buitink (2009), a more structured concept map is associated with a better developed interpersonal knowledge structure. For teacher education, this implies that concept maps are a useful tool to assess PSTs' knowledge development as they can be analysed and compared for the knowledge structure before and after a course. These more organised concept maps after the intervention also imply that the combination of theoretical lectures and watching 360-degree videos can be an asset for teacher education to improve PSTs' knowledge structures about a certain topic, such as interpersonal teacher behaviour.

With respect to the second research question, it was found that PSTs used statistically significantly more concepts at the post-test compared to the pre-test. Moreover, these concepts were also more relevant after the intervention, when compared with the expert map. This indicates that PSTs' theory-based interpersonal knowledge also developed in the desired direction after the Virtual Classroom. By having a closer look at the concepts of the post-test, the qualitative data revealed that PSTs at the post-test relied more on the theory they learned partly during the Virtual Classroom. This was reflected in mentioning concepts about the systems approach to communication (Watzlawick et al., 1967; Wubbels et al., 2006), the Teacher Interpersonal Circle (Wubbels et al., 2006; den Brok & van Tartwijk, 2015; Pennings et al., 2018), and teachers' verbal and non-verbal behaviour (van Tartwijk, 1993). It was surprising that only four PSTs referred to the videos in the Virtual Classroom. This implies that especially the theoretical lectures seemed to contribute to PSTs' improved theory-based interpersonal knowledge, while the actual addition of 360-degree videos to this remains limited. Overall, these data suggest that the use of theoretical lectures, in combination with 360-degree videos, develops PSTs' theory-based interpersonal knowledge and is, therefore, a useful method for teacher education.

With respect to the third research question, it appeared that PSTs were mainly capable in applying their theory-based interpersonal knowledge on vignettes from quadrants 1 directing-helpful and 4 imposing-confrontational. A high level of agency is a characteristic of behaviour in these both quadrants. PSTs struggled with scoring classroom situations from quadrant 2 understanding-compliant, which is associated with a low level of agency. There are three possible explanations for these results: (1) Most experienced teachers have higher scores on the agency dimension than beginning teachers (Brekelmans, 2010). In their own experiences as a student, PSTs were confronted with these experienced teachers, who possibly formed their perception on teacher behaviour. (2) In the Virtual Classroom the focus of the theoretical lectures was on quadrant 1 which can be seen as ideal interpersonal teacher behaviour (Brekelmans, 2010). (3) The majority of the vignettes corresponded with quadrant 1.

Although the interviews and the concept maps suggested that PSTs especially developed their interpersonal knowledge through the theoretical lectures, it was shown that the use of a VR headset positively influenced PSTs' theory-based knowledge development and application. Firstly, the number of clusters in PSTs' concept maps increased statistically significantly when all videos were watched using a VR headset which suggests more organised interpersonal knowledge. Secondly, PSTs interpersonal knowledge application was closer to that of experts after using a VR headset all the time, outperforming PSTs that used a VR headset less often. This implies that a higher level of immersiveness is a positive influence for interpersonal knowledge development. This is possibly due to VR's immersive ability to offer realistic and authentic situations (Martín-Gutiérrez et al., 2016) and its ability to disconnect PSTs from their surroundings (Olmos-Raya et al., 2018).

A first limitation of this study was that only 60 PSTs used the VR headset throughout all the sessions. This was because some mobile phones were not equipped with a gyroscope necessary for watching videos in 360-degrees, and some PSTs felt nausea. It would be interesting for further research to investigate which conditions contribute to and hinder the use of a VR headset. A second limitation was that the nature of the interrelations between concepts were underexposed. This study only investigated if PSTs used more relevant concepts and links, and the structure involved. However, it is still unknown if PSTs made correct connections between concepts. Further research into the interrelations between concepts would be recommended. A third limitation was that during the interviews there was a lack of mentioning interpersonal theory while watching 360-degree videos. It would be interesting to see what the specific influence of watching videos with a VR headset is for knowledge development in relation to the theoretical lectures. Future research could examine this. Thirdly, PSTs' vignettes were compared with the experts at the quadrant level. However, the Teacher Interpersonal Circle can also be divided on a more precise level in

eight segments (den Brok & van Tartwijk, 2015). Further research regarding comparisons at the segment level would be worthwhile. Lastly, differences in PSTs' network structures at the pre- and post-test approached significance. Buitink (2009) argued that the network structure is an indicator for the complexity of a person's knowledge structure. For this reason, future research could provide a deeper understanding about the influence of a combination of 360-degree videos and theoretical lectures on PSTs' theory-based interpersonal knowledge structures.

Despite these limitations, this study has certainly added to our understanding of (1) PSTs' knowledge development by assessing PSTs' knowledge structures with concept maps, (2) the developing of the content of PSTs' theory-based interpersonal knowledge, and (3) PSTs' theory-based interpersonal knowledge application through theoretical lectures combined with 360-degree videos. This study has shown that PSTs' theory-based interpersonal knowledge structure can be visualised using concept maps and interpreted by using social network analysis, by analysing measurements of structural complexity, and via comparisons with expert maps. Therefore, concept maps appear a useful method for teacher education institutes to assess PSTs' knowledge development. Finally, PSTs used more irrelevant concepts at the pre-test, while at the post-test they improved their concept maps with more relevant concepts due to the combination of theoretical lectures and watching 360-degree videos (the Virtual Classroom). This led to more precise concept maps with more relevant concepts and possibly a decreased the network cohesion. This implies that the Virtual Classroom is a valuable method for teacher education institutes to improve PSTs' theory-based interpersonal knowledge. To conclude, PSTs' theory-based interpersonal knowledge structures, development, and application can benefit from using VR headsets in combination with theoretical lectures. Possibly this is true for more sorts of theory-based knowledge, which offers an interesting angle for future research.

Chapter 7

Discussion & Reflection

7.1 Introduction

The main research question of this dissertation was: *How can computer-based classroom simulations be used in teacher education to train preservice teachers' interpersonal behaviour to reduce their professional anxiety and increase their self-efficacy?* To answer this main research question, the following sub-questions were investigated:

1. *How can virtual internships in blended learning environments positively support PSTs' professional anxiety? And how are virtual internships experienced by PSTs?*
2. *What main issues regarding computer-based classroom simulations, affordances, hindrances, learning experiences, interpersonal competence, professional anxiety and self-efficacy have emerged in the field of research on teacher education?*
3. *How can 360-degree videos, combined with theoretical lectures, support PSTs' interpersonal competence, their self-efficacy and their professional anxiety? And how is the video-lecture combination experienced by PSTs?*

These three sub-questions were answered in three consecutive studies, which were reported in five empirical chapters (chapters 2 through 6), each focusing on more specific sub-questions. In the present chapter, the results of these studies are summarized and synthesized to a general conclusion, followed by a discussion of the main results, limitations, suggestions for future research, and implications for practice.

7.2 Main findings

Virtual Internships as preparation for the professional teaching context

Study one (as described in chapter 2) presented a first exploratory investigation of the use of computer-based classroom simulations in teacher education. The study focused on the first research question of this dissertation and investigated whether virtual internships in blended learning environments as a type of classroom simulation could be useful to prepare PSTs for their work as teachers. The study explored if virtual internships reduced PSTs' professional anxiety and identified how virtual internships in blended learning environments were evaluated by PSTs in terms of technological, social, and educational affordances.

For the study, two virtual internships were designed (VI-1 and VI-2) using two different online systems. Purpose of these virtual internships was for PSTs to think and act like teachers in an authentic and scenario-driven online learning environment. Activities in VI-1 (*N = 27)* were about differentiation for a special education needs student and integrated

with lectures of a course about diversity in the classroom from a teacher education programme for secondary education in the Netherlands, creating a blended learning environment. Activities in VI-2 (N = 16) were about interpersonal teacher behaviour and integrated with lectures of a course about classroom management from the same teacher education programme.

Participants of the study were PSTs of a teacher education programme at Eindhoven University of Technology who enrolled in two courses. A mixed-method design was used. Professional anxiety and affordances were measured with pre- and post-intervention questionnaires. A focus group (n = 6) and semi-structured individual interviews (n = 9) were used after the intervention to gather more insight into PSTs' experiences with the virtual internships. The results of the pre- and post-test were compared using a paired samples t-test. Because of the small sample size, the non-parametric Wilcoxon signed-rank test was used to verify the t-test outcomes. Concerning the qualitative data categorisation on sensitizing concepts in an analysis matrix was conducted.

A significant decrease was found in PSTs' professional anxiety for VI-2, in which PSTs with little or no teaching experience participated. No significant differences were found in PSTs' professional anxiety for VI-1, in which PSTs with some earlier teaching experience participated. PSTs of VI-2 reported in the interviews that the virtual internship contributed to a more realistic image of educational practice. Consequently, PSTs of VI-2 felt better prepared for entering the actual teaching practice. The different effects for professional anxiety for both virtual internships may be due to the differences in earlier teaching experiences and differences in the online learning environments. After all, the online learning environment of VI-2 had a higher degree of personalisation (e.g., mother tongue, a familiar learning environment, personalised feedback) and used more video fragments. In conclusion, the quantitative and qualitative data showed that virtual internships were a useful method for teacher education to reduce PSTs' professional anxiety, under the condition that PSTs involved in the virtual internship had little or no earlier teaching experience. Virtual internships were beneficial for these PSTs because the internships contributed to a more realistic image of the actual teaching practice and consequently made PSTs feel more prepared. The interviews revealed added value especially for using a higher degree of personalisation and watching videos about other teachers at work.

Regarding the affordances, the pre- and post-intervention questionnaires showed the virtual internships were experienced as sufficiently user-friendly. The qualitative data revealed that PSTs felt flexible in time and place when using the virtual internships, which was highly appreciated, suggesting that virtual internships were a useful method to create a blended learning environment in which PSTs could prepare for the actual

teaching practice, at their own pace and place. PSTs appreciated the connection between lectures at the teaching education institute and assignments in the virtual internships. Furthermore, PSTs appreciated collaboration with their peers in the virtual internship by sharing examples and discussing their assignments. PSTs preferred a chat function over a discussion forum, however, because PSTs could enter the internship at their own pace, sometimes it was hard to meet peers simultaneously online.

Classroom simulations in teacher education: A literature review

Chapter 3 presented a literature review that focused on the second research question and mapped the main issues regarding computer-based classroom simulations, affordances, hindrances, learning experiences, interpersonal competence, and well-being that have emerged in the field of research on teacher education. In this study it was assumed that PSTs' well-being, consisting of PSTs' professional anxiety and self-efficacy as each other's counterparts, were positively influenced by positive teacher-student relationships (Wubbels et al., 2015). The ability to create these positive teacher-student relationships, and the meaning students and teachers give to their interactions, was defined as PSTs' interpersonal competence (Wubbels et al., 2015; Wubbels et al., 1985). We distinguished between three important components of interpersonal competence: *(1)* professional interpersonal vision, *(2)* interpersonal knowledge, and *(3)* professional interpersonal repertoire. Furthermore, it was assumed that PSTs' interpersonal competence can be trained with computer-based classroom simulations, bridging the gap between theory learned at the teacher educational institute and the actual teaching practice by new learning experiences.

Results of this second study revealed that little is known about the use of classroom simulations in teacher education to improve PSTs' well-being by training their interpersonal competence. The literature review only found 15 empirical studies eligible for inclusion and these studies only focused on single interrelations between the concepts (computer-based classroom simulations, PSTs' well-being, and PSTs' interpersonal competence) or used broader concepts (e.g., teaching skills or classroom management). Most of these included studies reported positive effects of simulations on PSTs' classroom management and teaching skills in general, rather than specifically on interpersonal competence. Concerning PSTs' well-being, four studies did show positive effects of simulations on PSTs' self-efficacy. However, none of the studies reported on PSTs' professional anxiety. Reported affordances were mostly educational (e.g., receiving teacher feedback, available resources) or social (e.g., peer observation, discussions), while the reported hindrances were mainly of a technical nature (e.g., lack of a user-friendly interface, malfunctioning audio or video). Positive learning experiences depended on the degree of realism and authenticity in the simulation. Overall, the included studies showed positive results for the

use of computer-based classroom simulations in teacher education as an added value to the already consisting curricula and real-life internships. Although research on classroom simulations in teacher education appeared scarce, the literature review strengthened the idea that simulations are promising tools to improve PSTs' well-being and interpersonal competence. Therefore, and because of the promising use of videos from study one, study three concentrated on the use of 360-degree videos as a type of classroom simulation to improve PSTs' well-being and interpersonal competence.

360-degree videos to prepare for the professional teaching context

Study three was one large-scale intervention focusing on research question 3 and the results of this study were subdivided over three empirical chapters (respectively chapters 4, 5, and 6). The intervention used 360-degree videos to simulate classroom events by providing PSTs with real-life authentic cases. The 141 PSTs from a teacher education programme for secondary education at Fontys University of Applied Science for teacher education in the Netherlands involved in this intervention could watch the 360-degree videos with a virtual reality (VR) headset. The videos contained classroom events concerning interpersonal teacher behaviour that PSTs typically struggled with, such as disruptive student behaviour. Besides watching the 360-degree videos, PSTs received lectures with theory regarding interpersonal teacher behaviour.

The first part of study three (chapter 4) investigated if the video-lecture combination could decrease PSTs' professional anxiety and increase PSTs' self-efficacy. Because PSTs' differed in their sense of self-efficacy and coped differently with feelings of anxiety, this study also investigated if different clusters of PSTs could be distinguished regarding PSTs' self-efficacy and professional anxiety. Furthermore, PSTs' self-perceived interpersonal behaviour was investigated. A mixed-method design was used with pre- and post-intervention questionnaires to measure PSTs' professional anxiety and self-efficacy, a post-intervention questionnaire was used to measure PSTs' self-perceived interpersonal behaviour, and semi-structured individual interviews ($n = 12$) to gather more insights in PSTs' experiences with the video-lecture combination. The results of the pre- and post-test were compared using a paired samples *t*-test. Regarding the qualitative data, categorisation via sensitizing concepts in an analysis matrix was conducted. A hierarchical cluster analysis was conducted at the pre-test to identify clusters of PSTs regarding PSTs' professional anxiety and self-efficacy. To determine if PSTs from different clusters developed their interpersonal behaviour differently, a one-way ANOVA was conducted with the cluster solution as an independent variable.

Student questionnaire data measured before and after the intervention revealed that the video-lecture combination contributed to a statistically significantly reduced professional anxiety and increased self-efficacy. In other words, PSTs became more confident in their

own abilities to handle classroom management issues and less anxious to teach. The qualitative data revealed that PSTs' anxiety reduced by observing the exemplary behaviour of experienced teachers in the videos. This made PSTs more familiar with the actual teaching practice. The post-intervention questionnaire regarding PSTs' self-perceived interpersonal behaviour showed that PSTs perceived themselves as more directing and less imposing, resulting in higher anticipated levels of communion after the intervention. This means that after the intervention PSTs perceived themselves as teachers that could create a higher degree of warmth in their teacher-student relationships than before the intervention. The cluster analysis on pre-test data revealed that two clusters of PSTs could be distinguished: PSTs from cluster 1 scored both high on professional anxiety and self-efficacy, PSTs from cluster 2 scored average on professional anxiety and high on self-efficacy. The one-way ANOVA showed that PSTs from both clusters differed significantly in their anxiety after the intervention. For PSTs from cluster 1 the reduction in anxiety was the highest, which seems logical because before the intervention they already scored much higher on anxiety. The results of this study suggested that the video-lecture combination might be a useful method to smoothen the transition from the teacher education institute to the actual teaching practice, as it was able to reduce PSTs' professional anxiety and increase their self-efficacy.

The second part of study three (chapter 5) examined if PSTs' interpretations of noticed classroom events (as part of their professional interpersonal vision) could be improved by the video-lecture combination. This was measured by tagging video fragments of authentic classroom situations at the pre- and post-test. PSTs were asked to note three to five aspects related to the teacher-student relationship they considered to be important. Furthermore, technological and educational affordances of the video-lecture combination were evaluated using a post-intervention questionnaire. To obtain insights in the manner in which PSTs tagged the video fragments and in how PSTs' experienced the Virtual Classroom, semi-structured individual interviews were conducted after the intervention ($n = 12$). The tags were coded into four levels based on the Learning to Notice Framework (van Es & Sherin, 2002): (1) descriptive tags, (2) evaluation tags, (3) analytic tags, and (4) prescriptive tags.

Results of the pre- and post-test were compared using a paired samples *t*-test and showed that PSTs improved in noticing classroom events and in applying a theory-based terminology to describe these events. In other words, PSTs interpreted the video fragments at the post-test at higher levels of the Learning to Notice Framework, indicating that they used more knowledge about teaching and learning principles for their interpretations. PSTs confirmed in the interviews that they used more interpersonal behaviour theory when tagging the video fragments. In terms of educational affordance, PSTs reported to

feel better prepared for the actual teaching practice after watching experienced teachers teach in the videos. Regarding the technological affordances, PSTs experienced watching 360-degree videos with a VR headset as an immersive learning experience. However, many PSTs experienced physical discomfort and technical hindrances using the VR headset. Results from a one-way ANOVA showed that PSTs improved professional vision was not influenced by watching 360-degree videos with or without a VR headset. In conclusion, this second part study found that the combination of 360-degree videos and lectures influenced PSTs' professional interpersonal vision positively, although the added value of a VR headset was not established. Furthermore, findings of this study emphasized the importance of good quality VR environments to improve the immersive experience.

The third part of study three (chapter 6) investigated PSTs' interpersonal knowledge structures and development of these structures via concept maps before and after the intervention. Interviews were conducted to understand the interpretations PSTs gave to concepts (n = 12). PSTs' concept maps were analysed with social network analysis, including measures of structure and conceptual relevance, and were compared to expert networks. To establish the concept map's structure, quantitative measurements were used (e.g., number of links, number of clusters, number of concepts, density). Results of these measurements at the pre- and post-test were compared using a paired samples t-test.

Results showed PSTs used more organised concept maps after the intervention, this was reflected in an increase of the number of links and clusters, and a decrease in the concept map's density and decrease in reciprocity between concepts. A more structured concept map is typically associated with a better developed (interpersonal) knowledge structure (Buitink, 2009). PSTs' interpersonal knowledge development was established by determining the relevance of used concepts, by comparing the PSTs' concepts with an expert concept map. Results showed that PSTs' concept maps included more relevant concepts after the video-lecture intervention. The qualitative data revealed that PSTs at the post-intervention concept map relied more on the theory they learned during the Virtual Classroom.

Furthermore, PSTs' knowledge application was measured via vignettes after the video-lecture combination. These vignettes contained descriptions of classroom situations with teacher behaviour. PSTs were asked to score this teacher behaviour on the communion and agency dimension of Teacher Interpersonal Circle (Pennings et al., 2018). These scores were compared with scores of experts on the vignettes by calculating absolute differences between PSTs and experts. PSTs were particularly capable in applying their interpersonal knowledge on vignettes focusing on high levels of interpersonal teacher control.

Finally, an ANOVA was used to determine if the device used for watching the videos (e.g., mobile phone in VR headset, only mobile phone, laptop, tablet) influenced PSTs' theory-based interpersonal knowledge structures, development, and application. It was shown that the use of a VR headset positively influenced PSTs' theory-based knowledge structures and application. PSTs that used a VR headset all the time used significantly more clusters in their concept maps, suggesting more organised interpersonal knowledge than PSTs that used the VR headset less often. Furthermore, PSTs that used a VR headset all the time outperformed PSTs that used the headset less often in interpersonal knowledge application. This implies that a higher level of immersiveness is a positive influence for interpersonal knowledge development. In conclusion, this study has shown that PSTs' theory-based interpersonal knowledge structure could be visualised using concept maps and interpreted by using social network analysis. Therefore, concept maps appeared a useful method for teacher education institutes to assess and improve PSTs' theory-based interpersonal knowledge.

General conclusion: Computer-based classroom simulations as a tool for teacher education institutes

Concerning the main research question of this dissertation, all three consecutive studies showed promising results for the use of computer-based classroom simulations in teacher education. Although it is yet unknown whether the classroom simulations contribute to improved interpersonal teacher behaviour in actual teaching practice in the classroom, the results of this dissertation indicated that interpersonal teacher behaviour can be trained with classroom simulations at different teacher education institutes. Even more important, after both types of classroom simulations (virtual internships and 360-degree videos) PSTs felt less anxious to enter the actual teaching practice. Classroom simulations appeared to be valuable tools to provide PSTs with a more realistic image of the teaching practice and consequently gave PSTs a better image of what student behaviour they could expect in classrooms and how they could act as a teacher (e.g., Blomberg, Sherin, Renkl, Glogger, & Seidel, 2014; Cho, Mansfield, & Claughton, 2020).

Computer-based classroom simulations come in various types, for example in non-immersive designs or more immersive designs (see also chapter 3). Because classroom simulations are context specific and because of differences in their design and content, it would be unfair to directly compare the two types of classroom simulations used in this dissertation (virtual internships and 360-degree videos).

The classroom simulations described in this dissertation differed in the degree of immersiveness. The virtual internships were non-immersive with classroom and school scenarios represented through text and static graphical output; contrary to watching

360-degree videos with a VR headset, which was intended to be more immersive by the visual representations of realistic classroom events. Because of dizziness and technical hindrances, however, not all PSTs used the VR headset, which made the 360-degree videos as classroom simulation less immersive for some PSTs. Despite the different degrees of immersiveness, both the non-immersive as well as the more immersive classroom simulations led to less anxious PSTs. Remarkable in study one was that PSTs overlooked the scenario of the virtual internship and solely focused on the assignments in the internship. This renders the question whether authenticity via immersiveness plays a role in learning outcomes. To be able to answer this question, further research focusing on the technical aspects of immersive simulations and their contribution to learning outcomes would be necessary.

A similar finding from both types of simulations was that the simulations appeared to be especially useful for PSTs with little or no teaching experience. Some PSTs with previous teaching experience struggled with the differences between a simulation and the actual teaching practice, perhaps because they already experienced a more realistic real-life classroom. Therefore, computer-based classroom simulation seemed to be extra useful for preparing beginning teachers for their first real-life internships. However, Herrington and colleagues (2007) argued that the physical fidelity of the simulation is less important than the task's characteristics and students' engagement in the simulation. They also stated that it is very expensive to create realistic simulations in education and that it is better to invest in authentic and engaging tasks in the simulation.

In the next section, the main results of this dissertation will be further discussed. First, the focus is on computer-based classroom simulations as a bridge between teacher education institutes and the actual teaching practice. Second, the mix of theoretical lectures and 360-degree videos is focused at. Third, a closer discussion of the added value of 360-degree videos over traditional videos is given.

7.3 Discussion of main results

Computer-based classroom simulations as a bridge between teacher education institutes and the actual teaching practice

One of the main concerns in teacher education is the transition from school to workplace. There is a gap between the formal learning environment of the teacher education institute and the actual teaching practice, which beginning teachers experience as difficult to bridge (Korthagen, 2010). Many feel anxious when starting as a teacher. This anxiety arises from the 'practice shock' that beginning teachers experience which influences their ability to

establish positive student-teacher relations. The current study showed positive results using simulations in teacher education institutes to develop interpersonal competence, which in turn led to a decrease in anxiety and may be helpful for beginning teachers possibly to partly bridge the gap between educational practice and the teacher education institute.

The use of classroom simulations in a curriculum creates a hybrid learning environment (Figure 7.1). According to Zitter and Hoeve (2012), such an environment brings together the formal (the teacher education institute) and informal (the actual teaching practice) learning environments. This way, computer-based classroom simulations can be used to smoothen the transition from the teacher education institute to teaching practice. Zitter & Hoeve's model of hybrid learning integrates characteristics from both formal and informal learning, creating an intermediate for the gap between theory and actual teaching practice.

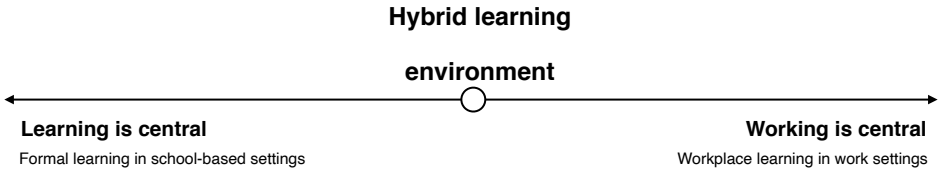

Figure 7.1 Hybrid learning environment (Zitter & Hoeve, 2012)

Formal learning is characterised as intentional, organized in a formal curriculum, and focused on explicit knowledge and generalized skills. In contrast, informal learning takes place in realistic settings becoming a member of a professional community, and focuses on tacit knowledge, contextualized action, and collaborative learning (Zitter & Hoeve, 2012). In this dissertation, formal learning and informal learning were merged into a hybrid learning environment using classroom simulations (virtual internships and the virtual classroom). The formal learning aspect of the used classroom simulations took place in the blended learning environments by theoretical lectures. The realistic settings, creating informal learning, were formed by the authentic settings of classroom simulations.

Interviewed PSTs from both types of classroom simulations (virtual internships and the virtual classroom) stated that by using classroom simulations the opportunity arises for PSTs to familiarise themselves with different classroom events and core practices of teachers. Although real-life internships are more authentic than simulated ones, they do not bring the opportunity to create specific events and practice with them in a safe environment like classroom simulations do. Contrary to real-life internships, classroom simulations are controlled environments which enable PSTs to practice events multiple

times. At this moment, the use of computer-based classroom simulations in teacher education is relatively new. Studies of this dissertation revealed positive outcomes of classroom simulations, contributing to PSTs' interpersonal competence by developing their interpersonal professional vision (study 4), interpersonal knowledge structures (study 5) and application (study 5). This way, PSTs were made familiar with the actual teaching practice, which reduced their professional anxiety and improved their self-efficacy. The positive outcomes in this dissertation might have been a result of the 'novelty effect' of the used classroom simulations. When learners are confronted with new technologies, these technologies can be experienced as exciting because of their novelty (Wells, Campbell, Valacich, & Featherman, 2010). It is possible, for example, that the temporary novelty of technology adds to gained educational effects, or in contrast that the infancy of technology limits educational gains due to certain hindrances (for example, low resolution 360-degree videos). However, in this dissertation, the novelty effect seems not to be a logical explanation because the results showed flaws in technology – that were also experienced as such – and that limited the yield of classroom simulations. When technologies for computer-based classroom simulations develop further, i.e., increasing video quality and more intuitive viewing options, classroom simulations can be an even more valuable method to bring PSTs in touch with classroom events at an early stage of their teacher education programme to prepare them for the actual teaching practice.

The advantage of computer-based classroom simulation in relation to simulations without computers (e.g., role play), is that they can be part of blended learning environments with benefits such as individual practice and practicing at a pace, time and place that fits individual PSTs. This supports more flexible learning trajectories, which is especially useful for small-scale and/or customized education programmes.

The combination of theoretical lectures and 360-degree videos

This dissertation showed that computer-based classroom simulations combining theory and 360-degree videos were beneficial in the context of PSTs and their interpersonal competence. The current study used a cocktail of theoretical lectures and 360-degree videos as format for the classroom simulation. Because PSTs developed their interpersonal knowledge using more developed concept maps with a higher-level theoretical concept (see chapter 6) and because PSTs' used more theory when noticing and interpreting relevant classroom events (see chapter 5), results underlined the importance of the theoretical lectures. Other results, however, indicated that especially the 360-degree videos were of importance. For example, PSTs that used the VR headset outperformed PSTs' that used the VR headset less often/not at all in terms of knowledge development. For other results, such as the decrease in professional anxiety and increase in self-efficacy,

it was not clear if especially the theoretical lectures, the 360-degree videos or the cocktail of both contributed. What is yet to be discovered is whether these results are the effects of one of the ingredients, a specific combination, or the entire cocktail.

In this dissertation, 360-degree videos were used to simulate classrooms (see chapter 4, 5, and 6). 360-Degree videos offer viewers the opportunity to observe the entire setting, contrary to a static viewing point (Reyna, 2018). As a result, a feeling of immersiveness arises, making the viewer more part of the experience than just being an observant (Martín-Gutiérrez et al., 2016). The use of VR headsets can further enhance this experience by changing the video's viewpoint by changing head movement, resembling natural viewing.

Surprisingly, the use of VR headsets to view the 360-degree videos did not benefit PSTs for the greater part of the results in this dissertation. Viewing videos both with and without VR headset mostly showed similar results. Although some respondents enjoyed using the VR headset, many respondents encountered issues hindering the experience. These hindrances often arose from the immature technological development, such as a low-resolution video, trouble with fitting the VR headset on respondents' heads, and a lack of a gyroscope function on respondents' phones to be able to change viewpoint by head movement.

The intervention in this dissertation used an affordable 360-degree video camera from the lower segment of the market and VR headsets where respondents placed their own smartphone in, which could be the cause of some of the hindrances. VR technology is developing fast. Every year new possibilities arise while the technology is maturing, offering more opportunities to incorporate VR experiences in educational research. 360-degree video cameras with a higher resolution and VR headsets with integrated screens are currently on the market and, when more budget is available these more matured technology could provide better quality videos. Another opportunity is Facebook's Occulus Rift Platform. Although this requires substantial development work to create a suitable simulation, Facebook's Horizon VR world (also on the Rift platform) would offer more uncomplicated possibilities to create custom experiences. These improved VR technologies could possibly take away the technological hindrances experienced in this dissertation, as classroom simulations could improve when budget is available to apply high-end technology. Further research is needed to confirm if this will be the case, and if this more clearly shows the added value of 360-degree videos.

For a good VR experience, the model of *the hierarchy of needs in Virtual Reality* (Figure 7.2), pitched by Cronin (2015), describes the quality of a VR experience in terms of four levels: (1) comforting experiencing VR without being nauseated, (2) feeling present in the simulation,

(3) the experience adding value, and (4) eventually a delighted experience you want to return back to. This could be an interesting model to reflect on when using VR in research. Following this model, it can be argued that a better VR experience leads to higher learning gains. This would imply that the current dissertation could have delivered more if the quality of the VR experience would have been better.

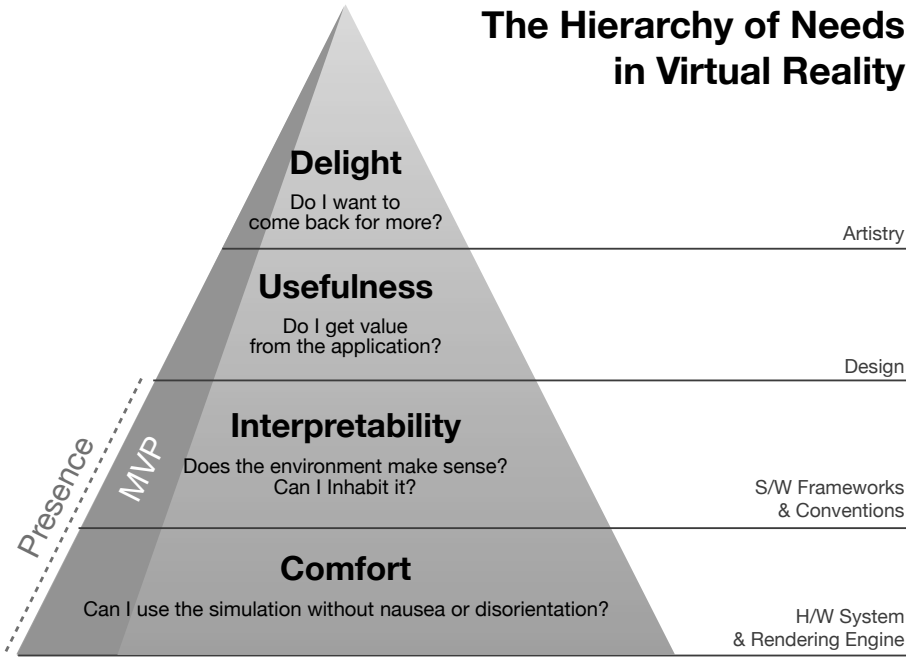

Figure 7.2. The Hierarchy of Needs in Virtual Reality (Cronin, 2015).

7.4 Limitations and suggestions for future research

In this section, limitations and suggestions for future research are discussed. First, this section goes more into detail about the development of interpersonal teacher behaviour with classroom simulations. Second, this section reflects on the used methods in this dissertation. Third, this section discusses potential future research into classroom simulations in teacher education with simulations using more interactivity. And finally, we take a closer look at virtual cognitions (simulated thoughts consisting of a set of pre-recorded voice-overs in a simulation) as a promising element of classroom situations.

Developing interpersonal teacher behaviour with classroom simulations

In this dissertation, classroom simulations were used to develop PSTs' interpersonal teacher behaviour. The current dissertation employed a strong cognitive focus, measuring PSTs' ability to notice and interpret relevant classroom events, PSTs' interpersonal knowledge development and its application. Noticing events, interpersonal knowledge, and correctly attributing events using this knowledge are important steps into finally applying knowledge into the actual teaching practice. However, these aspects of interpersonal teacher behaviour (knowledge, noticing, knowledge application) were investigated separately. Although qualified methods were used to measure knowledge development (concept maps), knowledge application (vignettes), and noticing classroom events better (tagging), the question remains how these aspects of interpersonal teacher behaviour are related to each other and, more importantly, if students' actual teaching practice has improved as well.

When referring to classroom management and therein creating positive relations between teacher and students, this study focussed on the teacher's perspective. Understanding students' backgrounds and contexts also helps teachers to create relationships with their students. As this student perspective is also relevant for classroom management (Raczynski & Horne, 2015), it would be interesting to investigate if this factor could be integrated in computer-based classroom simulations as well.

Reflection on methods to investigate the use of classroom in teacher education

In this dissertation, various data were collected using multiple methods: a systematic literature review, questionnaires, semi-structured interviews, a focus group, tagging video fragments, drawing concept maps, and teacher behaviour vignettes rendering a rich data set.

For example, this research incorporated questionnaires to investigate the system usability and user friendliness of simulation technologies, because simulations, 360-degree videos, and VR headsets are relatively new types of technology. Although it is not common in educational research to examine system usability and user friendliness, it is important to take the characteristics of these new technologies into account when drawing conclusions about their educational effects. These questionnaires provided valuable information about the technological affordances and hindrances of the used simulations, which for example led the researchers to wonder if lower quality of the used technologies could have negatively influenced the outcomes.

Also, relatively new in educational research is the use of social network analysis for analysing concepts maps. Although this type of analysis has originally mainly been used to investigate group networks, it appeared to be a suitable method for analysing knowledge

structures. Concepts maps provided not only insights about solely learned concepts, but more important about the relations between these concepts. A restriction of this method was that social network analysis appeared very time consuming, which makes this method less suitable to use in large-scale research.

Likewise, vignettes (descriptions of classroom situations with teacher behaviour) appeared to be a suitable tool for PSTs to analyse classroom events, generating data that was relatively easy to analyse. Vignettes are not hard to use in large-scale, can be analysed fast, and are a simple way to let PSTs analyse authentic cases. This way, it can be measured if PSTs can imagine themselves as teachers in classroom situations (de Jong et al., 2012).

However, the used methods also had their restrictions and flaws. For example, the earlier described novelty effect (section 2.1). Although the novelty effect is not obvious given the reported and experienced technical hindrances, only longitudinal research could establish if a novelty effect was present. Longitudinal research could also examine if the positive learning outcomes of this dissertation are long(er) lasting.

While the cocktail of theoretical lectures and 360-degree videos appeared successful, the specific working of the separate ingredients and their optimal composition in the cocktail could not be unravelled. For further research it would be interesting to investigate the individual ingredients of the cocktail to discover whether the success is in the combination or the consequence of a single ingredient. For example, by using different variations of the intervention (e.g., solely theoretical lectures or 360-degree videos). Future research could also contribute to more insights in the use of 360-degree videos by collecting more qualitative data about the use of these type of videos.

Finally, as stated before, despite the promising results of this dissertation, it is yet unknown whether the classroom simulations contributed to improved interpersonal teacher behaviour in the actual classroom. PSTs were not observed at their practice schools, nor interviewed after their first actual teaching practices. Is the practice shock really decreased when PSTs enter their internship schools? Are PSTs, after the simulated experiences, more competent to create positive teacher-student relationships? Are they indeed using a different interpersonal behaviour style after the intervention when entering a real classroom for the first time? Are PSTs better prepared to handle interpersonal classroom events? It would be interesting for future research, to examine the transfer of the simulated learning experiences into the actual teaching practice by longitudinal research.

Looking ahead: Studying interactions in classroom simulations

Could more simulated teacher-student interactions contribute to higher and better learning outcomes (e.g., more improved interpersonal competence) from using computer-based classroom simulations? In our virtual internship there was some level of interaction between the PST and simulated students, by means of the use of scenarios. However, these scenarios were not adaptive, so feedback on PSTs behaviour by the online system did not always respond correctly to their teacher behaviour.

Watching 360-degree videos is a relatively passive approach in which students only observe. Following the theory (van Es & Sherin, 2002), after noticing events and placing them in the correct theoretical frame, a suited action follows. Interactions in simulations should, in theory, be of great added value as they might offer a more complete practice experience with sequences of likely events. Building good interactions is difficult, however. For example, PSTs can get lost during long scripted dialogues, because they do not follow anticipated paths. Furthermore, scripting dialogues are difficult because sometimes PSTs can be forced to react in a particular direction (Jeuring et al., 2015). Several research projects used moderators (an expert that guides the interactions live) in simulations to create interaction. An example of such a research project is the 'Breaking Bad Behaviors project' of the University of Würzburg (Lugrin, Latoschik, Habel, Roth, Seufert, & Grafe, 2016). In this project a real-time 3D virtual simulation of a classroom was used focusing on learning to manage disruptive student behaviour in face-to-face, one-to-many (e.g., teacher to class of students) teaching scenarios. A teacher educator served as a moderator to guide the reactions of pupils (avatars in the virtual simulation). The use of moderators could be an alternative to the challenging task of developing automated adaptive interactions that cover most of the possible interactions of PSTs with students. Other research focusses on non-verbal behaviour using virtual reality simulations, for example the study on training presentation skills of van Ginkel and colleagues (2020). In their study, pre-university students practiced their presentation skills in a VR environment. Students perceived immediate computer-mediated feedback on their skills using icons. For example, an icon appeared when a student was lingering too long for eye contact.

Virtual cognitions as part of simulations

Another way of using simulations is to expose students to virtual cognitions to change their perception about a certain situation. Virtual cognitions can be defined as simulated thoughts consisting of a set of pre-recorded voice-overs in the simulation that provide understandable guided learning and motivating statements (Ding, Burger, Brinkman, & Neerincx, 2017). In other words, students can re-appraise a situation through virtual cognitions in simulations. An example is a study about a negotiation training system that exposes users to virtual cognitions during negotiation with virtual characters aiming to

improve people's negotiation knowledge and self-efficacy. The virtual cognitions, delivered as a personalized voice-over, provide users with a stream of thoughts that reflects on the negotiation and people's performance (Ding, Burger, Brinkman, & Neerincx, 2017).

Qu and colleagues (2015) used a virtual environment rendering a classroom setting of an English lesson to test a different way of implementing virtual cognitions. Participants of the simulation acted as a student in the virtual classroom and watched the teacher teach. At the same time, virtual students were whispering positively or negatively to each other about other virtual students' behaviour or were showing angry or happy facial expressions. Positive behaviour of the virtual students led to higher feelings of self-efficacy and less avoidance behaviour of the participants in their role as student. In contrast, negative behaviour of the virtual students led to higher feelings of anxiety of the participants in their role as student. Thus, participants were influenced by the virtual cognitions used in this classroom simulation.

In the context of developing interpersonal teacher behaviour via classroom simulations, the use of virtual cognitions would be interesting to investigate. This could be done, for example, by voice-overs of students' perceptions about (non)verbal behaviour of teachers standing in front of a classroom. This way, PSTs are forced to put themselves into the student's perspective.

The next section discusses implications for practice by focusing on the use of new technologies in teacher education and the right conditions for using classroom simulations in teacher education.

7.5 Implications for practice

Using new technology in teacher education

Technological advancement is one of the most important drivers of innovation in almost any field of work. Apart from presenting theoretical information digitally, new technology or technological innovation offer opportunities to enrich the standard curriculum of teacher educational institutes. The current dissertation provided positive learning outcomes using interventions with technology that is widely available at limited costs, which enables teacher education institutes to experiment with these interventions themselves rather quickly. In turn, this adoption of technology can open the door for further embedding of new (proven) methods using technology to enrich the curriculum and improve learning outcomes.

New technology used in this dissertation was formed by computer-based classroom simulations. Gibson, Knezek, Redmond, and Bradley (2014) distinguish five reasons to use simulations in teacher education as an added value to the curriculum: (1) are highly engaging for many students, (2) provide masterful learning, (3) create powerful insights, (4) visualize complex concepts, and (5) learners can play in a safe environment where failures are learning opportunities. Given the positive findings of the use of classroom simulations in teacher education from the present dissertation, classroom simulations could be used to extend PSTs' teaching experiences and already bring them into the teacher education programme before actual practice starts. In general, practice makes perfect. This also applies to the anxiety that many beginning teachers experience. The more time they have to practice during internships, the lower their level of anxiety (Morton et al., 1997). It does take time to become an expert, just like driving a car for example. Someone who just received a driver's licence is authorised to drive but drives very differently from someone who is an expert driver after many years of experience. PSTs can use simulations to gain more experience during their study.

Furthermore, in relation to the actual teaching practice, using computer-based simulations could help PSTs integrate more technology in their own future teachings as PSTs mostly teach how they were taught themselves. "Teach as you preach", as it were. Some PSTs enter the teacher education institute with low technological skills and consequently PSTs should be prepared technically and pedagogically for using simulations in their own courses (Gibson et al., 2014).

Finally, given the positive effects of the simulations in this dissertation, one may wonder if simulations using a combination of theory and videos would also work for other topics or competencies in teacher education? The literature – including our own review study - shows that computer-based simulations can be a valuable learning asset in many professions (Mayer & Mastik, 2007). As classroom simulations can help PSTs learn concepts and practice their own instructional skills, they might be considered for topics such as differentiated instruction, identifying at-risk students, curriculum design, sequencing tasks, and meeting the individualized needs of students (Gibson et al., 2014). Chances are that computer-based classroom simulations can contribute more to teacher education institutes beyond PSTs interpersonal behaviour. From another perspective, training interpersonal skills using simulations could be beneficial to other domains than teacher education as interpersonal skills play an important role in most human interactions. Possibilities for application could range from training general practitioners in patient contact to training restaurant staff in their daily social intercourse with clients.

Setting the right conditions for using classroom simulations in teacher education

Is it evident that teacher education institutes can use classroom simulations in their educational program? First, the right conditions should be created first before simulations can be used. Gibson and colleagues (2014) argue that, in an ideal world, three conditions have to be in place to promote the use of simulations to prepare PSTs for the actual teaching context in teacher education institutes: (1) leadership, (2) incentives, and (3) support.

Teacher education management must be brave! In other words, they should have the courage to face the challenges of integrating simulations into teacher education programs to achieve a more outstanding curriculum. Brave leaders believe in the opportunities of classroom simulations and support their staff in using simulations. Teacher educators may experiment, and failure should be allowed. They invest in computational science, develop a vision about the use of simulations, and reward experimenting and sharing new ideas (Gibson et al., 2014).

Gibson and colleagues (2014) argue that students nowadays are looking for technologically progressive educational institutions. Increased student enrolment might be a teacher education institute's incentive to integrate simulations into their teaching program. For individual teacher educators, being rewarded for taking risks, being entrepreneurial and making discoveries regarding simulations can be individual incentives (Gibson et al., 2014).

Lastly, teacher educators have to be supported by having access to technology. Technological equipment, software, and ICT-support are needed to experiment with classroom simulations. And not unimportantly, according to Gibson and colleagues (2014) teacher educators also need time and opportunities enabling them to experiment with simulations in their courses.

7.6 Concluding statement

Many (preservice) teachers feel anxiety about classroom management and interpersonal teacher behaviour, contributing to what PSTs experience as a practice shock. As this shock is an important reason for (preservice) teachers to leave their profession, bridging the gap between theory and practice remains an important topic. Emerging technologies offer many new ways to help bridge this gap. Wubbels (2014) concludes that 25 years of research into interpersonal teacher behaviour has gained many valuable insights, yet little research has been done to interventions in the actual teaching practice. Although we are only at the forefront of exploring the possibilities to enrich teacher education using technology. This dissertation can be seen as one of the first, yet promising steps towards a teaching context that benefits from recent technological developments.

Addendum

- References
- Appendices
- English summary
- Nederlandstalige samenvatting
- Dankwoord
- Curriculum Vitae
- List of publications

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Appendices

Appendix A

Interview questions

Question	Topic
Did you feel anxiety for teaching in an actual classroom before you entered the video-lecture combination?	professional anxiety
Did the video-lecture combination influence your professional anxiety? How?	professional anxiety
Do you think the video-lecture combination is a useful method to decrease PSTs' professional anxiety?	professional anxiety
How sure are you about you own skills to create positive teacher-student relationships?	self-efficacy
Did the video-lecture combination influence your feelings about your own skills to create positive teacher-student relationships?	self-efficacy

Appendix B

Descriptions video fragments used at the pre-test and post-test

Fragment 1 showed teacher-1 standing in front of a classroom. She promised this class to give them the results of a test in this lesson. However, she has not finished correcting the test and had to disappoint her students. She promised them to give the results in the next lesson and had a discussion with her students when this next lesson would be. After that, she started her lesson by asking student questions about the previous lesson. Not all students were paying attention and teacher-1 did not tolerate student questions in this stage of her lesson.

Fragment 2 showed teacher-2 sitting on a desk in front of the classroom. He wanted some students to read a text aloud. However, one group of three students were not paying attention to his lesson. They were laughing with each other and two students did not have a book on their desk. Teacher-2 demanded one girl to put a book in their desk and to read a text. However, she ripped a page out of the book that was not even hers. She and the boy next to her could not stop laughing. Teacher-2 gave the boy several warnings and finally removed him from the classroom.

Fragment 3 showed teacher-3 sitting behind his desk asking students one by one to show their homework. If the students did their homework, he gave them a sticker. One student did not deserve a sticker in the teacher's opinion. As a reaction, this student disagreed. Teacher-3 held onto his decision on not giving her a sticker.

Appendix C

Interview questions

Question	Topic
Can you describe what you saw and how that is relevant to interpersonal teacher behaviour?	professional interpersonal vision
Can you distinguish differences between your tags at the pre- and post-test?	professional interpersonal vision
What did you think about the quality of the content of the Virtual Classroom? Could this be improved?	quality of the content
What did you think about the coherence between meetings? Could this be improved?	coherence between meetings
Do you think that the Virtual Classroom added value to the curriculum of the teacher education program? In which way?	added value to the curriculum
Do you think that the Virtual Classroom contributed to you teaching skills? In which way?	contribution to PSTs' teaching skills
What is your opinion about watching 360-degree videos with a VR headset?	VR headset
What are your experiences with the technical aspects of your mobile phone in the VR headset? Which parts worked well? Which parts didn't? How can this be improved?	technological aspects of the VR headset

Appendix D

Teacher behaviour vignettes		
1. directing-helpful	V1	You position yourself in front of the classroom and indicate you would like to start the lesson.
	V3	To make something clearer, you tell the students about your own experiences.
	V7	The last couple of lessons you taught some difficult topics. At the end of the final lesson, you ask the students if there is anything they still need regarding these topics.
	V8	You gave your students a difficult and demanding task. While distributing the task, you also said you were fully confident in them.
	V9	Students have been working well. You show your appreciation.
	V15	This lesson is about a particular topic. You enthusiastically explain a particular part of it.
	V16	Students are allowed to work for themselves. You remain present so they can ask for help whenever they have any questions or problems.
	V17	You explain an assignment that has to be carried out in the lesson. While distributing it, you tell the students they have to work individually and in silence.
2. understanding-compliant	V4	In the previous lesson, you made a mistake in your explanation of a particular topic. In this lesson you again pay attention to this explanation, and you have just admitted that you have made this mistake.
	V5	It is the beginning of the lesson, the students are all seated and getting ready. You ask how they are doing.
	V13	The lesson is almost finished, you have told the students they may do something for themselves for the last ten minutes.
3. dissatisfied-uncertain	V10	In your view, students have shown a lack of effort. In the lesson you show them your dissatisfaction.
	V11	Three students are not paying attention. You react in an irritated way.
	V18	You are a bit ill-tempered today. A student makes the wrong remark at the wrong time. You react somewhat snappily.
	V20	Students' results are disappointing. You are quite certain they did not work hard enough and you show you are displeased.
4. imposing-confrontational	V2	A student did not perform well. You tell him/her that you expect him/her to try harder next time.
	V6	A couple of students arrive in class late. You resolutely confront them with the rules regarding attendance.
	V12	Two students are playing with a mobile phone or something, and because of that are not paying attention to the lesson. You give them both a straight look, without saying anything.
	V14	You tell students the consequences of not abiding by the rules.
	V19	A group of girls is talking and giggling. You look sternly in their direction and call out their names one by one.

English summary

Many preservice teachers (PSTs) experience feelings of stress and anxiety in their classrooms. They experience these feelings, also referred to as *professional anxiety*, despite being prepared via theoretical lectures and practical workshops at their teaching education institutes. It is a challenge for PSTs to change from a student to the role of a teacher. Classroom management in particular is a major concern for PSTs, and even experienced teachers consider this as one of the main reasons to leave the profession. At the same time, classroom management is important to improve student achievement and attitudes, and it contributes to PSTs' well-being.

A strategy to handle these classroom management struggles is creating positive teacher-student relationships, also known as *PSTs' interpersonal competence*. The interpersonal competence perspective used in this dissertation describes teaching in terms of relationships between teachers and students, and the actions teachers undertake to create positive learning environments. It also embraces the meanings students and teachers give to their interactions. These interactions are understood following dynamic systems theory. In this theory classes are considered as social systems in which teachers' and students' verbal and non-verbal behaviours mutually influence each other in a dynamic way. Interpersonal relationships are conceptualized via two independent dimensions forming a circumplex structure: communion and agency. Communion is referred to as the extent of warmth in the relationship between teacher and student. The agency dimension describes the degree of influence exerted by either teacher or students. Each section (imposing, directing, helpful, understanding, compliant, uncertain, dissatisfied, confrontational) in the circumplex refers to teacher behaviour with a unique blend of communion and agency. Typically, high levels of agency and communion coincide with high cognitive and affective student outcomes and a safe and good classroom climate and are regarded as healthy interpersonal relationships.

Because many PSTs' struggle with classroom management and their interpersonal teacher behaviour, the question arises how teacher education institutes could prepare PSTs better for the difficult task they are facing at their internship schools. When dealing with professional anxiety, PSTs' *self-efficacy,* defined as the belief in their own capability to influence student behaviour and achievement, is an important coping resource. PSTs gain classroom management self-efficacy by teaching experiences in classroom management and instructional preparation for classroom management.

In this dissertation we answer the intriguing question if *computer-based classroom simulations* could offer PSTs the possibility to extend their teaching experiences at the teacher education institute, while preparing for their internships. Classroom simulations

are simplified representations of real classrooms and give PSTs the opportunity to safely familiarise themselves with the teaching practice, without having full responsibility of an actual classroom. This way, PSTs could be better prepared for the teaching practice and at the same time reduce their anxiety.

This leads to the main research question of this dissertation, which is: *How can computer-based classroom simulations be used in teacher education to train preservice teachers' interpersonal competence to reduce their professional anxiety and increase their self-efficacy?*

In this dissertation two types of classroom simulations were designed: (1) *virtual internships* (described in chapter 2) and (2) *360-degree videos in combination with theoretical lectures* (described in chapters 4, 5, and 6). Both types of classroom simulations were embedded in blended learning environments combining online materials with face-to-face instruction and support.

Chapter 2 presents the first study of this dissertation, a small-scale exploratory study aiming to answer the question: *How can virtual internships in blended learning environments positively support PSTs' professional anxiety? And how are virtual internships experienced by PSTs?* For this study, two virtual internships (VI-1 and VI-2) were designed as computer-based classroom simulations, using two different online systems. During these virtual internships, PSTs were engaged in a scenario-driven online learning environment and were confronted with authentic tasks. They had to think and act as a teacher to complete these tasks. The purpose of both internships was to familiarise PSTs with the challenges of the actual teaching practice. Both internships were integrated with lectures about diversity in the classroom (VI-1) and classroom management (VI-2), creating a blended learning environment. This study was conducted at the teacher education programme of the Eindhoven School of Education and included two courses (N = 27 and N = 16). A mixed-method design was applied, using pre- and post-intervention questionnaires, a focus group (n = 6), and semi-structured individual interviews (n = 9).

The first aim of this study was to explore if virtual internships reduced PSTs' professional anxiety. This study showed that PSTs' professional anxiety from VI-2 (the video-based simulation) decreased significantly. This was not the case for PSTs from VI-1. PSTs from VI-2 reported in the interviews that after the virtual internship they conceived a more realistic image of educational practice, which made them feel more prepared for entering the actual teaching practice. However, the different effects for professional anxiety, may have occurred due to the differences in the online learning environments. The online

environment of VI-2 had a higher degree of personalisation (e.g., a familiar learning environment, personalised feedback, mother tongue). Furthermore, this internship used more video fragments than the other virtual internship, which was highly appreciated according to the respondents.

The second aim of this study was to identify how virtual internships in blended learning environments were evaluated by PSTs in terms of technological, social, and educational affordances. It was shown by the pre- and post-intervention questionnaires that both virtual internships were experienced as sufficiently user-friendly. The qualitative data revealed that PSTs highly appreciated that they were flexible in time and their own pace and place when using the internships. Furthermore, PSTs appreciated the blended learning environment connecting lectures at the teacher education institute with assignments of the virtual internships. Also, collaboration by sharing examples and discussing assignments with peers was highly appreciated.

In conclusion, virtual internships appeared to be useful for teacher education institutes to familiarise PSTs with the actual teaching practice, and consequently reducing their professional anxiety. Virtual internships worked best when there was personalisation, collaboration, the possibility to work at their own pace, and when video fragments were used.

The use of computer-based classroom simulations in teacher education is a relatively new research field. **Chapter 3** presents a systematic literature review focusing on a second question of this dissertation: *What main issues regarding computer-based classroom simulations, affordances, hindrances, learning experiences, interpersonal competence, professional anxiety and self-efficacy have emerged in the field of research on teacher education?*

Databases Scopus, ERIC, PsycINFO, and Web of Sciences were used to find peer-reviewed studies within the period of 2000 and 2016. Fifteen empirical studies were found eligible for inclusion. A theoretical coding scheme was applied to describe and categorise, revealing similarities and dissimilarities between results of the included studies.

Results of this study showed that little is known about the use of classroom simulations in teacher education to reduce PSTs' professional anxiety and increasing their self-efficacy via training their interpersonal behaviour. The included studies focused on single interrelations between the concepts (e.g., classroom simulations and self-efficacy) or used broader concepts (e.g., teaching skills). The included studies mostly reported positive effects of simulations on PSTs' classroom management and teaching skills in general, rather than specifically on interpersonal competence. Professional anxiety was not reported in the included studies.

In sum, the included studies showed promising results for the use of computer-based classroom simulations in teacher education as an addition to the already consisting curricula and real-life internships. This literature review strengthened the idea that simulations are promising tools to reduce PSTs' anxiety and improve their interpersonal competence. Therefore, and because of the promising use of videos from study one, study three concentrated on the use of 360-degree videos as a type of classroom simulation.

The third study was a large-scale study and consisted of a series of three more specific investigations (chapters 4, 5, and 6) concerning the intervention that used 360-degree videos in combination with theoretical lectures, answering a third question of this dissertation: *How can 360-degree videos combined with theoretical lectures support PSTs' interpersonal competence, their self-efficacy, and their professional anxiety? And how is the video-lecture combination experienced by PSTs?* In this intervention, 360-degree videos were used as computer-based classroom simulations and combined with theoretical lectures (together named the Virtual Classroom) providing PSTs with real-life authentic cases by capturing the richness and complexity of classrooms.

The 360-degree videos contained classroom events with interpersonal teacher behaviour that PSTs typically struggle with, such as disruptive student behaviour. The spherical view of 360-degree videos offered PSTs a classroom wide view on classroom events. By dragging the video or moving the smartphone to in a direction, PSTs could decide themselves on which aspects in the video they wanted to focus. To create a more immersive learning experience, the 360-degree videos were watched using a virtual reality headset. This disconnected PSTs from their surroundings and placed them in a realistic and authentic situation. Additionally, PSTs received theoretical lectures with the teacher interpersonal behaviour theory. Enrolled in this intervention were 141 First-year PSTs of a teacher education programme at Fontys University of Applied Sciences.

Chapter 4 presented the first sub-study that investigated the video-lecture combination. This particular chapter focussed on the influence of the video-lecture combination on PSTs' professional anxiety and self-efficacy. Could this combination decrease PSTs' professional anxiety and increase their self-efficacy? Furthermore, PSTs' self-perceived interpersonal behaviour was investigated.

This study used a mixed-method design containing pre- and post-intervention questionnaires measuring PSTs' professional anxiety and self-efficacy, a post-intervention questionnaire to measure PSTs' self-perceived interpersonal behaviour, and semi-structured individual interviews (n = 12) to deepen insights into PSTs' experiences with the Virtual Classroom. The quantitative data showed that both PSTs' professional anxiety decreased,

and that their self-efficacy increased significantly after the video-lecture combination. PSTs became more confident in their own abilities to handle classroom management issues and less anxious to teach. The qualitative data revealed that observing the exemplary behaviour of experienced teachers in the videos made them more familiar with the actual teaching practice and reduced their anxiety. The post-intervention questionnaire regarding PSTs' self-perceived interpersonal behaviour showed that PSTs perceived themselves as more directing and less imposing, resulting in higher anticipated levels of communion after the intervention. This means that after the intervention PSTs perceived themselves as teachers that could create a higher degree of warmth in their teacher-student relationships.

Because PSTs differed in their feelings of anxiety and sense of self-efficacy, this study also investigated if different clusters of PSTs could be distinguished regarding PSTs' self-efficacy and professional anxiety. A cluster analysis on pre-test data showed two clusters of PSTs: cluster 1 scored both high on professional anxiety and self-efficacy, cluster 2 scored average on professional anxiety and high on self-efficacy. Both clusters differed significantly in their anxiety after the intervention. The results of this study suggest that the video-lecture combination might be a useful method to smoothen the transition from the teacher education institute to the actual teaching practice, as it was able to reduce PSTs' professional anxiety and increase their self-efficacy.

Chapter 5 presents the second sub-study, investigating if PSTs' interpretations of noticed classroom events could be improved by the video-lecture combination. For interpersonal competence it is important that students observe and interpret classroom events before responding to them. PSTs' interpretations of noticed classroom events were measured by tagging video fragments of authentic classroom events at a pre- and post-test. Semi-structured individual interviews were conducted after the intervention (n = 12) to obtain insights in the manner in which PSTs tagged the video fragments. Results showed that PSTs improved in noticing classroom events and in applying a theory-based terminology to describe these events. This indicates that PSTs used more knowledge about interpersonal teacher behaviour when interpreting noticed classroom events. This was confirmed by the interviewees.

Furthermore, this study evaluated the perceived technological and educational affordances of the video-lecture combination using a post-intervention questionnaire and semi-structured individual interviews (n = 12). As an educational affordance, PSTs reported that they felt better prepared for the actual teaching practice after the video-lecture combination by watching experienced teachers teach. As a technological affordance, PSTs experienced watching the videos with a VR headset indeed as an immersive learning experience, although many PSTs also experienced physical discomfort and technical hindrances using the VR headset.

The results of this study suggest that the video-lecture combination influenced PSTs' interpretation of noticed events positively, although the added value of a VR headset could not be established. Findings of this study do emphasize the importance of good quality VR environments to improve the immersive experience.

Chapter 6 presents the third sub-study that investigated the video-lecture combination, by analysing PSTs' interpersonal knowledge structures and the development of these structures via concept maps before and after the video-lecture combination. Social network analysis, including measures of structure and conceptual relevance, were used to analyse PSTs' concept maps. In addition, the concept maps were compared to expert concept maps. To establish the concept maps' structure, quantitative measurements were used (e.g., number of links, number of clusters, number of concepts, density). Interviews were conducted to understand the interpretations PSTs gave to concepts (n = 12).

The quantitative data showed that PSTs used more organised concept maps after the video-lecture combination, shown as an increase of the number of links and clusters and a decrease in the concept map's density and decrease in reciprocity between concepts. These more structured concept maps can be associated with a better developed interpersonal knowledge structure. PSTs' concept maps compared with an expert concept map showed that PSTs' concept maps included more relevant concepts after the video-lecture intervention. The qualitative data confirmed that PSTs after the intervention relied more on the theory they learned during the Virtual Classroom.

Furthermore, PSTs' knowledge application was measured via vignettes after the video-lecture combination. These vignettes contained descriptions of classroom situations with interpersonal teacher behaviour. PSTs were asked to score this teacher behaviour on the communion and agency dimension of Teacher Interpersonal Circle. These scores were compared with scores of experts on the vignettes by calculating absolute differences between PSTs and experts. PSTs were particularly capable in applying their interpersonal knowledge on vignettes focusing on high levels of interpersonal teacher control.

Finally, this study showed that the use of a VR headset positively influenced PSTs' theory-based knowledge structures and application. PSTs that used a VR headset all the time used significantly more clusters in their concept maps, suggesting more organised interpersonal knowledge than PSTs that used the VR headset less often. These PSTs outperformed PSTs that used the headset less often in interpersonal knowledge application, implying that a higher level of immersiveness has a positive influence on interpersonal knowledge development.

In conclusion, this study showed that PSTs' theory-based interpersonal knowledge structure could be visualised using concept maps and interpreted by using social network analysis. Therefore, concept maps might be a useful method for teacher education institutes to assess and improve PSTs' theory-based interpersonal knowledge.

The findings of this dissertation may be somewhat limited because aspects of interpersonal teacher behaviour (knowledge, noticing, knowledge application) were investigated separately, the question remains how these aspects of interpersonal teacher behaviour are related to each other and, more importantly, if students' actual teaching practice has improved as well. Further, longitudinal research could establish this. PSTs enrolled in this research also reported technical hindrances of the classroom simulations. This raises the question if the lower quality of the used technologies could have negatively influenced the outcomes.

For future research it would be interesting to investigate classroom simulations with more adapted simulated teacher-student interactions. In the current dissertation, the virtual internships provided some level of interaction between the PST and the simulated students by the use of scenarios. However, these scenarios were not adaptive, so feedback on PSTs behaviour by the online system did not always respond correctly to their teacher behaviour. Watching the 360-degree videos was a relatively passive experience. Interactions in simulations should in theory be of great added value as they might offer a more complete practice experience with sequences of likely events.

In conclusion, all the consecutive studies of this dissertation showed promising results for the use of computer-based classroom simulations in teacher education. Although it is yet unknown whether the classroom simulations contribute to improved interpersonal teacher behaviour in actual teaching practice in the classroom, the results of this dissertation imply that interpersonal teacher behaviour can be trained with classroom simulations. Furthermore, both classroom simulations had a positive influence on PSTs' self-efficacy and were useful to reduce PSTs' professional anxiety.

Classroom simulations appeared to be valuable tools to provide PSTs with a more realistic image of the teaching practice and student behaviours they could expect in classrooms, and how they could act as a teacher. Therefore, classroom simulations could smoothen the transition between teacher education institutes and the actual teaching practice and offer the opportunity for PSTs to practice their interpersonal competence in a safe learning environment. Classroom simulations can be part of blended learning environments with benefits such as individual practice and practicing at a pace, time and place that fits individual PSTs. This supports more flexible learning trajectories, which is especially useful for small-scale and/or customized education programmes.

Nederlandstalige samenvatting

Veel Leraren-In-Opleiding (LIO's) vinden het lesgeven stressvol en voelen zich angstig voor de klas. Ze ervaren deze gevoelens, ook wel *professionele spanning* genoemd, ondanks dat ze op de lerarenopleiding voorbereid zijn via (theoretische) colleges. Het is een uitdaging voor LIO's om de transitie te maken van hun rol als student naar leraar. Met name klasmanagement is een grote zorg voor LIO's. Het is zelfs een van de belangrijkste redenen om het onderwijs te verlaten. Tegelijkertijd is klasmanagement een belangrijke competentie om de prestaties en attitudes van leerlingen te verbeteren en daarmee het welzijn van LIO's te vergroten.

Een strategie om met deze problemen in het klasmanagement om te gaan is het creëren van positieve leraar-leerlingrelaties, ook wel bekend als de *interpersoonlijke competentie*. Theorie over interpersoonlijk leraarsgedrag gaat over de relatie tussen leraren en leerlingen en beschrijft lesgeven als alle acties die een leraar onderneemt om een positief leerklimaat te creëren. Het betreft tevens de betekenis die leraren en leerlingen geven aan hun onderlinge interacties. Deze interacties kunnen beter begrepen worden middels de dynamische systeemtheorie, welke klassen beschouwt als sociale systemen waarin leraren en leerlingen elkaar continu beïnvloeden middels verbaal en non-verbaal gedrag. Interpersoonlijke relaties tussen leraren en leerlingen kunnen geconceptualiseerd worden middels twee onafhankelijke dimensies die samen een circumplex structuur vormen: nabijheid en invloed. Met invloed wordt gedoeld op de hoeveelheid warmte in een relatie tussen leraar en leerling. Invloed verwijst naar de mate van invloed uitgeoefend door de leraar of leerling. Elk segment uit de circumplex (dwingend, sturend, helpend, begrijpend, inschikkelijk, onzeker, ontevreden, corrigerend) verwijst naar leraarsgedrag met een unieke combinatie van nabijheid en invloed. Een positieve interpersoonlijke relatie bestaat doorgaans uit een hoge mate van nabijheid en invloed. Deze gaan meestal samen met cognitieve en affectieve leerresultaten van leerlingen en een veilig klassenklimaat.

Omdat veel LIO's moeite hebben met klassenmanagement en de interpersoonlijke competentie en hierdoor tegelijkertijd spanning ervaren tijdens hun stages, rees de vraag hoe lerarenopleidingen LIO's beter kunnen voorbereiden op hun stages. De *zelfeffectiviteit* van een LIO, het geloof in eigen capaciteiten om leerlinggedrag en -resultaten te beïnvloeden, is een belangrijke strategie om met de professionele spanning om te gaan.

In dit proefschrift beantwoorden we de intrigerende vraag of *klassensimulaties* de mogelijkheid bieden om LIO's ervaring met lesgeven uit kunnen breiden op de lerarenopleiding als voorbereiding op stages. Klassensimulaties zijn vereenvoudigde representaties van echte klaslokalen en geven LIO's de mogelijkheden om in een

veilige omgeving kennis te maken met de onderwijspraktijk zonder direct de volledige verantwoordelijkheid te hebben over een klas. Op deze manier kunnen LIO's beter voorbereid worden op de onderwijspraktijk en kan tegelijkertijd hun professionele spanning afnemen.

Hieruit volgt de primaire onderzoeksvraag van dit proefschrift: *Hoe kunnen klassensimulaties ingezet worden in de lerarenopleiding om de interpersoonlijke competentie van LIO's te vergroten, de zelfeffectiviteit te vergroten en de professionele spanning te verminderen?*

Er zijn twee type klassensimulaties ontwikkeld voor dit proefschrift: (1) *virtuele stages* (beschreven in hoofdstuk 2) en (2) *360-graden video's in combinatie met theoretische colleges* (beschreven in hoofdstukken 4, 5 en 6). Beide type klassensimulaties werden ingebed in blended leeromgevingen door de combinatie van online leermateriaal en fysieke instructie en ondersteuning.

Hoofdstuk 2 beschrijft de eerste studie van dit proefschrift. Deze kleinschalige, exploratieve studie beoogde de volgende vragen te beantwoorden: *Hoe kunnen virtuele stages in blended leeromgevingen LIO's positief ondersteunen bij hun professionele spanning? En hoe worden virtuele stages ervaren door LIO's?* Voor deze studie werden twee virtuele stages ontworpen (VS-1 en VS-2), gebruikmakend van twee verschillende onlinesystemen. Gedurende deze virtuele stages werden LIO's meegenomen in een scenario gestuurde online omgeving waarin zij geconfronteerd werden met authentieke leertaken. Zij moesten denken en handelen als een leraar om deze leertaken te volbrengen. Het doel van beide stages was LIO's bekend te maken met de uitdagingen van de daadwerkelijke onderwijspraktijk. Beide stages werden geïntegreerd met colleges over diversiteit in de klas (VS-1) en klassenmanagement (VS-2). Op deze manier werden blended leeromgevingen gecreëerd. Deze studie werd uitgevoerd op de lerarenopleiding van Eindhoven School of Education en betrof twee modules (N = 27 en N = 16). Een mixed-method design werd toegepast, gebruikmakend van een vragenlijst bij de voor- en nameting, een focusgroep (n = 6) en semigestructureerde interviews (n = 9).

Het eerste doel van deze studie was te verkennen of virtuele stages bijdragen aan het reduceren van LIO's professionele spanning. Deze studie liet zien dat de professionele spanning significant verminderde bij LIO's uit VS-2. Dit was niet het geval voor LIO's uit VS-1. LIO's uit VS-2 gaven in de interviews aan dat zij na de virtuele stage een realistischer beeld gevormd hadden van de onderwijspraktijk, waardoor zij zich beter voorbereid voelde voor hun daadwerkelijke stages. Het kan aan het gebruik van twee verschillende online leeromgevingen liggen dat LIO's uit VS-2 de virtuele stage anders dan LIO's uit VS-1 hebben ervaren met betrekking tot hun professionele spanning. De online leeromgeving van VS-2

was meer gepersonaliseerd (er werd bijvoorbeeld gebruik gemaakt van een reeds bekende leeromgeving, feedback was persoonlijker, het systeem was in LIO's moedertaal). Verder maakte VS-2 meer gebruik van videofragmenten, wat hoog werd gewaardeerd door de betrokken LIO's.

Het tweede doel van deze studie was in kaart brengen hoe LIO's de virtuele stages evalueren op basis van de technologische, sociale en educatieve *affordances*. De vragenlijsten van de voor- en nameting lieten zien dat beiden virtuele stages als gebruikersvriendelijk ervaren werden. De kwalitatieve data lieten zien dat LIO's het vooral waardeerden dat zij in hun eigen tijd op een zelfgekozen plek gebruik konden maken van de virtuele stages. Verder waardeerden zij de combinatie van opdrachten binnen de virtuele stages en de colleges op de lerarenopleiding, samen een blended leeromgeving vormend. Tot slot waardeerden LIO's het zeer om samen te werken met studiegenoten door het delen van voorbeelden en te discussiëren over opdrachten.

Het bleek dat virtuele stages bruikbaar zijn voor lerarenopleidingen om LIO's bekend te maken met de onderwijspraktijk en als gevolg hiervan hun professionele spanning te verminderen. Virtuele stages werken het best wanneer de leeromgevingen gepersonaliseerd zijn, er samenwerking mogelijk is, LIO's kunnen werken op een zelfgekozen moment en plek en wanneer er videofragmenten gebruikt worden.

Het gebruik van klassensimulaties in lerarenopleidingen is een relatief nieuw onderzoeksgebied. **Hoofdstuk 3** presenteert een systematische literatuurreview gericht op de tweede onderzoeksvraag van dit proefschrift: *Wat is er bekend over het gebruik van klassensimulaties, affordances, leerervaringen, interpersoonlijke competentie, professionele spanning en zelfeffectiviteit in het onderzoek binnen lerarenopleidingen?*

Er is gebruik gemaakt van de databases Scopus, ERIC, PsycINFO, and Web of Sciences om peerreviewed onderzoeken te vinden tussen de periode van 2000 tot 2016. Er werden vijftien onderzoeken gevonden die pasten binnen de zoekcriteria. Een theoretisch codeerschema werd gebruikt om de onderzoeken te beschrijven en te categoriseren. Op deze manier werden overeenkomsten en verschillen tussen de geïncludeerde onderzoeken zichtbaar.

Deze studie liet zien dat er weinig bekend is over het gebruik van klassensimulaties in de lerarenopleiding om de professionele spanning van LIO's te verminderen door hun interpersoonlijke competentie te vergroten en hiermee ook hun zelfeffectiviteit. De geïncludeerde onderzoeken richtten zich voornamelijk op enkele relaties tussen concepten (zoals klassensimulaties en zelfeffectiviteit) of op bredere concepten (zoals

doceervaardigheden). De geïncludeerde onderzoeken lieten voornamelijk positieve effecten van klassensimulaties zien op klassenmanagementvaardigheden en doceervaardigheden in het algemeen, in plaats van specifiek op de interpersoonlijke competentie.

Samengevat lieten de geïncludeerde onderzoeken veelbelovende resultaten zien voor het gebruik van klassensimulaties in de lerarenopleiding als aanvulling op het al bestaande curriculum en stages. Deze literatuurreview versterkt het idee dat klassensimulaties ingezet kunnen worden om de professionele spanning van LIO's te verkleinen en hun interpersoonlijke competentie te vergroten. Daarom, en vanwege het veelbelovende gebruik van de video's uit de eerste studie, richtte de derde studie zich op het gebruik van 360-graden video's om klassituaties te simuleren.

De derde studie was een grootschalige studie die bestond uit een serie van drie onderdelen (hoofdstukken 4, 5 en 6) betreffende een interventie die gebruik maakte van 360-graden video's in combinatie met theoretische colleges, genaamd de 'Virtual Classroom'. Deze studie beantwoordde de derde onderzoeksvraag van dit proefschrift: *Hoe kunnen 360-graden video's gecombineerd met theoretische colleges ingezet worden om de interpersoonlijke competentie, zelfeffectiviteit en professionele spanning van LIO's te ondersteunen? En hoe wordt de video-college-combinatie ervaren door LIO's?* Voor deze interventie werden 360-graden video's gebruikt om klassen te simuleren in combinatie met theoretische colleges (samen "Virtual Classroom" genaamd). Op deze manier werden LIO's geconfronteerd met levensechte, authentieke casussen die de rijkheid en complexiteit van een klaslokaal bevatten.

De 360-graden video's bestonden uit klassensituaties waar LIO's vaak mee worstelen, zoals ongehoorzaam gedrag van leerlingen. 360-graden video's boden LIO's de mogelijkheid om het hele klaslokaal rond te kijken. LIO's die de 360-graden video's op hun smartphone bekeken konden bewegen met hun telefoon om zelf te bepalen op welk aspecten in de video zij zich wilden focussen. Er werd gebruik gemaakt van virtual reality-brillen om een meer *immersive* leerervaring te creëren. Hierdoor werden LIO's afgesloten van omgevingsgeluiden en werden zij als het ware geplaatst in een realistische en authentieke situatie. Aanvullend ontvingen LIO's theoretische colleges over interpersoonlijk leraarsgedrag. 141 eerstejaars studenten van de Fontys Lerarenopleiding namen deel aan deze studie.

Hoofdstuk 4 presenteert de eerste studie die de Virtual Classroom onderzocht. In dit hoofdstuk ligt de focus op de invloed van de Virtual Classroom op de professionele spanning en zelfeffectiviteit van LIO's. Kan de professionele spanning verminderd worden en de zelfeffectiviteit vergroot door de video-college combinatie? Verder onderzocht deze studie het zelfwaargenomen interpersoonlijk leraarsgedrag van LIO's.

Deze studie maakte gebruik van een mixed-method design met een voor- en nameting bestaande uit een vragenlijst met betrekking tot de professionele spanning en zelfeffectiviteit van LIO's, een vragenlijst bij de nameting gericht op het zelfwaargenomen interpersoonlijk leraarsgedrag van LIO's en semigestructureerde interviews (n = 12) om meer inzicht te krijgen in de ervaringen met de Virtual Classroom. De kwantitatieve data lieten zien dat de professionele spanning van LIO's significant verminderde en hun zelfeffectiviteit significant steeg na de Virtual Classroom. LIO's werden zekerder van hun eigen mogelijkheden om met klassenmanagementproblemen om te gaan en werden minder angstig om les te geven. De kwalitatieve data lieten zien dat het observeren van voorbeeldgedrag van ervaren leraren LIO's meer bekend maakten met de onderwijspraktijk waardoor hun spanning om les te geven verminderde. De nameting liet tevens zien dat met betrekking tot LIO's interpersoonlijk leraarsgedrag zij zichzelf als leraren inschatten die meer sturend en minder dwingend handelen. Dit resulteerde in een hogere mate van nabijheid na de interventie, wat inhoudt dat LIO's zich na de interventie beschouwden als leraren die beter in staat zijn om warmte te creëren in hun leraar-leerlingrelaties.

Omdat LIO's bij aanvang van de studie verschilden in gevoelens van spanning en zelfeffectiviteit, heeft deze studie ook onderzocht of er verschillende clusters van LIO's vastgesteld konden worden met betrekking tot professionele spanning en zelfeffectiviteit. Een clusteranalyse liet zien dat er bij aanvang van de studie twee clusters LIO's vast te stellen waren: LIO's uit cluster 1 scoorden zowel hoog op professionele spanning als op zelfeffectiviteit, LIO's uit cluster 2 scoorden gemiddeld op professionele spanning en hoog op zelfeffectiviteit. Na de interventie verschilden beiden clusters ieder significant in hun professionele spanning. De resultaten van deze studie suggereren dat de Virtual Classroom een bruikbare methode kan zijn om de transitie van de lerarenopleiding naar de onderwijspraktijk te verzachten omdat de de professionele spanning van LIO's afnam en hun zelfeffectiviteit toenam na de Virtual Classroom.

Hoofdstuk 5 presenteert de tweede studie die onderzocht of de Virtual Classroom van invloed is op de LIO's interpretaties van waargenomen klassensituaties. Voor interpersoonlijk leraarsgedrag is het immers van belang dat LIO's belangrijke klassensituaties waarnemen en interpreteren voordat zij hierop reageren. LIO's interpretaties van waargenomen klassensituaties werden gemeten door hen videofragmenten te laten labelen tijdens de voor- en nameting. Na de Virtual Classroom werden semigestructureerde individuele interviews afgenomen (n = 12) om meer inzicht te verkrijgen in de manier waarop LIO's de videofragmenten gelabeld hebben. Resultaten lieten zien dat het waarnemen van waargenomen klassensituaties en het beschrijven van deze situaties met behulp van theorie verbeterd was na de interventie. Dit wijst erop dat LIO's meer gebruik maakten van theorie over interpersoonlijk leraarsgedrag wanneer zij een waargenomen klassensituatie interpreteerden. Dit werd ook bevestigd in de interviews.

Verder evalueerde deze studie de technologische en educatieve affordances van de Virtual Classroom met behulp van een vragenlijst tijdens de nameting en de semigestructureerde interviews (*n* = 12). Als een educatieve affordance gaven LIO's aan dat zij zich beter voorbereid voelden op de onderwijspraktijk door het observeren van ervaren leraren in de Virtual Classroom. Als technologische affordance werd de immersive leerbeleving door het gebruik van de VR-brillen genoemd. Echter waren er ook LIO's die technische hinderingen en fysiek ongemak ervaarden door het gebruik van deze brillen.

De resultaten van deze studie suggereren dat de Virtual Classroom LIO's interpretaties over waargenomen klassensituaties positief beïnvloeden, al kon de meerwaarde van de VR-bril niet vastgesteld worden. Uitkomsten van deze studie benadrukken tevens het belang van goede kwaliteit VR-omgevingen om de immersive leerbeleving te verbeteren.

Hoofdstuk 6 presenteert de derde studie die de Virtual Classroom onderzocht door het analyseren van LIO's interpersoonlijke kennisstructuren en de ontwikkeling van deze structuren met behulp van *concept maps* tijdens de voor- en nameting. Er werd gebruik gemaakt van sociale netwerkanalyses, inclusief de structuur van de concept maps en de relevantie van begrippen, om de concept maps te analyseren. Verder werden de concept maps vergeleken met concept maps van experts. Om de structuur van de concept maps vast te stellen werden kwantitatieve criteria gebruikt (bijvoorbeeld aantal onderlinge links, aantal clusters, aantal concepten, dichtheid van de concept map). Interviews (*n* = 12) werden afgenomen om beter inzicht te krijgen in de interpretaties die LIO's gaven aan hun concepten.

De kwantitatieve data lieten zien dat LIO's na de Virtual Classroom meer georganiseerde concept maps maakten. Dit was te zien in een toename van links en clusters, een afname in de dichtheid van het netwerk en de wederkerigheid tussen concepten. Beter georganiseerde concept maps worden geassocieerd met een beter ontwikkelde interpersoonlijke kennisstructuur. Het vergelijken van LIO's concept maps met experts liet zien dat LIO's na de Virtual Classroom meer relevante begrippen gebruikten in hun concept maps. De kwalitatieve data bevestigden dat LIO's meer gebruik van theorie–geleerd gedurende de Virtual Classroom– bij het opstellen van hun concept maps.

Verder werd de toepassing van LIO's interpersoonlijke kennis vastgesteld met behulp van vignetten bij de nameting. Deze vignetten bevatten beschrijvingen van klassensituaties met interpersoonlijk leraarsgedrag. LIO's werden gevraagd om het leraarsgedrag te scoren op de invloeds- en nabijheidsdimensie van de interpersoonlijke cirkel docent. Deze scores werden vergeleken met vignetten van experts door de absolute verschillen vast te stellen. LIO's bleken vooral in staat om hun interpersoonlijke kennis toe te passen bij vignetten die gericht waren op een hoge mate van invloed.

Tot slot liet deze studie zien dat het gebruik van de VR-brillen een positieve invloed had op LIO's interpersoonlijke kennisstructuren en het toepassen van deze kennis. LIO's die continu gebruik maakten van de VR-bril pastten significant meer clusters toe in hun concept maps, wat wijst op meer georganiseerde interpersoonlijke kennis in verhouding tot LIO's die minder gebruik maakten van de VR-bril. Dit impliceert dat een hogere mate van immersiveness een positieve invloed heeft op de ontwikkeling van interpersoonlijke kennis.

Concluderend liet deze studie zien dat de op theorie gebaseerde interpersoonlijke kennisstructuren van LIO's gevisualiseerd kan worden door gebruik van concept maps en geïnterpreteerd kan worden met behulp van sociale netwerkanalyses. Daarom zijn concept maps mogelijk een bruikbare methode voor lerarenopleiding om interpersoonlijke kennis vast te stellen.

De resultaten van dit proefschrift zijn mogelijk gelimiteerd omdat de verschillende aspecten van interpersoonlijk leraarsgedrag (kennis, waarneming, toepassing) apart zijn onderzocht. De vraag blijft hoe deze aspecten van interpersoonlijk leraarsgedrag zich tot elkaar verhouden en nog belangrijker of het interpersoonlijk leraarsgedrag van LIO's in de onderwijspraktijk daadwerkelijk verbeterd is. Langdurig vervolgonderzoek zou dit kunnen vaststellen. LIO's die deelgenomen hebben aan deze studie meldden ook technische hinderingen. Dit roept de vraag op of de lagere kwaliteit van de gebruikte technologieën de uitkomsten van dit onderzoek negatief beïnvloed hebben.

Voor toekomstig onderzoek zou het interessant zijn om klassensimulaties te onderzoeken die adaptiever zijn in het simuleren van leraar-leerling interacties. In het huidige proefschrift boden de virtuele stages een bepaalde mate van interactie tussen de LIO en de gesimuleerde leerlingen door het gebruik van scenario's. Echter, deze scenario's waren niet adaptief, dus feedback die LIO's ontvingen van het onlinesysteem sloot niet altijd juist aan bij hun leraarsgedrag. Het gebruik van de 360-graden video's was een relatief passieve ervaring. Interacties binnen de simulatie zouden, in theorie, een mooie aanvulling zijn omdat zij mogelijk een meer complete praktijkervaring bieden met reeksen van mogelijke gebeurtenissen.

Concluderend lieten alle opvolgende studies van dit proefschrift veelbelovende resultaten zien voor het gebruik van klassensimulaties binnen de lerarenopleiding. Hoewel het nog onbekend is of klassensimulaties bijdragen aan verbeterd interpersoonlijk leraarsgedrag in de daadwerkelijke onderwijspraktijk, impliceren de resultaten van dit proefschrift dat interpersoonlijk leraarsgedrag getraind kan worden met behulp van klassensimulaties. Verder hadden beide klassensimulaties een positieve invloed op de zelfeffectiviteit van LIO's en bleken zij bruikbaar om de professionele spanning van LIO's te verminderen.

Klassensimulaties blijken waardevolle tools om LIO's een meer realistisch beeld van de onderwijspraktijk te bieden en als gevolg hiervan LIO's een beter beeld geven van het leerlinggedrag dat zij kunnen verwachten in een klaslokaal, en hoe zij hier vervolgens op kunnen reageren als leraar. Daarom kunnen klassensimulaties de transitie van de lerarenopleiding naar de onderwijspraktijk verzachten en bieden zij LIO's de mogelijkheid om hun interpersoonlijke leraarsgedrag in een veilige leeromgeving te oefenen. Klassensimulaties kunnen onderdeel zijn van blended leeromgevingen met bijbehorende voordelen zoals het oefenen in eigen tijd, tempo en plaats. Dit biedt kansen voor meer flexibele leertrajecten en is vooral bruikbaar bij kleinschalige en/of educatieve programma's op maat.

Dankwoord

Wat heb ik genoten van het schrijven van dit proefschrift! Van begin tot eind was het een feestje en ik vind het bijna spijtig dat mijn promotietraject nu aan zijn einde gekomen is. Bijna, want ik ben ook ontzettend blij dat ik 'het boekje' nu eindelijk in handen heb. Uiteraard heb ik deze prestatie niet alleen bereikt en ben ik menigeen dankbaar.

Ten eerste Antoine en Perry, jullie waren een fantastisch begeleidingsteam. Ik had me geen betere begeleiders kunnen wensen. Antoine, als dagelijks begeleider heb jij me zo veel geleerd en daar ben ik je heel dankbaar voor. Ik stel je punctualiteit op prijs en waardeer oprecht je vele gedetailleerde, constructieve feedback. Zoals je weet houd ik van deze details. Vooral op het gebied van schrijfvaardigheid heb ik heel veel van je geleerd. Maar het mooiste en meest waardevolle dat je mij hebt gegeven is vertrouwen in mijn eigen onderzoeksvaardigheden. Jouw onvoorwaardelijke vertrouwen in mij heeft mij doen groeien tot de onderzoeker die ik nu ben. Perry, vanaf het eerste moment dat wij elkaar spraken hadden wij een klik. Jij was meteen enthousiast over mijn onderzoeksideeën en ik waardeer het enorm dat je me altijd mijn gang hebt laten gaan en ervoor gezorgd hebt dat mijn eigen ideeën beter werden. Je bent een ontzettend positieve en betrokken promotor waar ik heel blij van werd. Ondanks je volle agenda gaf je altijd razendsnel feedback. Hierdoor kon ik lekker doorwerken. Ook jij had altijd het volste vertrouwen in mijn vaardigheden. Ik dank jullie beiden daarvoor.

Dit promotieonderzoek had ik niet kunnen uitvoeren zonder de hulp van docenten en studenten van de Eindhoven School of Education (ESoE; TU Eindhoven), het Graaf Huyn College in Geleen en de Fontys Lerarenopleiding Sittard. Maaike Koopman en Antoine: bedankt voor het inzetten van de virtuele stages in jullie onderwijskundige modulen op de ESoE. Ook de studenten van de ESoE die deelnamen aan deze virtuele stages, vragenlijsten hebben ingevuld en aan de individuele interviews en focusgroep hebben deelgenomen, ontzettend bedankt. Annelot, Elske, Désirée, Maud, Ingrid, Robin, Patrick, Joep en Karel van het Graaf Huyn College, jullie zijn de eigenlijke sterren van dit proefschrift. Jullie hebben je klasdeur letterlijk voor mij opengezet en lieten mij jullie lessen filmen. Deze videofragmenten zijn van onschatbare waarde gebleken. Ook dank ik alle leerlingen uit jullie klassen die ik heb mogen filmen. En tot slot de 141 eerstejaars studenten cohort 2017-2018 van de Fontys Lerarenopleiding Sittard. Hartelijk dank voor het deelnemen aan de Virtual Classroom, het invullen van de vragenlijsten, het maken van de concept maps, het taggen van video's en het deelnemen aan interviews. Jullie inzet heeft een schat aan informatie opgeleverd en het was ook nog eens heel leuk! Dank jullie wel.

Naast de studenten van de Fontys Lerarenopleiding Sittard ben ik ook enkele collega's mijn dank verschuldigd. Ten eerste Anton van den Brink, directeur van de FLOS. Ontzettend bedankt dat jij mij de ruimte hebt gegeven om dit promotietraject te starten en uit te voeren. Je bent altijd geïnteresseerd geweest in mijn onderzoek en hebt mij veel vertrouwen gegeven. Je las als een van de eersten mijn artikelen en gaf inhoudelijke reactie. Dat waardeer ik enorm. Dave, wat vond ik het leuk dat wij elk jaar samen naar de onderwijs research dagen gingen. Ook heb ik veel gehad aan onze gesprekken over onderzoek in het algemeen en specifiek dit proefschrift waarbij je hebt geholpen met het beoordelen van data. Bedankt voor je goede tips en frisse blik. Jimmy, het was fijn om een maatje te hebben bij het aanvragen van de promotiebeurs en om op de vrijdagmiddagen bij te praten over onze proefschriften. Verder was het fijn om successen en uitdagingen te delen met de kenniskring (Frank, Frans, Ella, Jimmy, Dave en Meity) van het lectoraat. Frank, als lector werd jij altijd blij van collega's die onderzoek binnen Fontys op de kaart willen zetten. Dat gaf de nodige steun!

Ook op de ESoE heb ik het gezellig gehad. Het leven van een promovenda lijkt misschien eenzaam, maar met deze leuke medepromovendi en collega's voelde dat helemaal niet zo. Bram, wij hebben veel aan elkaar gehad. Van begin tot eind, bedankt voor je hulp. Myrthe en Rianne, mijn eerste studie hoefde ik niet helemaal alleen te doen, want ik had jullie aan mijn zijde. Het was niet alleen heel gezellig, maar ook ontzettend leerzaam. Dank hiervoor! Janneke, ik vond het fijn om met jou kopjes thee te drinken, te kletsen over onze onderzoeken, het onderwijs en het leven en het samen volgen van de cursus schrijfvaardigheden. Annemieke, jij was mijn stabiele factor in de 'flexkamer'. Wat hebben wij veel woensdagen naast elkaar zitten schrijven. Tim, Saskia, Marloes, Cui, Janine, Henderijn, Rens en iedereen die ik vergeet, wat vond ik het gezellig dat jullie zo regelmatig langs kwamen voor een praatje. Hierdoor voelde ik mij echt onderdeel van de ESoE.

Dank ook aan mijn collega's van de Education and Learning Sciences in Wageningen voor jullie interesse in mijn onderzoek!

Tom, ook al hebben we elkaar nooit live gesproken, ik vond het toch erg fijn om ervaringen met jou uit te wisselen. Als Fontys-collega en mede-promovendus van Perry konden we onze successen en ervaringen delen.

Mijn ICO-maatjes Laura en Serge. Als de enigen uit het diepe zuiden hadden wij meteen een band. Ik vond het erg leuk om samen met jullie deel te nemen aan cursussen en vond het erg interessant om onze onderzoeken uit te wisselen over verschillende disciplines heen. En het was ook nog eens gezellig iedere keer! Dank hiervoor :-).

Lieve opa, wat vind ik het fijn dat u vandaag naast mijn zijde staat als paranimf. U bent altijd zo geïnteresseerd in alles wat er in de wereld gebeurt, inclusief mijn proefschrift. Ik vind het heel bijzonder dat u vandaag getuige bent van mijn verdediging. Bedankt!

Lieve (schoon)familie, wat fijn dat ik al mijn successen met jullie kon vieren. Bedankt voor alle interesse. Jo, your efforts were priceless. Thank you for checking all of my texts! Speciaal voor pap en mam, jullie zijn twee docenten in hart en nieren. Wat dat betreft raakte mijn onderzoek jullie leefwereld direct. Ook al vonden jullie het lastig om de Engelse artikelen te lezen, ik heb altijd jullie trots gevoeld. Mijn hele leven hebben jullie mij gestimuleerd om door te leren. Ook al luisterde ik niet altijd, het is toch goed gekomen.

Tot slot mijn liefste Jim en Pim. Lieve Pim, wat vond ik het gezellig dat jij bij de laatste loodjes in je stoeltje naast me zat te lachen. Mochten er nog fouten in dit proefschrift staan dan komt dat doordat ik mijn proefschrift helemaal in de wolken heb afgerond en meer gefascineerd werd door lieve babygeluidjes dan het editen van mijn 'meesterwerk'. Mijn excuses voor de lezer, maar laten we eerlijk zijn, Pim jij bent mijn echte meesterwerk! Lieve Jim, jij bent van onschatbare waarde. Vanaf het moment dat ik wilde promoveren heb jij me onvoorwaardelijk gesteund en geholpen. Van het brainstormen over onderwerpen, het uitzoeken van virtual reality-brillen, het nalezen van mijn teksten, en nog eens, en nog eens... Jij stond altijd voor mij klaar, werd mee enthousiast en hebt mij ontzettend geholpen. Eigenlijk ben jij nu ook een beetje doctor. Ik ben dan ook ontzettend blij dat jij vandaag naast mijn zijde staat als paranimf. Met jou in mijn team voel ik mij veel sterker. Jij bent mijn liefste!

Curriculum Vitae

Hanneke Theelen was born on July 1st, 1986 in Landgraaf, The Netherlands. After completing her secondary schooling, Hanneke attended the teacher education institute for primary education at the Zuyd University of Applied Sciences in 2003, where she graduated cum laude in 2007. After her graduation she started as a primary school teacher, while simultaneously obtaining her Master of Education in special educational needs at the HU University of Applied Sciences in 2009. After obtaining this degree cum laude, Hanneke started as a dyslexia specialist. However, she was still interested in educational sciences and alongside her job, she obtained a Master of Science degree in educational sciences at the Open University in 2012. Her master's thesis focused on the use of digital learning tools for the consolidation of infants' vocabulary. After completing her master's degree, Hanneke started working in higher education as a student counsellor and a teacher educator at the teacher education institute for primary education. Since 2013 Hanneke is a teacher educator at the Fontys University of Applied Sciences for Teacher Education. In 2016 Hanneke started, alongside her work as teacher educator, her PhD project on the use of classroom simulations in teacher education to develop preservice teachers' interpersonal competence, funded by the Netherlands Organization for Scientific Research (NWO).

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This work was conducted while the first author was supported with a grant from the Netherlands Organisation for Scientific Research [grant number 023.009.002] and was partly supported by a grant from the TU/e Education Innovation Fund 2016: Blended Learning & New ways to supervise education.

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