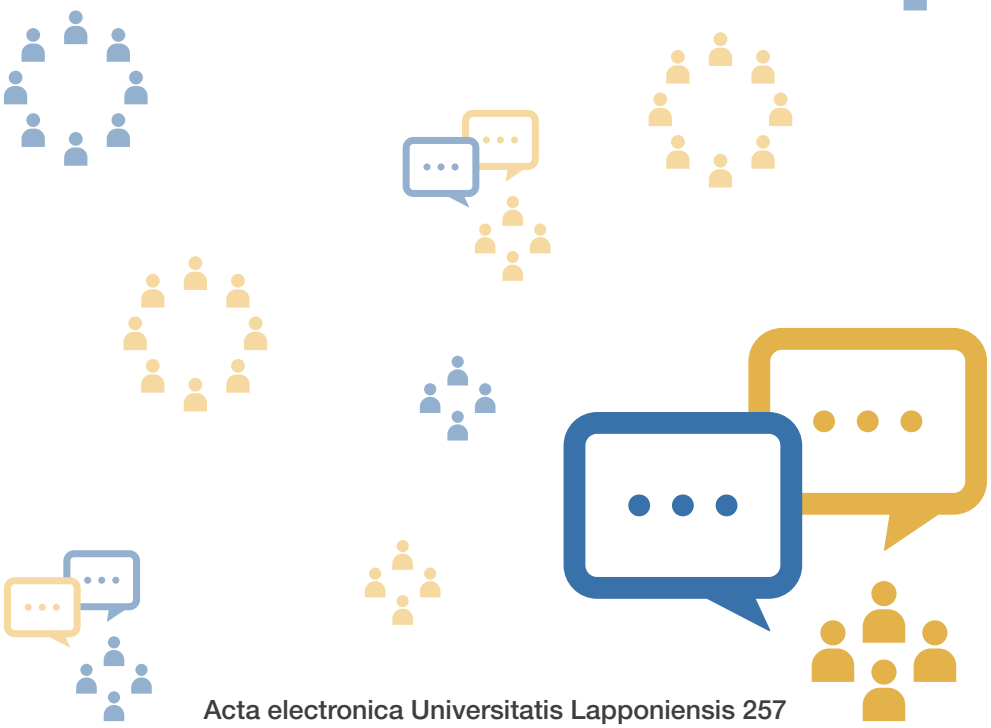
Sanna Ruhalahti

Redesigning a Pedagogical Model for Scaffolding Dialogical, Digital and Deep Learning in Vocational Teacher Education



Acta electronica Universitatis Lapponiensis 257

Acta electronica Universitatis Lapponiensis 257

SANNA RUHALAHTI

Redesigning a Pedagogical Model for Scaffolding Dialogical, Digital and Deep Learning in Vocational Teacher Education

Academic dissertation
to be publicly defended with the permission
of the Faculty of Education at the University of Lapland
in Castrén hall on 12 April 2019 at 12 noon

LAPIN YLIOPISTO
UNIVERSITY OF LAPLAND

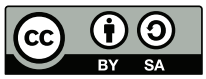
Rovaniemi 2019

University of Lapland
Faculty of Education

Supervised by
Professor Heli Ruokamo, University of Lapland
Associate Professor Päivi Rasi, University of Lapland

Reviewed by
Professor Rupert Wegerif, University of Cambridge
Associate Professor Sami Paavola, University of Helsinki

Opponent
Associate Professor Sami Paavola, University of Helsinki



Layout: Taittotalo PrintOne
Cover, figures 8 & 9: Johanna Rintanen

Acta electronica Universitatis Lapponiensis 257
ISSN 1796-6310
ISBN 978-952-337-145-3

Permanent address to the publication: http://urn.fi/URN:ISBN:978-952-337-145-3

Abstract

Sanna Ruhalahti
Redesigning a Pedagogical Model for Scaffolding Dialogical, Digital and Deep Learning in Vocational Teacher Education
Rovaniemi: University of Lapland 2019, 185 p.
Acta electronica Universitatis Lapponiensis 257
Thesis: University of Lapland, Faculty of Education, Centre for Media Pedagogy
ISBN 978-952-337-145-3
ISSN 1796-6310

The main goal of the study was to identify the type of pedagogical model that scaffolds the construction of dialogical collaborative knowledge in digital environments toward deep learning in vocational teacher education. Another goal was to identify the type of framework that supports the evaluation of deep learning. The research redesigned the Dialogical Authentic Netlearning Activity (DIANA) pedagogical model. The specific aims of the research were to identify the challenges and opportunities associated with adopting the DIANA model for blended and mobile learning and to understand how student teachers reflect on and evaluate the construction of authentic and dialogical collaborative knowledge. Additionally, this study explores how digital personal learning environments are scaffolded and determines authentic and dialogical collaborative knowledge constructions used with the DIANA model.

Multiple research questions were set to meet these aims, and the case study used qualitative research methods to answer these questions. The study population included international, vocational teachers (n = 14) and Finnish vocational student teachers (n = 76) who participated between 2013 and 2016. Data were collected through online questionnaires, in-depth interviews, self-reflective accounts and open blog entries (synthesis, artefacts). Data were analysed using qualitative content, deductive and abductive analyses. In the third sub-study, the design-based implementation research approach was used to provide a re-design process for implementing scaffolding.

The principle result of this study is a redesigned Dialogical, Digital and Deep learning (DDD) pedagogical model informed by educational theories and based on both the previously developed DIANA model and studies about the construction of authentic and dialogical collaborative knowledge. This information was used to

develop specific design principles that scaffold dialogical, digital and deep learning. The study provides a redesigned, pragmatic evaluation framework for deep-learning activities that supports the design, construction and evaluation of dialogical collaborative knowledge. The study results have several implications for learning design, research and practice in vocational teacher education. The study indicated that deep learning activities in authentic and dialogical collaborative knowledge construction offer a promising approach to developing learning processes for vocational teacher education, especially in the digital learning context. Vocational student teachers ought to gain positive experiences in dialogical collaborative knowledge construction, which requires deep learning in digital environments. In addition, dialogical competences ought to be integrated more deeply into the processes of teacher education to ensure acquisition of deeply oriented skills and knowledge rather than disconnected add-on elements, and such competences should be principle among teachers.

Keywords: dialogical collaborative knowledge construction, digital environments, deep learning evaluation, pedagogical model, scaffolding, vocational teacher education

Tiivistelmä

Pedagogisen mallin edelleen kehittäminen dialogiseen, digitaaliseen ja syväoppimiseen suuntaavaan ohjaukseen ammatillisessa opettajankoulutuksessa
Rovaniemi: Lapin yliopisto 2019, 185 p.
Acta electronica Universitatis Lapponiensis 257
Väitöskirja: Lapin yliopisto, Kasvatustieteiden tiedekunta, Mediapedagogiikkakeskus
ISBN 978-952-337-145-3
ISSN 1796-6310

Tutkimuksen tavoitteena oli tutkia millainen pedagoginen malli ohjaa yhteisölliseen dialogiseen tiedonrakentamiseen syväoppimisen suunnassa digitaalisissa ympäristöissä ammatillisen opettajankoulutuksen konktekstissa sekä lisäksi tarkentaa syväoppimisen arviointia tukevaa viitekehystä. Tutkimus kehitti eteenpäin DIANA (Dialogical Authentic Netlearning Activity) pedagogista mallia. Tutkimuksessa tarkasteltiin myös sitä, minkälaisia haasteita ja mahdollisuuksia DIANA-mallin mukaisessa monimuotoisessa ja mobiilioppimisessa on. Tutkimus syvensi sitä, miten opettajaopiskelijat reflektoivat sekä arvioivat omaa autenttista ja dialogista yhteisöllistä tiedonrakentamista. Tutkimus selvitti myös, miten ohjata henkilökohtaisten oppimisympäristöjen käyttöä DIANA-mallin mukaisessa autenttisessa ja dialogisessa yhteisöllisessä tiedonrakentamisessa.

Tutkimuksessa määriteltiin useita tutkimuskysymyksiä, joilla pyrittiin vastaamaan tutkimuksen tavoitteisiin ja kysymyksiin laadullista tapaustutkimusta hyödyntämällä. Tutkimukseen osallistui kansainvälisiä, ammatillisia opettajia (n = 14) ja suomalaisia ammatillisia opettajaopiskelijoita (n = 76), jotka osallistuivat ammatilliseen opettajankoulutukseen vuosien 2013 ja 2016 aikana. Aineiston hankintamenetelminä olivat verkkokyselyt, syvähaastattelut, itsereflektiot ja avoimet verkkoblogit (synteesit, artefaktit). Case-tutkimuksen aineisto analysoitiin laadullisin menetelmin, teorialähtöisen ja abduktiivisen sisällönanalyysin avulla. Kolmannessa osatutkimuksessa käytettiin DBIR-menetelmää (Design-Based Implementation Research) ohjauksen uudelleen kehittämisen tukena.

Tutkimuksen keskeisena tuloksena syntyi uudistettu pedagoginen malli DDD (Dialogical, Digital and Deep learning), joka perustuu oppimisen teorioihin, aiemmin kehitettyyn DIANA-malliin sekä aiempiin tutkimuksiin autenttisesta ja dialogisesta tiedonrakentamisesta. Edellä mainittuja hyödynnettiin myös DDD

pedagogisen mallin mukaisten suunnitteluperiaatteiden luomisessa, jotka tukevat dialogista, digitaalista ja syväoppimista. Tutkimuksessa esitetään praktinen syväoppimisen arvioinnin viitekehys, joka tukee dialogisen yhteisöllisen tiedonrakentamisen suunnittelua ja arviointia. Tutkimus osoitti, että syväoppimista tukeva autenttinen ja dialoginen yhteisöllinen tiedonrakentaminen tarjoaa käytännönlähteisen lähestymisen, kun ammatillista opettajankoulutusta kehitetään digitaalisen oppimisen kontekstissa. Myös dialogiosaaminen pitäisi integroida syvemmin ammatillisen opettajankoulutuksen prosesseihin. Näin varmistetaan opettajien osaamiseen kuuluvien syvätasoisten dialogitaitojen oppiminen, eikä pelkästään irrallisten tekniikoiden opiskelua.

Avainsanat: dialoginen yhteisöllinen tiedonrakentaminen, digitaaliset ympäristöt, syväoppimisen arviointi, pedagoginen malli, ohjaus, ammatillinen opettajankoulutus

Acknowledgements

This dissertation represents my voyage as a vocational teacher, teacher educator, and researcher. I embarked on this voyage at the beginning of the millennium when I was involved in developing Virtual Schools (funded by the Finnish National Board of Education) at the Pori Adult Education Centre. Around that time, I began to question my own pedagogical learning design practices in online and blended learning environments. The real needs I saw reflected in my students' online learning communities indicated a lack of certain dialogical skills and knowledge. I subsequently discovered the DIANA model and, most importantly, a deeper understanding of dialogical participation. The developers of the model, Helena Aarnio, Ph.D., and Jouni Enqvist, Ph.D., have helped to light the way from the starting point of my journey right up until today. An enduring passion to carry on their important research has helped me chart a course of discovery with abundant potential opportunities to deepen learning through dialogue in all kinds of communities.

A voyage of this magnitude cannot be undertaken alone. Many companions have come alongside and briefly stepped aboard; others have sailed with me the entire way, sometimes trying to steer my understanding, but other times just pointing out the seamarks to let me find my own route.

I´m deeply grateful to you, my supervisor, Professor Heli Ruokamo for seeing the potential in me in the first place. I find your dedication to science and media education truly inspiring. Your support and guidance have been indispensable to my voyage as you have always been ready to point out alternative solutions and opportunities. And to my second supervisor, Associate Professor Päivi Rasi, let me say that you are the kind of supervisor that every Ph.D. student should have. I learnt so much from your expertise, ethical research practice and scientific wisdom throughout our research co-writing process; you truly have a dialogical attitude and an engaged heart for scaffolding novices like me. Please allow me to express my deep appreciation to both of you for the considerable time and effort you have invested in me throughout this process. Your vital words of encouragement have shone like a lighthouse beacon whenever I encountered rough seas.

To my invaluable mentor, Helena Aarnio, let me say that none of this could ever have happened without you. Your eternal optimism, encouragement, and personal strength were steadying forces in my research life. I´m so grateful for your belief in my abilities and passion as well as for the way you always manage to inspire hope

and positive energy for navigating the complex oceans of science. You're a delightful woman, an exceptional friend, but first and foremost, a great co-author. Through contact with your wisdom, I have learnt a great deal about myself as a human. Even though we have worked and investigated together for countless hours, I have to say that our best and most inspirational ideas emerged during our flights around Europe. So Helena—shall we now get weigh anchor for our next destination?

For the successful completion of this dissertation, I express my sincere thanks to my pre-examiners, Professor Rupert Wegerif and Associate Professor Sami Paavola. I deeply appreciate the valuable comments made regarding my manuscript: Wegefir's guidance regarding educational dialogue and Paavola's insights on the metaphors for learning. I felt very privileged to have such influential professionals review my manuscript. I also wish to express my thanks to my opponent. Paavola's research has been extremely influential on the work conducted for this dissertation, and having him as my opponent has truly been an honour.

Next, I would like to thank my wonderful colleagues at HAMK UAS School of Professional Teacher Education. Anne-Maria Korhonen, I thank you for believing in new ideas, for dreaming together, for inspiring me with your thoughts, for encouraging me, and for steadfastly remaining alongside for the entire length of the voyage, from the formulation of the first words till the last. Working with you at a deep level as we navigated this rocky route has made the trip much easier and more pleasant. You have become a seasoned sailor familiar with the trickiest knots. Irma Kunnari, thank you for being generous with your academic wisdom through both fair and foul weather. I have learnt so much from you during this new and challenging process. Your support has meant more than I can say, and I will always be grateful that you revealed to me the secrets of content analysis. Jaana Muttonen, you have been there for me throughout the twists and turns of my route, consistently demonstrating your deepest interest in my research process. Leena Nikander, you saw my passion, and I am thankful for the chance I was given to develop and implement a study module. Anita Eskola-Kronqvist, thank you for the empowering moments you provided during these years. Thank you for being kind of crosstree. Jouni Enqvist, thank you for shaping my thinking. My special thanks must be extended to Research Manager Martti Majuri and Director Seija Mahlamäki-Kultanen, who believed in me and supported my doctoral process at the upper management level. Martti, thank you for providing any and all opportunities and for your trustworthiness; your encouragement meant so much to me as I made my way along these highly travelled sea lanes. I'd also be remiss not to point out that without the professional guidance of Information Specialist Katja Laitila's and HAMK UAS librarians, this study might have taken a very different course. Naturally, it is quite difficult to individually highlight all the names of people who contributed to a project of this scale, but my heartfelt thanks go out to the many other colleagues who have helped me to get where I am now.

During my doctoral studies, I was fortunate to have been part of the Centre for Media Pedagogy research group at the University of Lapland and owe much to each of the team members. Special thanks to Sanna Brauer for her endless stream of ideas, caring and support as my pre-opponent. You have done yeoman's work. The voyage with you has never been stuck in the doldrums; your positive energy has sparkled and provided fresh impetus, even in the deepest waters. Thank you for staying close from day one till now, sharing my interest in problems that are at the heart of carrying out research. I also thank Satu-Maarit Frangou, Solja Upola and Anitra Arkko-Saukkonen for moulding my belief and trust in myself and for being such strong supporters. And I mustn't forget all the others, among them Lauri Palsa and Information Specialists, who have influenced and broadened my thinking over the years. I also wish to extend my thanks to Dean Tuija Turunen for giving very professional, constructive feedback in the final seminar and to Professor Anu Valtonen and Adjunct Professors Pirkko Siklander and Marjaana Kangas, each of whom in one way or another influenced my direction as a doctoral candidate.

I would also like to extend my heartfelt thanks to all my student teachers who have participated in this research or been around it in one capacity or another. Each of you has provided me with an opportunity to dive more deeply into your thoughts and collaborative processes. The way you have entrusted your learning path to my hands has been empowering. I will always be grateful to all of you. I feel the progress of our dialogues has been favoured throughout by fair winds. For me, it has been a genuine joy to discover that your developmental potential is something worth striving for, and this potential often becomes manifest when you have found the empowerment of authentic and dialogical collaborative knowledge construction within your own learning community, proudly reflected in your artefacts. I have seen first-hand the empowerment of working in a dialogical learning community rather than alone. Resent years I have been fortunate working very dialogically as a part of international teacher´s learning communities in Brazil, Kazakhstan and Nepal. You have been an important source of my inspiration and passion of teaching. Teaching needs a *deep vocare*; you all know what this means in practice.

I owe a deep debt of gratitude to Ulla Susimetsä and Nicholas Rowe, who have shaped my language skills. I'm also grateful to Koulutusrahasto (The Education Fund), The Häme Foundation for Professional Higher Education and Research, The Foundation for Economic Education, and the University of Lapland for financially supporting this study. In addition, I'm thankful to Johanna Rintanen, who helped me with the graphic design and main figures.

I am tremendously grateful to my close friends who have seen my ups and downs and have nevertheless always been there for me. Kaisa Virtanen, Outi Kunnas, and Riikka Tähtinen, all of you, along with your partners, have kept me sane and brought me joy through the very intensive years of this process, and for that you have my eternal gratitude. Tiina and Eero Sorri, I thank you both for living this

immersive period of my life with me and seeing the world through the same lens while sharing the same scenery of our beloved lakes, from Päijänne and Keitele to the Gulf of Thailand. My friends, all our shared moments have brought lots of happiness as we crossed each line of longitude on the way to our final port of call.

Amanda, my one and only. You have seen your mum always studying something as a living example of a lifelong student. I hope you will remember that education makes sense and opens new routes and opportunities. My dearest younger sisters Mari and Elina, you are always the lifeboat of my life, no matter what we go through or the time or distance between us. Eila, my mother-in-law, you have taken care of me or us in many ways while I have been buried under my research. I must also express my deep thanks to my mother Sylvi and father Arvo for providing me with such a caring environment in childhood. Mother, you have always been the loving foundation for my growth from 1971 until today. Father, the sea is whispering my endless longing. I have felt so deeply that you were navigating this route with me. I am always grateful for all your support and encouragement and for all your many wise words which have supported me over the years when sailing against the wind. Because of your worldwide working experience, you knew very well that education is the most powerful way to change and empower women's lives.

Above all, I thank Kaitsu, my husband, who has stood by me. I am grateful for all the ways in which you have supported me over the years, especially during times when I have been so immersed in writing that I have not had much mental space for anything else. Thanks for always being near. I realise there is now a space for improving my seamanship. But most importantly, I thank you for "the tailwinds and clear waters" that you have brought to my life.

I owe this book to my dearest daughter Amanda, my beloved nephews Valtteri, Sanni, Aaron, Rasmus, and Hanna, and to my long-awaited godson Viljami. Thanks to each of you for being one of the reasons to reach the shore—before a new voyage begins.

"*He who loves practice without theory is like the sailor who boards ship without a rudder and compass and never knows where he may cast*." Leonardo da Vinci

List of articles

Study I
Ruhalahti, S., Korhonen, A.-M., & Ruokamo, H. (2016). The dialogical authentic netlearning activity (DIANA) model for collaborative knowledge construction in mOOC. *The Online Journal of Distance Education and e-Learning, 4*(2), 58–67.

Study II
Ruhalahti, S., Korhonen, A-M., & Rasi, P. (2017). Authentic, dialogical knowledge construction: A blended and mobile teacher education programme. *Educational Research, 59*(4), 373–390. https://doi.org/10.1080/00131881.2017.1369858

Study III
Korhonen, A-M., Ruhalahti, S., & Veermans, M. (2019). The online learning process and scaffolding student teachers' personal learning environments. *Education and Information Technologies*, *24*(1), 755–779.

Study IV
Ruhalahti, S., Aarnio, H., & Ruokamo, H. (2018). Evaluation of deep learning in vocational teacher education: Conducted on the principles of authentic and dialogical collaborative knowledge construction. *Nordic Journal of Vocational Education and Training, 8*(2), 22–47.

List of figures and tables

Figures

Tables

List of abbreviations

ADL	= Actual Development Level
cMOOC	= connectivist MOOC
DDD	= Dialogical, Digital and Deep Learning
DIANA	= Dialogical Authentic Netlearning Activity
DP	= Design Principle
ECTS	= European Credit Transfer System
EU	= European Union
HAMK SPTE	= Häme University of Applied Sciences, School of Professional Teacher Education
mLearning	= Mobile Learning
MOOC	= Massive Open Online Course
mOOC	= micro Open Online Course
NMC	= New Media Consortium
PDL	= Potential Development Level
PLE	= Personal Learning Environment
PWT	= Personal Web Tools
ZPD	= Zone of Proximal Development

CONTENTS

1 Introduction

Globally, the on-going process of digitalisation has required changes in educational structures and learning environments. Digital technologies open a wide range of possibilities for education but also present a need for pedagogical learning design. According to Lonka (2015), the traditional individual knowledge acquisition is moving towards collaborative knowledge construction; thus, diverse digital environments must include more student-centred activities and collaboration to meet these needs.

Teacher education and higher and vocational education face challenges when attempting to bridge education and work. The on-going reform of Finnish vocational education presents further challenges due to complex and technology-driven global thinking that requires a deeper level of learning (Ministry of Education and Culture, 2017a). According to Wheeler (2015), future digital learning should put pedagogy first and technology second, but to foster this development, digital wisdom is necessary as information becomes more democratic and learning more open and collaborative (Adams Becker et al., 2017; Lonka, 2015). The sociocultural approaches to learning have influenced research and the wider discussion by focusing on the interplay between digital technologies and deep learning (Gibson 2013; Ludvigsen, Lund, Rasmussen, & Säljö, 2011, p. 3). According to Traxler and Kukulska-Hulme (2016, p. 2), the next generation of learning is context aware, which requires new learning designs. Scanlon, McAndrew and O'Shea (2015, p. 7) point out that the greatest benefits of learning design, learning analytics and open education resources can be attained through an integrated approach that combines design, technology and pedagogy.

This study investigates authentic and dialogical collaborative knowledge construction in digital environments to understand learning processes and competences development in deep learning. To be successful in the modern working world, students must develop higher-order thinking skills, such as applying, analysing, synthesising and evaluating information, all of which are products of deep learning (Adams Becker et al., 2017; Anderson et al., 2001; Biggs & Moore, 1993; Gibson, 2013). To teach these skills, inquiry, problem-based and project-based learning are important and capitalise on authentic professional practices and problem solving (Brush & Saye, 2014; Hunt, 2015). This study contributes to vocational teacher education by presenting current diverse digital environments and authentic and dialogical collaborative content construction practices based on the preferences and cultures of present student teachers and future vocational students.

In this study, I combine *sociocultural theory* (e.g. Lave & Wenger, 1991; Palincsar, 1998; Rogoff, 1990; Säljö, 2004; Vygotsky, 1978) and *authenticity* (Shaffer & Resnick, 1999) with *authentic learning* (Aarnio, 2006; Herrington, Reeves, & Oliver, 2010) and *dialogical collaborative knowledge construction* (Aarnio, 1999; Aarnio & Enqvist, 2001; Bohm, 2004; Enqvist & Aarnio, 2004; Lave & Wenger, 1991; Paavola, Lipponen, & Hakkarainen, 2002; Sfard, 1998). Furthermore, I utilise *scaffolding* in learning (Lave & Wenger, 1991; Palincsar, 1998; Vygotsky, 1978), *deep learning evaluation* (Anderson et al., 2001; Nelson Laird, Seifert, Pascarella, Mayhew, & Blaich, 2014; Schraw, Flowerday, & Lehman, 2001), the DIANA (Dialogical Authentic Netlearning Activity) pedagogical model (Aarnio & Enqvist, 2002; 2016), and previous research, in order to deepen a theory of the pedagogical model and the deep learning evaluation framework. Sociocultural theory also forms a theoretical framework for the assumptions of *three metaphors of learning*: learning as individual knowledge acquisition, as participation in dialogue in a community (Sfard, 1998), and as knowledge creation (Paavola et al., 2002). This study bridges these three metaphors.

1.1 Research Addressing the Gap

A range of former research has influenced the formulation of the research questions. Previous studies from vocational education and teacher education have indicated that the DIANA pedagogical model is a demanding model and entails difficulties closely connected to a lack of dialogical competence (Aarnio & Enqvist, 2016). Aarnio (1999, p. 217) concluded that there was a need to take care of vocational student teachers' dialogical skills and knowledge, in order to ensure their ability to develop their own learning communities and society. Hence, as Aarnio and Enqvist (2002) later concluded, in the field of vocational education, it is difficult to identify authentic and dialogical knowledge construction based on the net presence. Furthermore, Enqvist and Aarnio (2003) stated that increasing deep-orientated learning through dialogical actions is the most challenging part of using the DIANA model in vocational teacher education. A year later, they concluded a study in vocational teacher education with the observation that there were significant differences in the dialogical actions of study circles, and that dialogue was a key element for constructing new knowledge (Enqvist & Aarnio, 2004). Aarnio (2006, p. 68) broached the fact that further research on authentic and dialogical learning process is necessary, as incompetent structuring can result in authenticity and dialogical knowledge construction disappearing from the learning process. Aarnio and Enqvist (2007a) also indicated that dialogical knowledge construction in digital environments should be skilfully structured. Tillema and van der Westhuizen (2006) concluded that dialogue is needed throughout

collaborative knowledge construction to ensure tangible outcomes. However, little research has focused on what learning outcomes authentic and dialogical knowledge construction results in. The developers of the DIANA model point out that taking a dialogical leap is a precondition for deep-orientated learning and that dialogical actions are essential for creating a learning community (Aarnio, 2006; Aarnio & Enqvist, 2002; 2007a; 2007b; 2016) as well as for achieving efficient learning in the diverse digital environments. Although deep learning has been studied widely since the 1970s, research in the context of vocational teacher education or teacher education generally has been meagre.

My study seeks to fill the research gap by presenting scaffolding for deep learning outcomes that utilises authentic and dialogical collaborative knowledge construction in diverse digital environments. My work as a vocational teacher educator informed the exploration of learning that benefits current vocational teacher education outcomes through the learning and teaching processes for deep learning and fostering a collaborative knowledge construction culture (Lonka, 2015). This culture should support competences in dialogue, higher-order thinking skills and learning dispositions that strengthen learning outcomes (Gibson, 2013, p. 462).

1.2 Background and Aims of the Study

My previous experience designing online and blended learning in vocational teacher education provided a good starting point for the design, development and research for the present work. Previous research revealed a research gap in understanding design in relation to the DIANA model learning process (Aarnio, 2006; Aarnio & Enqvist, 2002; 2004; 2007a). In 2013, the researcher was a teacher educator in vocational teacher education in Finland tasked with redesigning the 'Networks in Vocational Education' study module of the teacher education programme. The participants (n = 76) in the module consisted of five vocational student teacher implementation groups and the redesign took place between 2013 and 2016. The participants came from diverse socioeconomic, cultural and vocational backgrounds and had zero to more than 20 years of teaching experience in vocational education.

At the same time, I had an opportunity to co-design and implement a learning process for a micro open online course (mOOC) as a part of a European Union (EU) project. The course was implemented with Coleg Gambria (Wales, United Kingdom) and the Häme University of Applied Sciences, School of Professional Teacher Education (HAMK SPTE). International vocational teachers (n = 14) participated in the course "Making Learning Personal", which aimed to train teachers how to develop individualised approaches in vocational education and training.

Against this backdrop, I faced a challenge of how to design a learning process which constructed the student teachers' knowledge from an authentic starting

point and through dialogical actions in their learning community or study circles. At this point, it became clear that I would have to redesign earlier learnings, and thus, I adopted the DIANA pedagogical model as a framing for my study module implementations and research process. This model guided the process, and the knowledge gained during the different research phases directly inspired the re-design and further development of the model.

One of the main objectives of the present study was to redesign pedagogical model scaffolding for dialogical collaborative knowledge construction and deep learning in digital environments in vocational teacher education.

In particular, the present study aims to address the following.

1. How does the Dialogical Authentic Netlearning Activity (DIANA) model support collaborative knowledge construction in a mOOC? (Sub-study I)
2. What are the challenges and opportunities of the adoption of the DIANA model for blended and mobile learning, from the perspective of student teachers? How do student teachers reflect on and evaluate authentic and dialogical knowledge construction, based on their mobile learning experiences? (Sub-study II)
3. How and by what means can learning in Personal Learning Environments (PLEs) be scaffolded during an online learning process? (Sub-study III)
4. Towards what kind of authentic and dialogical collaborative knowledge construction does the DIANA model direct students? (Sub-study IV)

1.3 The Research Process and the Researcher's Position

I began to write up this research in the summer of 2015 and had collected the data during 2013–2016. *Three of the sub-studies* comprising this thesis originated from the vocational teacher education study module. *The first sub-study* originated from the *Mapping*, a transfer of an innovation project which has been funded by the EU's Lifelong Learning programme. Participants ($n = 14$) were vocational education and further education teachers from around the world. Figure 1 gives an overview of the research process as a part of the DIANA model learning process.

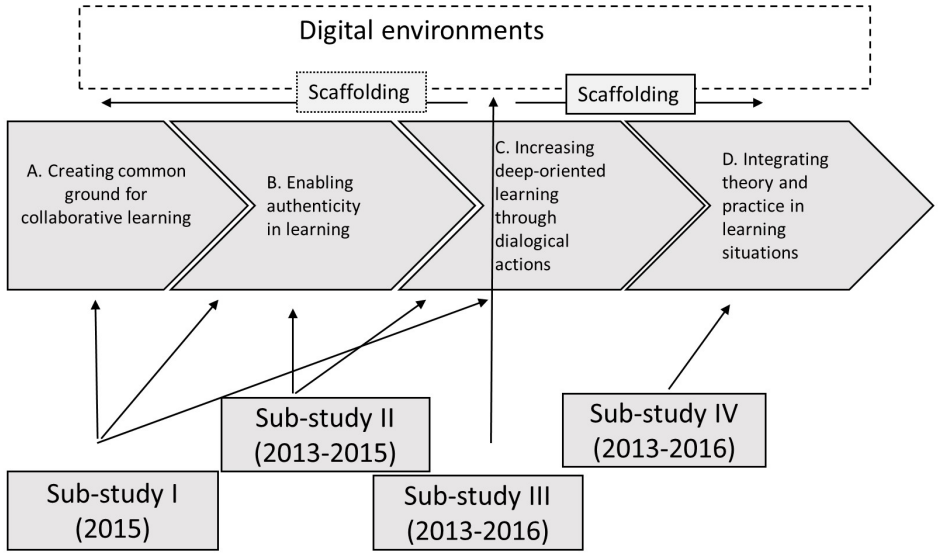


Figure 1. Dissertation study process following the DIANA pedagogical model cornerstones.

In the process, I had a triple role as a learning co-designer, teacher educator, and researcher, which made my experience learningful. The research process gave me an opportunity to delve deeper into each article, and that in turn ensured a broader understanding of how to design a learning process which combines authentic and dialogical collaborative knowledge construction with deep learning outcomes. Table 1 describes the contributions made by the authors of the publications featured in this thesis summary.

Table 1. Description of authors' roles and contributions in each research article.

	S. Ruhalahti's contribution	Other authors' contributions
Study I	- collected and analysed the data - interpreted the results - wrote the major part of the manuscript - wrote up and finalised the article - revised the article based on the review process	- second author contributed to the analysis - third author revised the theoretical background and results of the analysis, provided methodological guidance
Study II	- collected and analysed the data - interpreted the results - wrote the majority of the manuscript - wrote up and finalised the article - revised the article based on the review process	- second author contributed to the analysis and results - third author revised the theoretical background and results of the analysis, provided methodological guidance, and participated in the revising process
Study III	- contributed to the DBIR process and analysis - took part in revising the theoretical background - revised the article based on the review process	- first author wrote up and finalised the article and conducted the review process - third author revised the theoretical background and results of the analysis, took part in the revising process
Study IV	- collected and analysed the data - interpreted the results - wrote the majority of the manuscript - wrote up and finalised the article - revised the article based on the review process	- second author contributed to the co-analysis, revised the theoretical background and results of the analysis - third author revised the theoretical background and results of the analysis

Chapters 2 and 3 of this thesis summary describe the theoretical frames of the study. Chapter 4 presents the research questions, and Chapter 5 addresses the methodological approaches and research design. Chapter 6 summarises and provides an evaluation of the sub-studies that form the basis for the redesigned pedagogical model, design principles and deep learning evaluation framework. Chapter 7 presents the main results of the study. In the concluding chapter, I discuss the results of the research, its limitations, and its practical implications. I conclude by providing suggestions for future research.

2 Theoretical Framework for Authentic, Dialogical Collaborative Knowledge Construction

In this chapter, I introduce the theoretical framework which forms the basis of the DIANA pedagogical model. The model consists of three different theoretical frameworks: the sociocultural theory of learning, authentic learning, and dialogical collaborative knowledge construction. In the following sections, the theoretical perspectives supporting the research and the DIANA model are presented in more detail. Sub-studies III and IV undertaken as part of the research path have influenced the practical implications of the dissertation, and therefore, the theoretical perspectives of scaffolding and deep learning evaluation are presented as a part of this chapter.

2.1 Sociocultural Theory as an Explanatory Conceptual Framework

Sociocultural theory provides the main explanatory framework for this research, where learning is seen as an integral aspect of social activity in and with the world (Vygotsky, 1978). The genesis of sociocultural theory is usually attributed to Vygotsky, and the theory posits that learning is a process of the internalisation of cultural settings such as tools, ways of speaking, acting, thinking, and the product of a collaborative construction (Vygotsky, 1978; Säljö, 2004). In this study, these cultural settings are seen as digital environments which are used as part of dialogical knowledge construction, in the way students speak, act, write, think together and construct shared artefacts. Learning is seen as a social process and the origination of human intelligence in society or culture (Bereiter, 2002, p. 437; Säljö, 2009; Vygotsky, 1978). As Wegerif (2013, p. 24) noted, dialogic theories of education have roots in sociocultural theory, but dialogue should be understood as development from within. In the theoretical framework, social interaction plays a fundamental role in the development of cognition. According to Vygotsky (1978), learning is seen on two levels: social (through interaction with others, inter-psychological) and individual (internal, intra-psychological). In contrast, Säljö (2004) pointed out that this type of thinking might decrease our understanding of learning.

According to Vygotsky (1978), complex transformations require active participation by students in order to achieve understanding, and this cognition should be understood in a social and human development context, treated as a process of acquiring culture through social interaction. By this reasoning, the *zone of*

proximal development (ZPD) is one of the crucial concepts of Vygotsky's sociocultural theory. Vygotsky formulated the concept in two parts; an *actual development level* (ADL) and a *potential development level* (PDL). ADL means that the student is able to work and learn on his or her own, whereas PDL is the higher level of potential development determined through problem-solving under guidance or in dialogue with peers (cf. Palincsar, 1998). ZPD is defined that the distance between an actual developmental level as determined by independent problem-solving and the potential level of development as determined in collaboration with peers. (Vygotsky, 1978, p. 86.) This development process can be supported by providing *scaffolding* to support the student in developing an understanding of knowledge or developing complex competences and through cognitive apprenticeship (Brown & Palincsar, 1989; Rogoloff, 1990).

Sociocultural theory advocates learning in collaborative groups that are engaged in an inquiring approach to authentic assignments related to the real world rather than in learning component knowledge and skills (Hmelo-Silver & Chinn, 2016). This forms an application of the concepts, and in the sociocultural approach, symbolic cognitive artefacts are seen to mediate human actions (Palincsar, 1998; Säljö, 2004; 2009; Vygotsky, 1978). The latest research recommends that study circles produce public artefacts so that the intellectual outputs produced can stimulate further inquiry in the entire group (Hmelo-Silver & Chinn, 2016). Miettinen and Paavola (2018) conclude that artefacts develop and call for constant collaboration with other students. Furthermore, cognitive tools scaffold knowledge construction and internalisation in order to achieve complex learning skills (Palincsar, 1998).

Sociocultural theory also forms a theoretical framework for the assumptions of *three metaphors of learning*: learning as individual knowledge acquisition, as participation in dialogue in a community (Sfard, 1998), and as knowledge creation (Paavola et al., 2002). According to Sfard (1998), the metaphor of acquisition is an individual activity of knowing and learning, which is seen in this study as an activity strengthening the student's ADL, whereas the participation metaphor is seen as learning in communities (Lave & Wenger 1991; Sfard 1998), and the process involved is a social one through dialogue. The students learn in their PDL. The third metaphor, the knowledge creation metaphor, emphasises learning not as individuals or in communities, but as students collaboratively constructing artefacts (Paavola & Hakkarainen, 2005).

By applying sociocultural theory in the context of vocational teacher education, new skills and knowledge are learned through an authentic and dialogical collaborative knowledge construction learning process, with the scaffolding being provided by peers (Lave & Wenger, 1991) and teachers. Learning is seen as a real-world objective that involves a transformation by students regarding inquiries and activities (Säljö, 2009). The role of the teacher is to provide appropriate scaffolding that reinforces the learning.

Sociocultural theory has made an impact on research and the wider discussion by focusing on the interplay between digital technologies and learning (Ludvigsen et al., 2011, p. 3); hence, there is a need for a better understanding of learning processes at the individual and community levels. Diverse digital environments enable learning to be designed from the sociocultural perspective in new, more transparent ways.

In this research, learning is approached from the perspective of sociocultural theory. In the Dialogical, Digital, and Deep Learning (DDD) redesigned pedagogical model presented here, sociocultural theory was used as a framework for the learning process to make working in the student's zone of proximal development (ZDP) more transparent and to promote the internalisation of knowledge (Vygotsky, 1978). Theory supports scaffolding in instructional contexts, allowing individual student needs to be accommodated, while design increases student responsibilities (Palincsar, 1998, p. 373). To emphasise individual knowledge acquisition, I placed three metaphors of learning inside the redesigned pedagogical model (Sfard, 1998). In addition, dialogical participation in learning communities (Aarnio 1999; Sfard, 1998; Lave & Wenger, 1991) and construction of dialogical collaborative knowledge as knowledge creation influenced my research process (Aarnio & Enqvist, 2016; Paavola & Hakkarainen, 2005). All this together provides a basis for seeing learning from the perspective of sociocultural theory and for exploring how authenticity can be a part of the process.

2.2 Authentic Learning

Authenticity is seen as extensive and complicated, and the term is generally used to refer to something which is real, true, or genuine, or something that is not a fake or forgery. Authenticity is seen as a concept which is rooted in philosophy (Golomb, 1995, p. 201; Heidegger, 1993). Doyle (2000) defined authenticity from three perspectives. For students it refers to learning content that is genuine and meaningful, subject-oriented authenticity connects assignments to current learning topics and authentic learning is the result of situated, real activities. According to Shaffer and Resnick (1999), authenticity arises when an activity is seen as meaningful and when the learning target is defined and interpreted from the students' point of view (cf. Keskitalo, Pyykkö, & Ruokamo, 2011; Resnick, 1987). Authenticity requires creation, construction, and finding through dialogue (Taylor, 1995, pp. 95, 102). Shaffer and Resnick (1999) stated that more comprehensive views of authenticity combine learning environments with all aspects of authentic learning; they are personally authentic for the learners, are related to the real world, and provide an opportunity to think in an authentic mode of a particular discipline. Vocational teacher education studies have revealed that students have difficulties understanding the concept of authenticity (Aarnio, 2006; Ruhalahti, Korhonen, & Ruokamo,

2016); therefore, students' commitment and the feeling that they own their learning are strongly linked to how feelings of authenticity are born and maintained during a learning process.

According to Aarnio and Enqvist (2016), *authentic learning* is viewed too narrowly, and the process of finding and constructing authentic knowledge by integrating theory into practice has often been designed and implemented in a weak way. Furthermore, they note, authentic learning is often seen only as authentic learning tasks pertaining to work or everyday life, a perspective which disregards individual- and group-specific authenticity, the use of authentic sources, and the production of authentic materials and fails to connect authenticity to evaluation. Sources and materials are authentic when they are required in order to understand a topic, stemming from a practical approach to inquiring or creating a product or artefact (Aarnio & Enqvist, 2002, pp. 29–30). Herrington et al. (2010, p. 18) listed nine elements of authentic learning: 1) authentic context that reflects the way knowledge is used in real life, 2) authentic tasks, 3) access to expert performances and the modelling of processes, 4) multiple roles and perspectives, 5) collaborative knowledge construction, 6) reflection to enable abstractions to be formed, 7) articulation to enable tacit knowledge to be made explicit, 8) scaffolding by the teacher at critical points, and 9) authentic assessment of learning with tasks.

When the learning process is based on authentic settings, *authentic evaluation* coincides with the learning process and becomes part of the learning process itself (Shaffer & Resnick, 1999). Herrington et al. (2010, p. 1) stressed that designing learning settings that use authentic activities as anchoring assignments can be a difficult process if the previous design was based on a teacher-centred approach. Assessments should include authentic reflections on the learning process itself.

Authentic learning becomes deeply meaningful when the students create questions and when the learning process is shared. For example, in the field of the science education, Fleer and Canhill (2001) pointed out that using authentic questions formed by the students creates a stimulating learning environment. Furthermore, Rahm, Miller, Hartley, and Moore (2003) showed how authentic learning emerges when interaction and collaborative activities are included in the process (see also Adams Becker et al., 2017).

Studies have also indicated that teachers and students have difficulty understanding the concept of authenticity, and it is therefore necessary to enhance the pedagogical learning design, as well as to improve student-centred scaffolding (Aarnio, 2006; Ruhalahti et al., 2016). To support authentic learning design, Aarnio (2006, pp. 58–62) developed a method for supporting authentic knowledge construction in online environments. Designing and implementing authentic learning also requires teachers to take risks; hence, an authentic approach requires more effort than standard academic lectures. Moreover, scaffolding is seen as a crucial activity for generating authentic learning (Aarnio, 2006; Teräs & Herrington, 2014).

In addition, authentic learning promotes deep learning (Czerkawski, 2014; McGee & Wickersham, 2005), as well as knowledge-sharing when learners collaboratively construct conceptual artefacts based on authentic learning settings (Tillema, 2006). When the goal is to achieve deep learning, a sense of community is seen as a motivating factor (Ryan & Deci, 2000), and authenticity influences the desire to construct knowledge with students from various fields (Herrington et al., 2010, p. 18). If the learning process specifies higher-order thinking outcomes, it should be aligned with the learning outcomes as authentic learning settings change during the process and may vary at the individual and community levels (cf. Herrington et al., 2010, p. 136; Williams, 2017).

In sum up, authenticity creates a basis for socioculturally based learning design. As a starting point, authenticity combines the opportunity to construct meaningful knowledge from authentic settings, which are related to the real world and based on existing competences. Thus, the content of learning is assumed to become relevant, engaging, genuine, and meaningful. In my point of view, this can be accomplished through inquiring authentic questions developed individually and collaboratively through scaffolding, using authentic sources, and then dialogically constructing collaborative knowledge (cf. Aarnio & Enqvist, 2016). Relatedly, genuine authentic learning demands skills and knowledge of dialogue (Taylor, 1995).

2.3 Dialogical Collaborative Knowledge Construction

Dialogical collaborative knowledge construction is another key characteristic of the framework which is closely linked to authentic learning settings. As noted earlier, learning demands social interaction and knowledge construction is fundamentally seen as a social process (e.g. Lave & Wenger, 1991; Vygotsky, 1978) and gains personal and culture-specific meanings. This is primarily linked to the participation and action in learning communities (Wenger, 1998), but simply putting students into groups will not necessarily lead to collaborative knowledge construction through dialogue. In the following section, I introduce the characteristics of dialogical collaborative knowledge construction, which, in this thesis, are a combination of dialogue, dialogical participation, collaborative learning, and collaborative knowledge construction. The approach in the study is that knowledge is constructed through dialogue in learning communities, and authenticity and authentic learning settings create the grounds for this to take place.

The term *dialogue* is commonly found in the research literature. According to Bohm (2004) and Isaacs (1999), dialogue does not simply mean talking or discussing. Discussion can consist of many monologues rather than shared thinking (Enqvist & Aarnio, 2004). In contrast, dialogue is defined as the chaining of utterances and shared thinking through different perspectives (Bakhtin 1986; Phillipson &

Wegerif, 2017, p. 188). As Bohm (2004) has pointed out that in dialogue, active participation is required, and this has two meanings: to take part both 'of' and 'in'. Bakhtin (1986) pays attention to the resicprocity, which creates common and shared understanding, which in turn leads to a type of polyphonic thinking that creates and constructs new knowledge (cf. Bohm, 2004). Dialogue requires humility while learning and acting and furthermore requires an intense faith in community (Freire, 2001). According to Isaacs (1999), dialogue enables a person's attitudes and self-knowledge to undergo changes, and improves our ability to listen and familiarise ourselves with others' points of view. This is in line with Asghar's (2016) and Dueñas (2013, p.88) findings that dialogue supports constructive conversation and develops social conscience among students.

When collaborating through *dialogical action*, it is essential to be equally and consciously present, engaged, listening, participating, and suspending utterances. Likewise, Isaacs (1999) noted that dialogue involves thinking together, although as a phenomenon, dialogue is more extensive and complex. In the context of teaching and learning, Aarnio (1999) emphasised in a teacher education study that the start of a dialogue was mostly about opening one's own thoughts and relating events in an informative manner. According to Enqvist and Aarnio's (2004) definition, dialogue is based on an equal co-construction of understanding. Dialogue requires equal participation, which is based on thinking together and familiarising oneself with a particular topic, matter, or activity. Students and teachers need skills in dialogue, so that shared knowledge construction can take place. Aarnio and Enqvist (2001, p. 19) viewed that *dialogical participation* consists of active and equal participation, engagement and reciprocal reaction, and the letting go of egocentricity. In practice, it means that a student is active in providing his or her own contributions, is responsive, develops ideas, inquires, opens the meanings of utterances, continues the utterances of others, and engages in the often time-taking process of constructing a shared understanding (Enqvist & Aarnio, 2004). Furthermore, Wegerif et al. (2017) use interpretative analysis to conclude that empathy and understanding others' perspectives are key dialogical change factors in team blogging.

The key concept in online and blended learning is dialogue (Aarnio & Enqvist, 2001; 2002). The research literature on *dialogicality* in blended and online teacher education and higher education has focused primarily on *dialogical discourse, interaction, and teaching* (e.g. Cramp, Lamond, Coleyshaw, & Beck, 2015; Ligorio, Loperfido, & Sansone, 2013; Sedova, Sedlacek, & Svaricek, 2016; Reznitskaya, 2012). Moreover, Bound (2010) developed and implemented the Map of Dialogic Inquiry model to improve online dialogue in the context of adult and vocational education. The results showed that the model supported and scaffold dialogical inquiry. Similarly, in Canada, a dialogic learning community model which emphasised dialogue focused on real-world inquiries was used to instruct adult learners. Aarnio (1999) indicated that when seeing dialogue as a specific action, it

may help students to reach a competence. To support the awareness of dialogical actions, Aarnio, Enqvist, Sukuvaara, Kekki, and Kokkonen (2008) created a web-service to promote deep learning through dialogical actions. Furthermore, based on the web-service piloting results and to make dialogical actions more concrete, Aarnio (2012) developed a scheme of *dialogical methods.* The aim was to create practical methods to foster teachers' skills and knowledge of the use of dialogical actions in practice. The dialogue method's sub-areas are dialogical attitude, making dialogue non-fuzzy, creating a dialogical moment, and creating an overall view and new understanding through dialogue. Furthermore, beyond these dialogical methods developments are Huttunen's (1995) re-formulated norms of how dialogical factors are actualised in practice. These include 1) the rule of participation, 3) the rule of commitment, 3) the rule of reciprocity, 4) the rule of appreciation, and 5) the rule of reflectivity (cf. Burbules, 1993, pp. 80–82; Mezirow, 1995). In addition, Aarnio (1999) pointed out that these are not external rules, but rather seen as a skills which are needed in the dialogue process.

The education literature defines *collaborative* in numerous ways; for example, Dillenbourg (1999) stated that 'any situation can be labelled collaborative' (p. 1). Understanding the collaborative grounds of this study context calls for an examination of the concept of collaborative learning, which is an umbrella term for a variety of educational approaches in which teachers divide students into groups to work together (Barkley, Major, & Cross, 2014). When designing learning, it is important to be aware of these definition and not to oversimplify the concept. According to Dillenbourg (1999, p. 5), collaborative learning involves distinct forms of interaction among students that trigger learning, but there is no guarantee that the expected interaction will occur. Collaborative learning interactions can be designed through deeper understanding of knowledge construction (Dillenbourg & Fischer, 2007).

Collaborative knowledge construction can be understood as a gathering term referring to a variety of practical implementations and approaches. During the learning process, peers depend on others with more experience, which increases the need for joint participation in learning (Lave & Wenger, 1991), and group members share a goal and contribute new knowledge in order to create a common understanding through interaction. This leads to collaborative knowledge construction and is achieved by creating questions, evaluating knowledge, and modifying the collaborative approach (see also Dillenbourg, 2002). Collaboratively constructed real-world and open-ended questions engage students in the process of developing new artefacts (Eklund, Mäkitalo, & Säljö, 2011, p. 124; Fredriks, 2014; Muukkonen, Lakkala, & Paavola, 2011, p. 172). Unique products and new knowledge are the results of collaborative knowledge construction. This, however, requires reciprocal, committed, goal-orientated, and shared activities (Byman, Järvelä, & Häkkinen, 2005; Resnick, 1991). Students should employ approaches

which facilitate deep learning by creating and constructing meanings through collectively-shared artefacts that expand the students' expertise (Paavola, Engeström, & Hakkarainen, 2012; Paavola, Lipponen, & Hakkarainen, 2004). In research on higher education, Aarnio (2015) concluded that students cannot achieve deep learning without the skills and knowledge of collaborative knowledge construction.

Since social interaction and dialogical participation have been emphasised in learning (Vygotsky, 1978; Wells, 2000), it cannot be ignored in digital learning environments. Engeström and Toiviainen (2011, p. 33) challenged learning designers to consider how to integrate demanding theoretical principles of productive learning, communities and technological solutions into one process and develop a meaningful product. According to Blumenfeld et al. (1991), providing students with opportunities to represent their knowledge in different ways, to solve open-ended questions, and to create artefacts that are shared with their peers creates authenticity and engages students in learning. Technology is seen as a possibility that enhances collaborative knowledge construction and learning through dialogical actions and can result in better engagement and collaboratively shared artefacts (Aarnio & Enqvist, 2016; Enqvist & Aarnio, 2004; Wegerif, 2006). However, dialogical collaborative knowledge construction in digital learning environments is feasible (Aarnio & Enqvist, 2016). Gibson (2013, pp. 459–460) stated that open learning environments provide students with new possibilities by engaging them in practices such as learning communities, learning from others, and publishing one's work for a peer audience. Herrington et al. (2010, pp. 27–28) stated that the opportunity for learners to collaborate is an important design element, especially when it comes to distance learning. Collaborative knowledge construction is an important element of authentic online learning and can be encouraged through various assignments.

In this study, I view that *dialogical collaborative knowledge construction* means a social learning process where students, through dialogue, equal participation, and collaboration construct a shared understanding and knowledge. It is important to notice that competence of dialogue is seen as a crucial element for creating a base for dialogical collaborative knowledge construction and that, therefore, the integration of dialogical methods is seen as crucial. These elements deeply divide *collaborative learning* from *dialogical collaborative knowledge construction* by leaning toward deep learning activities. Two metaphors of learning are closely intertwined with the process: participation through dialogue competence (Sfard, 1998) and knowledge creation (Paavola & Hakkarainen, 2005) through collaborative shared artefacts. Previous research (Aarnio & Enqvist, 2002; Aarnio, 2006; Ruhalahti, Korhonen, & Rasi, 2017) clearly demonstrated that dialogical collaborative knowledge construction does not happen by itself and requires pedagogical learning design and structuring.

2.4 DIANA Model as a Framework for the Learning Design

In the study, I use the term *learning design* to refer to choosing a pedagogical model, planning and developing the structure, and implementing the process. Dalziel (2016) defined learning design as a practice and a verb, rather than just a static concept. In that way, an educator can design teaching and learning activities which may be based on various pedagogical models. The same principle was advocated by Laurillard (2012, p. 66), who stated that it is more apt to talk about designing for learning than learning design.

Education is being challenged by complex, collaborative, and technology-driven global thinking which requires certain competences to achieve a major amount of deep learning. Interdisciplinary teaching requires integrative and transdisciplinary learning, which is closely entwined with collaborative thinking and collaborative problem solving, and independent of culture, substance, or fields of study (Stokols, 2014). Intrinsically, this skill and knowledge includes evaluating information and arguments, understanding connections, constructing meaningful knowledge, and applying that knowledge in work settings. In addition, professional and vocational work requires students to be competent in higher-order thinking skills (see Brookhart, 2010; West, 2015). Moreover, students should be capable of collaboratively dealing with the complexity of the assignments in which they will engage in professional situations. Obviously, when scaffolding deep learning, a learning design is required that inevitably involves curriculum implementation.

In order to design learning settings, teachers should consider which pedagogical model would be most appropriate for their specific teaching and learning context. Competence-based education requires authentic learning settings, and furthermore, dialogical collaborative knowledge construction to achieve deep learning. When the goal is to achieve deep learning through constructing knowledge of complex competences, the DIANA model creates a basis for the learning design. According to the principles of the DIANA model (Fig. 2), learning requires the development of higher-order thinking skills. Learning is based on the construction of authentic and dialogical knowledge in a learning community. The entire learning process has to be designed to encourage learners to act in ways which guide them towards deep learning (Aarnio & Enqvist, 2002; 2016).

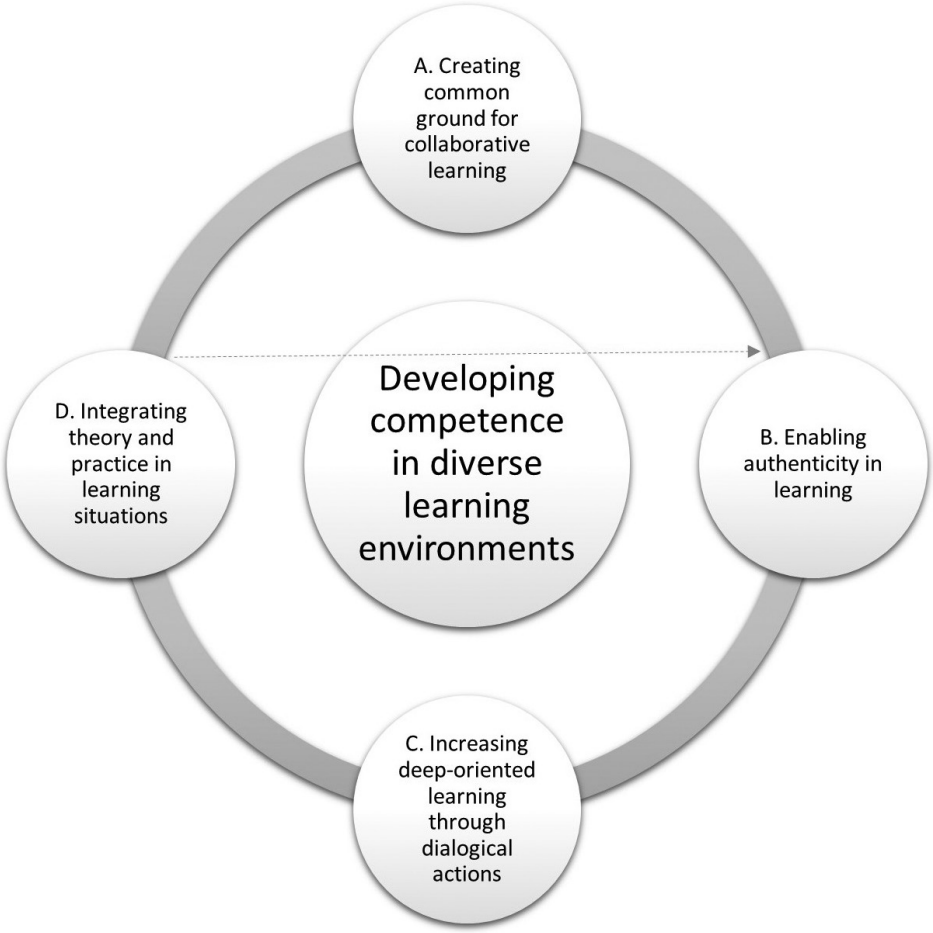


Figure 2. Structure of the revised DIANA model (Aarnio & Enqvist, 2016, p. 44).

The model is based on the elements of authenticity, dialogical and collaborative knowledge construction, and a pedagogical model which is suitable for all kinds of digital learning environments (Aarnio & Enqvist, 2016). In the DIANA model, four components constitute authenticity: learning is connected to everyday life or work, learning assignments have been personalised either at an individual or group level, authentic sources and materials are required to construct knowledge and to create products, and an authentic evaluation is included in the learning process (Aarnio & Enqvist, 2016). Achieving a genuine authentic process requires skills and knowledge of dialogue (Taylor, 1995). The developers of the model (Aarnio & Enqvist, 2001; 2002) refer to online teaching, but the model is equally well-suited to modern, digital learning environments. In the model, peers in the study circles have an important role. The model development is based on dissertation studies (Aarnio,

1999; Enqvist, 1999), was first published in 2001 (Aarnio & Enqvist, 2001), and has been further developed with piloting and developments until 2016 in higher and teacher education settings, as well in vocational education (Aarnio, 2006; Aarnio & Enqvist, 2007b; 2016; Enqvist & Aarnio, 2004). Table 2 gives a practical overview of the model and its operative dimensions.

Table 2. An overview of the pedagogical learning design of the revised DIANA model (Aarnio & Enqvist, 2016, pp. 41–46).

Cornerstone of the DIANA model	**Operative dimensions**
A. Creating a common ground for collaborative learning	A1. The idea of authentic and dialogical learning A2. Preparing for dialogical participation in the learning community A3. Structuring and starting the collective work
B. Enabling authenticity in learning	B1. Deriving authentic learning tasks, learner-centred from real life and work situations, formulating and inquiring open learning questions using the language used by students, the starting point being their everyday conceptions B2. Using authentic sources and materials or data to create content and products
C. Increasing deep-orientated learning through dialogical actions	C1. Inquiring and constructing knowledge through dialogical actions C2. Working as equals, participating reciprocally and symmetrically, listening to others, open and constructive inquiry, and weaving syntheses C3. The focus is on open, inquiring questions which are used to find solutions and create content
D. Integrating theory and practice in learning situations	D1. Alternating theory and practise, weaving a synthesis, finding gaps in thinking and actions, formulating new questions on the basis of those gaps D2. Continuous reflection and evaluation throughout the learning process; individually and collectively

As described in Table 2, the revised DIANA model's operational dimensions begin from cornerstone A. In practice, this means that cornerstone A creates the common ground for authentic, dialogical, collaborative knowledge construction in study circles or the learning community. Afterwards, developed dialogical methods are suggested to enhance students' dialogical skills and knowledge (Aarnio, 2012). Dialogue creates the grounds for a learning process where, for example subject-specific knowledge from various disciplines is combined. Dialogue is seen as a form of conversation that supports deep learning. Cornerstone B deepens the process by formulating authentic learning questions which are connected to and derived directly from the learning objectives of the study module. The teacher's role is to offer scaffolding and guide the students' learning in the right direction. The objective is to establish authenticity in learning related to real life, in a process which promotes inquiry and helps to formulate authentic learning questions or assessments. Through specific dialogical actions and collaborative knowledge construction, deep learning is

at the heart of cornerstone C. In practice, this entails answers to the questions which have been earlier set out, providing the opportunity for individual contributions, clarifying and opening up the meaning of utterances, having a continuing focus on the utterances of others, and engaging in collaborative knowledge creation and the construction of a shared understanding, based on dialogical skills and knowledge. Cornerstone D integrates theory into practice and invites students to weave a collaborative synthesis of the knowledge they have derived, in order to create a shared artefact and define new learning questions based on the missing pieces of information pertaining to the learning goals of the study module. Dialogical evaluation forms the other part of the cornerstone and enables dialogical reflection and the development of new contextual understandings (Aarnio & Enqvist, 2016). To combine all of these elements and to make learning design more concrete, in the first sub-study, scaffolding was found to be a crucial issue to achieve better learning outcomes.

2.5 Scaffolding of Learning

In this study, creating the context for authentic and dialogical collaborative knowledge construction occurs in part through *scaffolding* and social interaction. A key component in this is Vygotsky's (1978, pp. 84–91) ZPD, which offers an opportunity to deconstruct the learning actions within the learner's zone of proximal development. Work on proleptic instruction has been influenced by Vygotsky's (1978) developmental theory. According to Vygotsky (1978), expert coaching was pivotal issue, and when students are assisted by more experienced others, a student can experience new models or participate more meaningfully in complex social activities (cf. Lave & Wenger, 1991). This kind of circumstance creates zones of proximal development for individuals and offers them the chance to engage in mutual scaffolding.

Scaffolding is seen as an instructional process which has become synonymous with the expert–novice relationship and inquiry-based learning (Palincsar, 1998), and with equal knowledge construction, such as that seen in a group of students who are working on a shared assignments (Donato, 1994). In a large literature review, Van de Pol, Volman, and Beishuizen (2010) noted that the term scaffolding does not have a consensus of definition. Scaffolding is closely related to the whole learning process as interaction was mostly referred to as collaborative work (Howe & Mercer, 2010). According to Stone (1998), scaffolding is viewed as an interactive process that occurs between teacher and student, who must both actively participate. Scaffolding refers to guidance given to students in accordance with students' individual need (ADL) or learning community level (PDL to achieve learning goals the student might not otherwise have accomplished. Stone (1998) concluded that trust and reciprocity

are keys to successful scaffolding, and this conclusion is in line with Palincsar's (1998) findings that scaffolding is most effective within the context of reciprocal teaching. Previous studies have indicated that scaffolding is seen as a crucial activity for generating authentic learning (Aarnio, 2006; Teräs & Herrington, 2014), but as students have difficulty understanding the concept of authenticity, it is therefore necessary to enhance the concept of student-centred scaffolding (Sub-study I; Teräs, 2016).

For the support of *collaborative online learning and scaffolding*, Salmon (2011, p. 32) designed a *Five-Stage model*, based on her years of action research that offers a practice-orientated approach to online scaffolding. The Five-stage model provides a framework for scaffolding a structured process through teacher education of scaffolding collaborative learning processes, increasing students' independence and responsibility for their own learning process. The first stage sets up learning. The second stage focuses on socialising with online learners to bridge cultural, social and learning environment differences. The third stage is to exchange information about personalising software, scaffolding assignments and the use of learning resources. The fourth stage involves constructing knowledge, and the fifth stage involves the teacher supporting students' further development. At higher stages of the model, students should become self-directed in their own learning. (Salmon, 2011, pp. 31–32.)

In this study, scaffolding is seen as a dynamic activity which needs to be tuned to the students' on-going learning process. Dialogue is seen as providing quality and depth for an online scaffolding process (Aarnio & Enqvist, 2016). Especially, the scaffolding provided by the teacher depends on the situation (such as the type of learning assignment) and the dialogue between the students or in the study circle's learning community. Therefore, based on my understanding, scaffolding never looks the same and is not a 'technique' which can be applied in the same way to every situation (Sub-study III).

2.6 Towards Deep Learning and Evaluation Taxonomies

The question of what promotes *deep learning* has been researched for decades. Marton and Säljö (1976; 1984), Entwistle and Ramsen (1983) and Biggs (1987) all attempted to develop both deep and surface approaches to learning. The shift from passive to active learning activities promises to guide students towards deeper levels of understanding, thinking and reasoning as students apply what they are learning to real working life situations (Lave & Wenger, 1991; Tagg, 2003). In this section, deep learning approaches and evaluations are discussed, leaving aside surface approaches.

Deep learning is defined as the achievement of higher-order thinking skills, such as analysing, interpreting, inquiring, comparing, evaluating, producing, and

creating knowledge (Anderson et al., 2001; Nelson Laird et al., 2014; Paavola, et al., 2002; Schraw et al., 2001). Deep learning involves a higher level of cognitive processing (Craik & Lockhart, 1972; Garrison & Cleveland-Innes, 2005), in contrast to superficial learning (Lucas, 2001; Marton & Säljö, 1976), which is associated with memorisation and lower-level cognitive processes, such as recalling and comprehending facts. The theory of deep learning has been used to develop pedagogies that promote comprehensive educational outcomes for students (Howie & Bagnall, 2015).

Biggs and Tang (2011, p. 26) found that deep learning occurs when students engage in assignments in meaningful ways by using cognitive activities most appropriate to each task. Schraw et al. (2001) suggested that the degree of situational interest among students can be increased by offering autonomy, more engaging texts and helping students' process information at a deeper level. According to the progressive inquiry model, learning as knowledge construction is a process that enrich itself and changes considerably (Paavola et al., 2002).

In the field of teacher education, Lynch, McNamara and Seery (2012) concluded that self and peer assessments play a significant role in promoting deep learning. Dialogue is also a key factor of learning and supports and encourages deep learning in learning communities (Bohm, 2004; Isaacs, 1999; Aarnio, 2006; Chapman, Ramondt, & Smiley, 2005; Enqvist & Aarnio, 2004; Mercer & Howe, 2012; Ruhalahti et al., 2017; Smith & Colby, 2007); in addition, community-based learning results in deep learning (Bereiter, 2002; Enqvist & Aarnio, 2004; Näykki, 2014). In the field of teacher education research, Korthagen and Kessel (1999) suggested that giving students an opportunity to personally construct knowledge, meaning and theory through experience has a positive impact on teaching. Creating and finding meaning through one's own experience is itself an example of deep learning, which is further strengthened by authentic learning (Czerkawski, 2014; McGee & Wickesham, 2005). Osman and Herring (2007) found that synchronous chatting can be used to scaffold deep learning by increasing collaborative and online interactions (see also Offir, Lev, & Bezalel, 2008). Hill and Woodland (2002) indicated that deep learning can be achieved through problem-solving activities that are individually constructed and often assessment driven. The shift from passive, teacher-centred pedagogy to active, student-centred activities promises to help students achieve deeper levels of understanding, thinking and reasoning as students apply what they are learning to real work situations (Cho & Rathbun, 2013).

This study also focuses on deep learning outcomes. Smith and Colby (2007) examined teaching practices and students' learning outcomes and found that the majority of students learned only at a superficial level. They argued that these results were due to the instruction provided by the teachers, which resulted in students memorising, reproducing and repeating information without understanding it. Their study provided evidence that deep learning requires teachers to engage

and reconsider their teaching practices and the resultant learning, by rethinking classroom assessments with a deep learning approach in mind. Nelson, Laird, Shoup, Kuh and Schwarz (2008) argued that it is important to take into account how deep learning outcomes vary between disciplines, while Fredriks (2014) stated that learning assignments requires recall and repetition of abstract and decontextualised knowledge, while understanding requires solving open-ended and real-world questions and creating shared artefacts. Whilst learning outcomes are essential in the context of deep learning, interaction and collaborative engagement present additional topics of consideration. Serby's (2011) research revealed that online collaborative learning with peers resulted in deep learning outcomes. Thus, authentic and digital online-learning settings and collaborative knowledge construction through dialogue promote deep learning. To enhance these settings, a focus on social processes helps students bridge the gap between the known and the unknown (i.e., the ZPD) and form key processes in personal development of higher-order thinking skills.

Higher education integrating deep learning pedagogies is a growing area of development (Adams Becker et al., 2017). However, vocational student teachers come from various disciplines that should be taken into account when making broader conclusions about deep-learning outcomes. Better understanding of learning design is needed to achieve these outcomes, which raises the question: how can deep learning and outcomes be evaluated?

Several taxonomies (see Table 3) have been developed for promoting deep learning evaluation (Anderson et al., 2001; Biggs & Collis, 1982; Marzano, 2001). The most widely used is the taxonomy framework developed by Bloom (1956). By definition, a taxonomy is simply a tool used in a classifying process. Bloom's taxonomy dates back to 1956, but it has been updated to reflect 21st-century learning and teaching (Anderson et al., 2001). The taxonomy classifies objectives, which contain a verb and a noun. The verb and noun describe the knowledge that students are expected to acquire or construct. The taxonomy's cognitive dimension contains six categories which lie along a continuum (Anderson et al., 2001). In order to understand teachers' classroom practices and the depth of teaching and learning outcomes, Biggs and Collis (1982) designed a research-based framework for observing these dimensions. This taxonomy named SOLO, Structure of the Observed Learning Outcome describes five levels of learning outcomes and is suggested for use in determining learning outcomes and promoting deep learning for teaching activities. Marzano's framework is seen to facilitate the development of higher-order thinking skills by offering an operational definition of the difference between lower- and higher-order thinking skills: lower-order thinking skills involve accessing and making sense of existing knowledge, and higher-order thinking skills elicit the construction of new knowledge (Marzano & Kendall, 2008).

Table 3. Deep learning evaluation taxonomies.

Author	Process categories and cognitive processes
Bloom's Taxonomy (As revised by Anderson et al., 2001, p. 31)	• Remember (recognise, recall) • Understand (interpret, classify, summarise, infer, compare, explain) • Apply (execute, implement) • Analyse (differentiate, organise, attribute) • Evaluate (check, critique) • Create (generate, plan, produce)
Biggs and Collis's (1982) SOLO Taxonomy	• Pre-structural: No logical relationship to the display • Uni-structural: Contains one relevant item from the display (state, describe) • Multi-structural: Contains several relevant items (classify, comment upon) • Relational: Most or all of the relevant data are used (explain, analyse, compare, apply) • Extended abstract: New understanding (theorise, generalise, reflect, evaluate)
Marzano's New Taxonomy (Marzano & Kendall, 2008)	• Retrieval: recognising, recalling, executing • Comprehension: integrating, symbolising • Analysis: matching, classifying, analysing errors, generalising, specialising • Knowledge utilisation: making decisions, problem solving, experimenting, investigating • Metacognition: specifying goals, process monitoring, monitoring clarity, monitoring accuracy • Self-system thinking: examining importance, examining efficacy, examining emotional response, examining motivation

Table 3 shows that the SOLO taxonomy is functionally close to Bloom's taxonomy and includes many similarities, as does Marzano's new taxonomy, which focuses on examining ongoing learning processes (Biggs, 1992; Marzano & Kendall, 2008). Bloom's taxonomy is a more broadly used set of cognitive skills, which, at higher levels, promote deep learning and evaluation of outcomes, whereas the SOLO taxonomy focuses on evaluating quantitative competences (Hermida, 2014, p. 26). In this study, the objective was not to make detailed comparisons between the different taxonomies but to introduce taxonomies that can serve as a methodology for deep learning evaluation. The presented taxonomies represent very individual approaches to learning; however, deep-learning research has shown the great importance of collaborative and dialogical learning communities when constructing complex knowledge (cf. Aarnio, 2006; Bohm, 2004; Bereiter, 2002; Enqvist & Aarnio, 2004; Isaacs, 1999; Mercer & Howe, 2012). The deep learning evaluation framework has also evolved by becoming less structured, and learning designers have used more digital and learning environments.

To give an outline, when learning is based on the DIANA model, students define inquiring learning questions themselves, derived from the learning objectives. They search for meanings, and they investigate the phenomena and principles either individually or in groups by familiarising themselves with the theory and by applying it to practice. Through dialogue, they further analyse, compare, inquire,

evaluate, and test new knowledge and procedures in real-life situations, evaluating what they have learned by formulating new learning questions and constructing syntheses, understanding, and artefacts. The entire learning process has been designed to encourage learners to act in ways that direct them towards deep learning outcomes (Aarnio & Enqvist, 2002; 2016). Furthermore, self- or peer assessment procedures are integrated with teaching and learning processes to result in deep learning (Czerkawski, 2014), as the framework is included in the DIANA model. According to Ludvigsen, Cress, Law, Rose, and Stahl (2016), teachers need to design activities which will encourage students to construct their knowledge using digital tools (Ludvigsen et al., 2016). From my point of view, all of these elements require higher-order thinking skills in relation to use in diverse digital environments.

3 Diverse Digital Settings in the Study Context

On-going digitalisation has required us to renew our educational structures and learning environments. Accessible digital technology offers new opportunities for the design of learning processes. Distance, blended, e-learning, and other online forms of digital learning have a rich history of research, development, and pedagogy. However, there is still a need to rethink pedagogical learning design practices and how to seamlessly integrate digital technology with the goal of combining classroom and online teaching processes (see also McLaughlin et al., 2014; Pearson, 2012; Tune, Sturek, & Basile, 2013). Online learning environments need to include more student-centred activity, yet there are too many open online courses that are excessively technology driven.

As mentioned previously in this study, the sociocultural theory and cultural settings of learning have influenced research and developments by focusing on the co-actions which occur between digital environments and learning (Ludvigsen et al., 2011, p. 3), and it is obvious that the tools employed may affect the depth of learning. The developments in digitalisation have caused us to change our understanding of digital environments. However, these changes also create new possibilities. A recent New Media Consortium report foresaw that if higher education institutions do not already have robust strategies for integrating comprehensive approaches, then the institutions simply will not survive. Hence, it is important to evaluate how the use of digital environments actively enriches learning outcomes (Adams Becker et al., 2017).

The role of vocational teacher education has never been as compendious within this new context, as teachers must be qualified and agile users of pedagogically meaningful new digital environments. Digitalisation in education is not a goal per se, but rather, it creates a foundation for modern society by offering flexible and personalised learning, and at the same time, the massive digital transformation we have witnessed invites us to make learning and teaching open. In this chapter, I introduce the digital learning settings and environments that are used in this study. In using the term *digital environments* in the study, I cover a wide variety of learning settings, such as blended, mobile learning, and open online courses. Moreover, the study draws on the framework for use which covers personal learning environments which varies from the social media applications to closed learning management systems.

3.1 Blended Learning Settings

As a part of the framework of this study, the term *blended learning* is currently used in learning settings that combines face-to-face and online instruction (Graham, Woodfield, & Harrison, 2013; Archambault & Kennedy, 2014; Wagner, 2006). Blended learning is seen as one of the more effective settings (Graham, 2006) which encompasses active learning, peer learning, and student-centred strategies (Morgan, 2002). Some empirical studies have indicated that blended learning may enhance student engagement and learning outcomes (Means, Toyama, Murphy, Bakia, & Jones, 2010; Tay, 2016) and promote flexibility and self-pacing (Jung & Ling, 2011; Sardessai & Kamat, 2011).

In the context of teacher education, blended teaching and learning approaches have become more common and have attracted increasing interest from researchers (Hunt, 2015; Tomas, Lasen, Field, & Skamp, 2015). Tomas et al. (2015, p. 101) found that "a powerful blended learning design can be achieved by using online affordances to scaffold students' learning in their physical environment". An example is the online experiential activities students can undertake in their local environment and share, for example, through video blogs, which can in turn become shared artefacts for learning.

For a successful blended learning process to occur, it is important to apply an open structure by providing different learning resources. In this study, blended learning is understood as a process which integrates face-to-face and online teaching activities by using open and diverse digital environments in a seamless manner.

3.2 Open Online Courses

Massive open online courses are defined by various prefixes whose purpose is to describe the implementation methods or pedagogical approach of a particular course. In this study, I use the term *micro Open Online Course* (mOOC) which is based on the same principles as MOOCs (Massive Open Online Courses), but where the number of participants is limited. The term MOOC originates from American universities where the first course was launched in 2008 (Haber, 2014, p. 37). The words describing this new form of online courses have specific meanings. *Massive* means that the number of participants is unlimited, and *open* means that there are no entry requirements or tuition fees. Haber (2014) gave a concise interpretation that open means a free of cost or entrance requirement, and with no barriers to entry and are reliant on eLearning (p. 83). The courses function entirely as online courses and are structured in the form of goal-directed teaching (McAuley, Steward, & Siemens, 2010). Sanchez-Gordon and Luján-Mora (2017) concluded in their findings that MOOCs have five different development roots: distance education

and online learning, testing/teaching machines and computer-assisted instruction, learning management systems, open education and open educational resources, and online massive teaching.

One of the MOOC pedagogy branches is the cMOOC, and is based on *collaborative and community-orientated* learning where learning is viewed as a social and collaborative learning event, enabled by technology (Haavind & Sistek-Chandler, 2015; O'Toole, 2013). Siemens (2005) stated that connectivism as a learning theory is driven by the understanding that decisions are based on rapidly altering foundations, and that new information is continually being acquired. This concept has been adapted to the digital learning settings, and Grünewald et al. (2013) used it to describe learning as the construction of connections between information, and view that Web 2.0 functionalities lend support for this process. Connectivist knowledge and connectivism (Downes, 2012; Siemens, 2005) include insights into the cycle of collaborative knowledge construction. This means that individuals can provide the community with knowledge and gain knowledge from the community. Means, Bakia and Murphy (2014, p. 55) describe cMOOCs as endeavouring to generate online discussion and collaboration, through which the networked community of students will construct their knowledge and understanding. According to some researchers, the *MOOC pedagogy* is based on the principle of student-centricity. In this, the students decide, for instance, what, when, and where they study and to what extent they commit themselves to the learning community (Grünewald et al., 2013; McAuley et al., 2010).

MOOCs as a brand form an important way of learning and of acknowledging learning, and also offer challenges to our pedagogical thinking and critically thinking about learning design. There are several major criticisms according to MOOC pedagogy in general and the low completion rate (Daniel, 2012). Means et al. (2014, p. 69) argued that many MOOC designers neglect basic knowledge acquisition processes among learners. Toven-Lindsey, Rhoads, and Lozano (2015) have concluded in their MOOC research that learning designers should strive for more creative and empowering forms of courses. However, online learning based on dialogical collaborative knowledge construction requires carefully-planned structures and scaffolding processes (Ruhalahti et al., 2016). The roots of mOOC learning design originate in New Zealand, where at Otago Polytechnic pedagogic leader John Daniel created a new way to combine open educational resources and open online learning in a smaller scope. Those courses were highly targeted, and one of the aims was to offer high-quality teaching and guidance, thus creating more flexibility to manage learning around students' commitments and learning interest (Hiidenmaa, 2014).

In the future, open learning settings ought to attain an integrated approach that combines design, technology and pedagogy (Scanlon, 2017, p.7). In this study, the mOOC learning design principles agreed with those for cMOOCs. Open online courses and their open pedagogical decisions can promote the development of

digitalisation on many levels, thus offering an opportunity to integrate more mobile-based technology for learning purposes.

3.3 Mobile Learning

The concepts and definitions of *mobile learning (mLearning)* design vary. Many researchers agree that technology is not the central concept when defining mobile learning (see also Glahn, 2016; Sharples, Taylor, & Vavoula, 2005; Traxler, 2007). Bachmair and Pachler (2015) have indicated that mobile learning is proceeding to a new state as a result of tablet devices being accepted for use in schools, and the growing amount of practical experience in their use. According to Shuler, Winters, and West (2013), mobile learning is a process of learning mediated by handheld devices. Mobile learning is an extensive concept, which at its simplest refers to learning and teaching with the help of mobile devices. In future, it is estimated that mobile devices will be significantly more affordable and accessible in the year 2030, and data will be transferred more seamlessly, but it is difficult to predict what new mobile devices might look like 12 years from now (Shuler, Winters, & West, 2013).

Traxler and Kukulska-Hulme (2016, pp. 1–2) believe that the next generation of mobile learners is becoming context-aware, and that the design of learning will have a significant role. Bachmair and Pachler (2015) have pointed out that the focal points for designing mobile learning are more individualised and flexible learning (the use of informal learning strategies and learning environments, situated learning, collaborative knowledge construction, context-aware learning, and learning as a conversation) has become more common. Glahn (2016, p. 180) has emphasised learning design factors as follows: "Mobile learning refers to technology-supported learning process and practices that take advantage of mobility of people and consider learning opportunities that are created by context as well as relations and transitions between those contexts". It is therefore necessary to develop and realise transparent learning processes.

In the field of teacher education, knowledge and technology have been identified as critical for understanding the future. Royle, Stager, and Traxler (2014) have challenged the relevance of the existing teacher education programmes which fail to consider major adaptations as a result of emerging technologies, and in particular, the increased mobility arising from learning with mobile technologies. Teachers' willingness and acceptance to integrate mobile learning are only the first step (Christensen & Knezek, 2017). In the field of teacher education, Foulger et al. (2013) have found that innovators are using a variety of methods as they explore possibilities, but have not reached the tipping point necessary for the wide-scale use of mobile technologies. Knowledge is sought, applied, and created collaboratively from authentic starting points, and possibilities for this are created by new mobile

environments, learner-centred approaches, authenticity, and dialogical collaborative work. However, learning design and structuring are still necessary for teaching.

One element in the study was *openness* as seen in mLearning. Environments must be open, easy to access, and be portable, but openness also applies to the way that the technology used has to be open software and use open content. Iiyoshi and Kumar (2008) pointed out that there are three main subcategories regarding educational openness. The first is open educational technologies and software, the second category is open content, and the final category is open knowledge-sharing and construction. Open social software is specified as software that enables people to easily collaborate, interact, and create online communities (Özkan & McKenzie, 2008). As Iiyoshi and Kumar (2008) stated, educators should use more pedagogical know-how to design this openness as a process and share public educational content.

To sum up, the desired type of design are the achievement of a more individualised and flexible style of learning and the use of informal learning strategies and environments, situated learning, collaborative knowledge construction, context-aware learning, and learning as a conversation (Bachmair & Pachler, 2015). Rasi and Vuojärvi (2017) explored audio feedback in collaborative case-based mobile learning in an inter-university course and found that formative audio feedback promoted student's emotional engagement and personal connectivity with course content. Other studies have noted that mobile learning is increasing students' motivation and scaffolding for collaborative learning (Geer, White, Zeegers, Au, & Barnes, 2017; AlEmran, Elsherif, & Shaalan, 2016). As Holley and Sentance (2015) stated, the use of mobile devices should be included in university studies, especially in teacher education. In this study, mLearning and its applications increased students' ownership of learning, therefore making it more personalised and motivational.

3.4 Personal Learning Environments

There is no clear consensus about the conceptualisation of the *personal learning environment* (PLE) or the tools teachers can use to best support learning in these environments. PLEs must meet the varied needs of students (Attwell, 2007). Sahin and Uluyol (2016) have found that the use of PLEs tends to focus more on access and sharing purposes, rather than knowledge construction. PLEs are seen as an opportunity to support personal learning and collaborative knowledge construction in learning communities (Attwell, 2007; Korhonen, Ruhalahti, & Veermans, 2019; Rahimi, van den Berg, & Veen, 2012).

In future, PLEs will likely be central to lifelong learning, and therefore, teachers must design learning processes based on this premise. As noted by Rahimi, van den Berg, and Veen (2015), the use of PLEs in learning requires a clear pedagogical design and should ensure that students have the competences to deal with their

own personal learning environments. These PLEs are web, digital, or online tools, so teachers need to have knowledge of web tools in order to be able to recommend suitable ones to students for use as their *personal web tools* (PWTs). These web tools should be open and consist of applications that are easy and free to use (Wheeler, 2015, p. 124). Open social software enables students to collaborate, interact, and easily create online communities (Özkan & McKenzie, 2008). Wheeler (2015, p. 79) has emphasised that open web tools are not only for sharing and constructing something but also shape our minds in new ways. Examples of good tools which combine content-generating and -sharing are blogs and wikis (Bassani & Barbosa, 2014; Wheeler, 2015, p. 127). It is good to notice that as a tool, blogs combine several functions for writing, sharing, collaborating, and constructing knowledge (Bassani & Barbosa, 2014). According to Deng and Yuen (2011), blogs make educational affordance an expressive, reflective, and collaborative medium amongst student teachers. Määttä, Järvenoja, and Järvelä (2012) concluded that blogs are a collaborative learning content where students are actively constructing and reflecting knowledge. According to Yang, Quadir, Chen, and Miao (2016), cognitively effective blog learning requires active dialog amongst peer students with the teacher as the discussion moderator. In this study, blogs were used as study-circle environments for group-blogging that offered a tool for both online scaffolding activities and constructing dialogical collaborative knowledge. During various stages of learning, blogs were used following the DIANA model, a structured process of learning that requires teachers and students to interact throughout the process. The blogs were seen as dialogical spaces, as Wegerif (2018) has defined them.

However, further research is needed to improve scaffolding and to discover more scaffolding tools to enhance learning outcomes in this context. PLEs (and especially blogs) offer opportunities for students to become self-directed learners with specific learning activities, such as generating learning goals, planning how to tackle problems, evaluating whether the learning goals have been met, and finally, documenting the evaluation (Robertson, 2011).

To summarise, in this study, a PLE is not only a digital environment, although digital technologies are needed to construct the base system. The personal learning environment must be clarified as they are not meant to be used alone by a student during the learning processes. As part of the study (sub-studies II–IV), the authentic and dialogical collaborative knowledge construction was organised in study circle based digital environments, and the ownership belonged to each member of the circle. In this study, I used blogs as the main environment, in addition to suitable mobile and social media applications and easy-to-access cloud services as a part of the blended online learning process. To conclude this chapter, I gain an understanding of a diverse range of contemporary digital environments. It is clear that terms vary, and the digital environments originally developed for other uses are now deployed in teaching and learning.

4 Research Design

The goal of the study was to explicitly identify the additional elements of the DIANA model in order to scaffold deep learning, to examine what kind of learning is produced by a sociocultural approach where learning is seen as an authentic and dialogical collaborative knowledge construction, and finally, to redesign a pedagogical model which is adapted from the DIANA model with the study findings and enhances students' potential to achieve deep learning. Based on the stated aims and theoretical framework review in the preceding chapters, the main goal of the study was to answer the following research questions:

> *1. What kind of pedagogical model scaffolds dialogical collaborative knowledge construction in digital environments, towards deep learning in vocational teacher education?*
> *2. What kind of framework supports deep learning evaluation?*

The aim of the *first sub-study* was to investigate how the DIANA model supports collaborative knowledge construction in an open online course. The study addressed one main research question and five sub-questions. *The second sub-study* looked to identify the challenges and opportunities inherent in the adoption of the DIANA model and to examine student teachers' reflections concerning authentic and dialogical knowledge construction. The study addressed two research questions. After the second study was conducted, we became more interested in scaffolding processes based on the DIANA model implementations. Personal learning environments were the focal issue. In *the third sub-study,* we posed one main research question and three specific sub-questions. Based on sub-studies I–III, I continued to explore the learning process based on the DIANA model, and more specifically, to study deep learning evaluation. Hence, *the fourth sub-study* pursued deep learning activities through authentic and dialogical knowledge construction. In this study, there were two specific sub-questions in order to answer the main research question.

Each of the four sub-studies contributes to answering the study's overarching research questions (see Table 4). The study includes four sub-studies, which have all contributed to the redesigning the pedagogical model. All of the studies have been reported in peer-reviewed international scientific journals. In this chapter, I present a more detailed description of the research design, including the qualitative research methods, research context, data collection, and participants. As Schreier (2012)

pointed out, the key features of qualitative research are interpretive, naturalistic, situational, reflective, flexible, inductive, and case-orientated and emphasise validity (p. 21). These features intertwine with this study's qualitative methodology.

4.1 Research Context and Participants

This study was conducted as a part of HAMK SPTE's normal teaching and developing processes, through vocational teacher education programs and one developing international project. The Finnish vocational teacher education entrance demand at least master or bachelor level education completed, some exceptions may accepted. Furthermore, at least three to five years of working experience is required in their own specialty or discipline (sub-studies II-IV). Accordingly, the intertwining theme was the DIANA model, which was used in each sub-study as a pedagogical model, to pursue the study aims. The teaching and learning environments were partly classrooms but mainly online, digital platforms and mobile applications. It should also be noted that the DIANA model was originally developed for online and on-the-job learning in vocational education (Aarnio & Enqvist 2001; 2002) but has been extensively used and researched in the field of vocational teacher education (e.g. Aarnio, 2006; Enqvist & Aarnio, 2003; 2004).

The context of *the first sub-study* was a seven-week international online course which was carried out in the Canvas MOOC learning environment. The HAMK SPTE (Finland) in cooperation with Coleg Cambria (United Kingdom) created and implemented a mOOC the learning design of which was based on the DIANA model. The course was titled "Making Learning Personal: How to Develop Individualised Approaches in Vocational Education and Training", and its value was two European Credit Transfer System (ECTS) credits. Research was conducted as a part of a Mapping project. The course consisted of four modules. The first two modules had been designed according to the DIANA model. The course was designed for vocational education teachers who wished to deepen their knowledge of individualisation and individual study plans. A total of 155 international participants enrolled on the course and were divided into 14 study groups of 8–10 people. The study groups were free to choose from various social media platforms which foster dialogical and collaborative knowledge construction (e.g. Facebook, Google Drive, Padlet, and Hackpad). Throughout the process, the teachers could be contacted via the learning environment and in a Facebook clinic, enabling learners to deepen their knowledge of dialogical guidance and scaffolding. Active, dialogical, and collaborative participation was expected from the students.

In *the second, third, and fourth sub-studies*, the context was the study module "Networks in Vocational Education" (4 ECTS credits) in the Finnish Vocational Teacher Education programme (1–1.5 years, 60 ECTS credits), delivered by the

Table 4. Summary of the research design.

Aims	Research questions	Data collection, methods and research data	Data analysis methods	Publications / Refereed international scientific journal
Sub-study I: To investigate how the Dialogical Authentic Netlearning Activity (DIANA) model supports collaborative knowledge construction in an open online course.	1. How does the Dialogical Authentic Netlearning Activity (DIANA) model support collaborative knowledge construction in a mOOC? 1.1. What is the significance of group formation for a learning community in a learning process? 1.2. How did the participants experience the formulation of authentic questions? 1.3. How does dialogical participation work in an open online course? 1.4. Which factors facilitate collaborative learning and knowledge creation? 1.5. How does a pedagogical model structure learning on a micro open online course?	Online questionnaire: international teachers (n = 14) Semi-structured in-depth online interviews: (n = 4)	Case study approach: Qualitative content analysis	Ruhalahti, S., Korhonen, A.-M., & Ruokamo, H. (2016). The dialogical authentic netlearning activity (DIANA) model for collaborative knowledge construction in mOOC. *The Online Journal of Distance Education and e-Learning, 4*(2), 58–67.
Sub-study II: To identify the challenges and opportunities inherent in the adoption of the DIANA model, and to examine student teachers' reflections concerning authentic and dialogical knowledge construction.	1. What are the challenges and opportunities of the adoption of the DIANA model for blended and mobile learning, from the perspective of student teachers? 2. How do student teachers reflect on and evaluate authentic and dialogical knowledge construction, based on their mobile learning experiences?	Online questionnaire by Finnish student teachers (n = 63) and participants' (n = 16) self-reflective accounts	Case study approach: Qualitative deductive content analysis	Ruhalahti, S., Korhonen, A.-M., & Rasi, P. (2017). Authentic, dialogical knowledge construction: A blended and mobile teacher education programme. *Educational Research, 59*(4), 373–390.
Sub-study III: To study the scaffolding process used within a pedagogical model and to explore possibilities for scaffolding activities and tools.	1. How and by what means can *learning in* Personal Learning Environments (PLEs) be scaffolded during an online learning process? 1.1. Which web tools are useful for Personal Learning Environments during an online learning process? 1.2. How are scaffolding elements shown in the DIANA model? 1.3. Which web tools are needed in order to reach scaffolding with the DIANA model, and what are the critical points accordingly during an online learning process?	Online questionnaire: Finnish student teachers (n = 63) Additional online questionnaire during the third phase: Participants (n = 13)	Design-Based Implementation Research approach: Qualitative deductive content analysis	Korhonen, A.-M., Ruhalahti, S., & Veermans, M. (2019). The online learning process and scaffolding student teachers' personal learning environments. *Education and Information Technologies*, *24*(1), 755–779.
Sub-study IV: To investigate what kind of dialogical knowledge construction demonstrating characteristics of deep learning can be observed in a learning process based on the DIANA model.	1. Towards what kind of authentic and dialogical collaborative knowledge construction does the DIANA model direct students? 1.1. What kind of authentic learning questions are formulated collaboratively by the study circles? 1.2. What kind of learning activities and results does authentic and dialogical collaborative knowledge construction prompt in superficial and deep learning-orientated study circles?	Online open blog entries by Finnish vocational student teachers (n = 76)	Case study approach: *Quantification of qualitative data, abductive analysis*	Ruhalahti, S., Aarnio, H., & Ruokamo, H. (2018). Evaluation of deep learning in vocational teacher education: Conducted on the principles of authentic and dialogical collaborative knowledge construction. *Nordic Journal of Vocational Education and Training, 8*(2), 22–47

HAMK SPTE. The vocational teacher education curriculum is competence-based, and the implementation plan is built on five competence-based modules, each with its own learning outcomes. The learning outcomes will give student teachers the required competence for their future work as a teacher, as well as keys to personal and professional development in their teaching career (HAMK SPTE, 2013). The aim of the study module was that the students would be able to do the following: 1) build and utilise different national cooperative networks in the field of vocational education and training, 2) function in international networks, 3) understand the administration, financing, and management of an institution of vocational education, and 4) apply in their work plans and documents guiding the activities of such organisations (HAMK SPTE, 2013). The represented student teachers were from various fields of vocational education (Figure 3), with some already working as teachers. Those who were specialists in competence-based qualifications or who had previously gained skills and knowledge (e.g. through work experience) in areas defined in the learning objectives of the study module were accredited for the module. In this study, the term group refers to one implementation set.

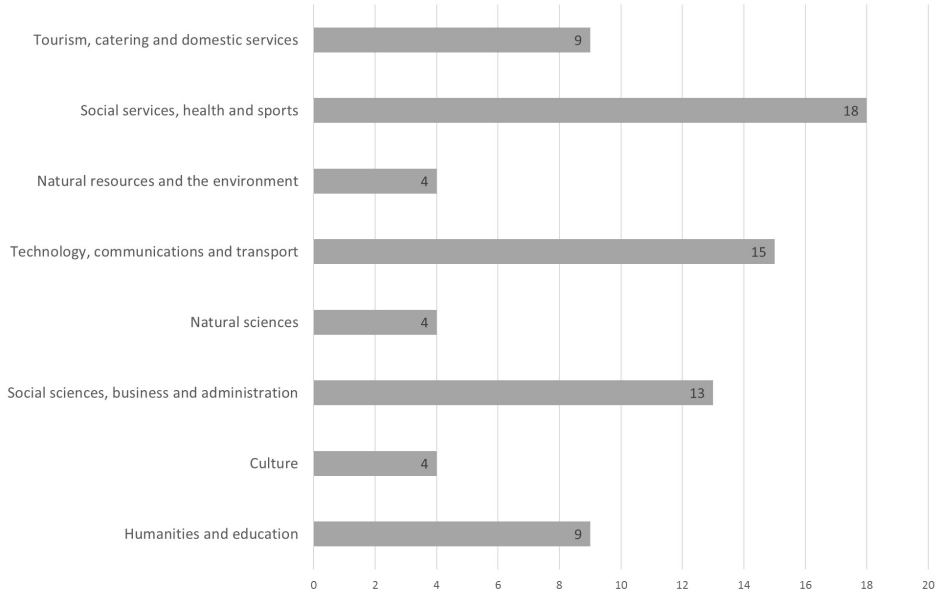


Figure 3. Sub-studies II–IV: Student-teachers (n = 76) from various vocational fields.

The study module was designed and implemented using the DIANA model (see Fig. 4). The main components of the learning environment provided by the teachers consisted of an open course blog containing free and open educational resources and open blogs for the individual study circles.

The module was designed so that each online learning application could be used via mobile devices. Four of the five module implementations included contact teaching (1+1 days), whilst the remainder of the course was solely based on digital, online, and mobile learning environments. The online work in the blog and other collaborative online learning environments took place between the contact teaching days. In the study circles, the participants took part in a learning process that was based on the DIANA model. The learning processes included step-by-step descriptions of the learning activities available during the various cornerstones of the learning process. The participants were given four to five weeks to complete the study module.

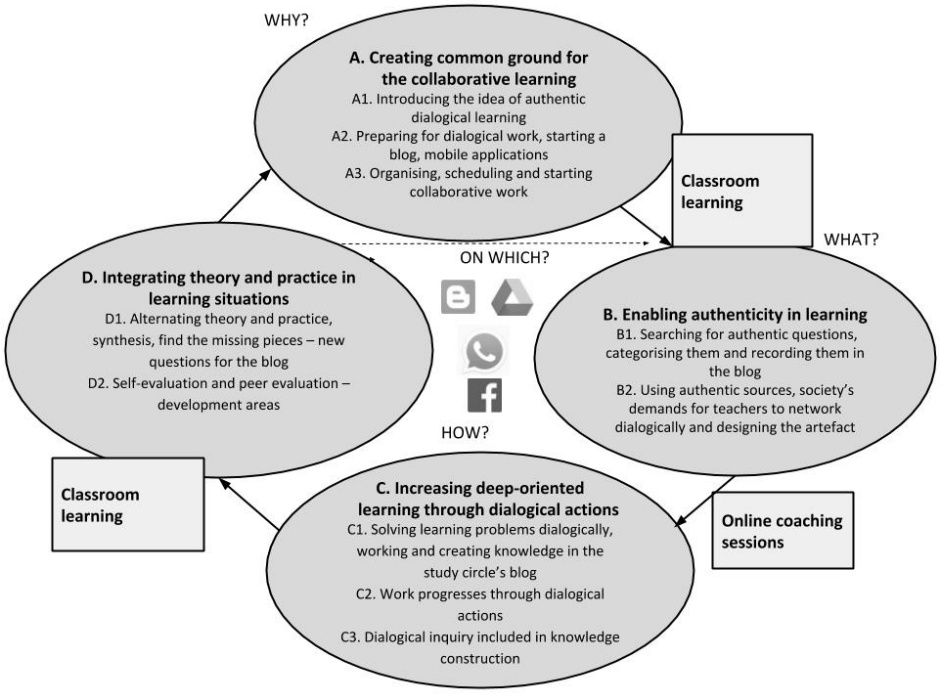


Figure 4. Implementation description of learning activities and digital environments based on the DIANA model (Aarnio & Enqvist, 2016) in sub-studies II–IV.

4.2 Data Collection

The data provided by the research is qualitative. The data (Fig. 5) were first-hand, which means that I collected data by myself (sub-studies I and IV) or with colleagues (sub-studies II and III). Three of the four sub-studies were conducted in Finnish, where the data collection and analysis were conducted in Finnish, and the results were translated into English by a first-language translator.

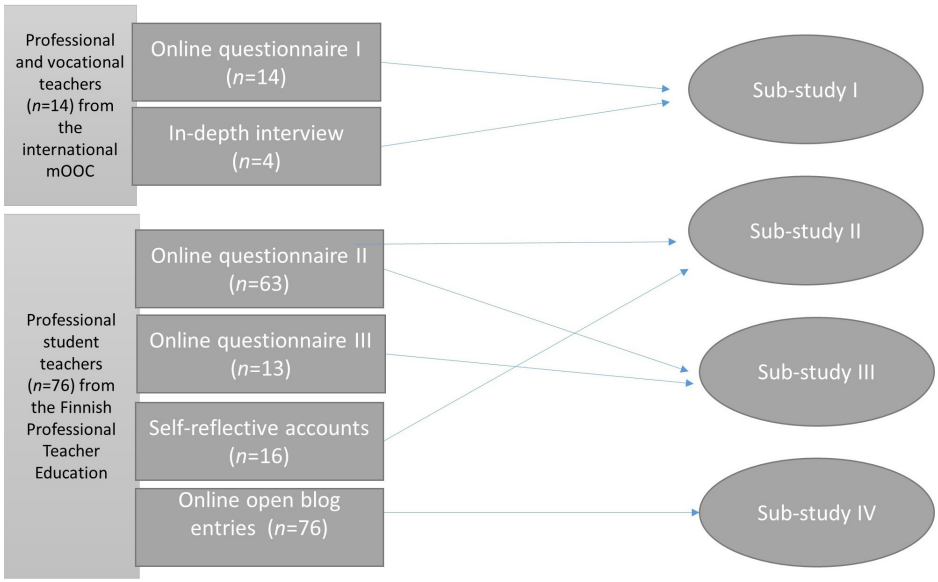


Figure 5. Data collection of the study.

In the **first sub-study**, *online questionnaire* and *in-depth interviews* were chosen as the means of data collection. The questionnaire was based on authentic and dialogical collaborative knowledge construction, which supported the research questions and consisted of open-ended questions about building a learning community, learning outcomes, and dialogical participation. In addition, the questionnaire featured closed-ended questions concerning the participants' background, motivation, number of hours used for course work, group formation, use of collaborative tools, formulating authentic questions, organising authentic questions thematically, creating syntheses, online meetings, the dialogical attitude of the study group, creating an individual study plan, and learning from each other's models or plans. The questionnaire was created in collaboration with the course designers. The participants (n = 14) in the study were international vocational teachers from seven countries. The majority of

the teachers (n = 6) who completed the questionnaire were from vocational schools. There were teachers from universities of applied sciences (n = 4), from the adult or further education sector (n = 2) and from university-level institutions (n = 2). The participants represented teachers interested in developing their individualisation and personalisation knowledge in an international learning community. Participation in the study was voluntary. In addition, four participants volunteered to take part in in-depth interviews and came from Brazil, Mexico, Slovenia, and Finland. Interviewees were given the five main questions in advance. A WebEx video meeting programme was used to conduct the online interviews, and each interview was recorded and later transcribed. The data was collected at the end of the course in June 2015, and the in-depth online interviews were carried out in early September 2015.

In the **second sub-study,** participants were 63 Finnish student teachers (43 female and 20 male), aged between 25 and 60 years of age, and who were following the four implementations of the study module "Networks in Vocational Education" between 2014 and 2015. The data for this study was drawn from *an online questionnaire II* (n = 63). The questionnaire was designed in reference to background theories which illuminated the research questions. These theories were used to form questions to inquire about phenomena, understanding, and experiences that arose during the learning process. The questionnaire included three multiple-choice questions about the participants' use of mobile devices and applications, as well as their experiences related to such use. Three open-ended questions were used to investigate the challenges experienced by the students during the learning process. In addition, the research data included the *self-reflective accounts* of students (n = 16) enrolled in the third implementation of the study module. For these accounts, students were asked to answer eight open questions regarding their roles and contributions in the authentic and dialogically constructed knowledge construction processes.

The **third sub-study** involved the same number of student teachers (n = 63), and the data were collected during 2014–2016 with the same *online questionnaire II* that was used in the second sub-study. The survey included multiple-choice questions related to web tools and blogging. The data were analysed by segmenting and coding the text, and thereby deriving meanings (Johnson & Christensen, 2008, p. 534). Second, the DIANA and Five-stage models were used to identify scaffolding elements and activities. From student teachers (n = 13) from the fifth implementation group, data were collected after each DIANA model-based cornerstone (A–D) using the online questionnaire III. The questionnaire included open and multiple-choice questions regarding the teachers' scaffolding and multiple-choice questions about dialogical collaborative knowledge construction using the DIANA model.

For the **fourth sub-study**, data were collected from the nineteen study circles' *online open blog entries*. The unit of the analysis was the study circle. The participants of this study were 76 vocational student teachers (53 women and 23 men) in the HAMK School of Professional Teacher Education. The participants' ages varied

from 28 to 57 years, and all were participating in one of the five implementations of the module between 2014 and 2016. According to Yin (2009), the aim of a case study is to describe a particular situation to gain an understanding of the specific case by making direct observations. The quantified qualitative data included *authentic learning questions* ($f = 350$) formulated collectively by the study circles. In the second part of the case study, abductive analysis (Tavory & Timmermans, 2014) was used to answer the question about the kind of learning activities and results that authentic and dialogical collaborative knowledge construction prompts in superficial and deep learning-orientated study circles. Six study circles were chosen for the abductive analysis. Three superficial and three deep learning-orientated groups were selected at random. From the perspective of collaborative knowledge construction, three study circles had defined authentic learning questions which were mainly superficial learning-orientated, whilst three study circles had defined learning questions that were mainly deep learning-orientated. The data used in this study included dialogical knowledge construction in the blogs of the study circles, the syntheses of knowledge construction, and collaboratively created and constructed artefacts.

4.3 Case Study Approach

Case study methodology provides a variety of tools with which to study complex phenomena within a specific context (Baxter & Jack, 2008). The term case study is widely defined in the literature, and two key approaches steer the methodology (Stake, 2004; Yin, 2009). These approaches include similarities but differ, for example, in the terms used to describe a variety of case studies. Yin (2009) categorised cases as descriptive (intervention or phenomenon), explanatory (complex), or exploratory (lack of detailed preliminary research), and further differentiated between single, holistic, and multiple-case studies. Stake (2004) divided case studies into intrinsic (unique situation or subject), instrumental (particular situation or phenomenon), and collective case studies. For this study, I have adopted Yin's (2009) descriptive multiple case-study approach.

When applying a case study approach, it is important that the setting for study is connected to previous theories, which form a base for the analyses, as well any interpretations used in the conclusions. In particular, the aim is to understand and interpret the individual cases in their own context and find new information (Aaltio & Heilmann, 2010, p. 68). According to Yin (2009), the aim of a case study is to describe a particular situation to get an understanding of the specific case by making direct observations. Yin (2009) suggested using the case study approach when the focus of the study is to answer "how" and "why" questions, and also if one wants to cover contextual conditions because they are relevant to the phenomenon under study. Lodico, Spaulding, and Voegtle (2006, p. 269) also note that at the beginning

of the process the researcher should identify the problem and develop a rationale for why the case study approach is suitable for use. Gathering information or data through multiple sources and perspectives is a key characteristic of the case study approach (Lodico et al., 2006, p. 15).

In the present study, multiple case studies were conducted during the research process. According to Creswell (2013, p. 97), this method allows exploration of multiple bounded cases over time, through detailed, in-depth data collection, involving multiple data sources. In this study, each case was a sub-study; the single more detailed case was an international course, and three other cases were study modules in diverse digital environments. As stated by Yin (2009, p. 59), multiple-case design involves the selection of cases that represent replications; thus in this study, the cases followed the DIANA model learning process. The case studies and the analysis methods are summarised in more detail in Table 4. In addition, multiple data collection methods were used, such as an online questionnaire, in-depth interviews (Salmon, 2015), self-reflective accounts and open blog entries. To make the case study more relevant and broader (Yin, 2009, p. 133), data were analysed quantitatively to interpret and describe the case study and to make internal generalisation procedures more explicit. During the analysis, only basic analysing procedures were used to define learning questions ($f = 350$), which were set by study circles.

4.3.1 Qualitative Content Analysis

For the study, I applied qualitative content analysis as an interpretation method in case study research. In education studies, researchers have been interested in systematically analysing data. In qualitative studies, content analysis was formally developed in the social sciences (Krippendorff, 2004). Schreier (2012, p. 17) has noted that qualitative content analysis is a qualitative research method and has roots in the qualitative and quantitative research traditions.

At the beginning of the process, research questions specify what to analyse and what to develop (Schreier, 2012). Qualitative content analysis can be approached in three ways: inductive, deductive and abductive. All approaches consist of three main phases: preparation, organisation, and reporting of results (Elo et al., 2014). The second phase differed, using an inductive approach, to include open coding, categorisation and abstraction. A *deductive approach* involves the development of a categorisation matrix, and all data are reviewed for context and coded through identified categories (Elo et al., 2014). As a part of this study, a deductive content analysis was conducted to discern relationships among the data, the existing theory and the elements of the DIANA model (Schreier, 2012). The *Atlas.ti* software was used to identify the items that best corresponded to the theory. The main categories of this analysis were derived from the DIANA model and agreed upon by the two primary authors before the commencement of the analysis (i.e., Sub-study II). These

authors created a coding scheme that guided the process and aimed to increase the validity of the research. To increase coding reliability, two researchers reviewed the material throughout the coding process (Vaismoradi, Bondas, & Turunen, 2013).

In the fourth study, an *abductive analysis* was chosen because it included all aspects of the data and incomplete observations. Especially observations that did not fit neatly into existing theories. Abduction is seen as the form of reasoning through which we perceive a phenomenon. The roots of abductive analysis lead to Charles S. Peirce, who stated that if rational explanation is possible at all, it can be achieved only through abduction (Psillos, 2011). As Psillos (2011) has described, abduction is the sole method by which new ideas are presented by being explained. A researcher posits to lead away from old perspectives and create new theoretical insights. Paavola's (2006) idea was to develop a broader understanding of abduction by focusing on the process of abduction, and by seeing it as one element within a large process of inquiry.

According to Tavory and Timmermans (2014), observation of the data is key in abduction and can be seen in four intertwined activities: gathering observations, reading theories extensively, working with observation data, and actively inquiring. In the field of research, abduction refers to an inferential creative process of developing new hypotheses and theories, based on surprising research data and evidence. Abductive analysis emphasises that researchers should enter the field with the deepest and broadest theoretical base possible, and develop their theoretical repertoires throughout the research process (Timmermans & Tavory, 2012).

In the study, abductive analysis was used for research questions that required abductive reasoning and observations to interpret the data, whilst simultaneously striving to comprehend and understand it. Abductive analysis typical begins with an incomplete set of observations; here, six study circles containing 21 student teachers were chosen for analysis. The multiform data included knowledge construction in study circle blogs, the syntheses of collaborative knowledge construction and collaboratively created and constructed artefacts. Abductive analysis was used to answer the question about the types of learning activities and results that authentic and dialogical collaborative knowledge construction prompts in superficial and deep learning oriented study circles. The analysis began with reading the data to obtain an overall understanding of the study circles' materials, blog entries and printouts and reviewing the artefacts produced by the study circles. Then, abductive reasoning was used to jointly interpret the data while striving to comprehend and understand it. The abductive analysis process is connected to the theoretical framework of Sub-study IV and to the framework for deep-learning activities that was redesigned and used to understand deep-learning evaluation. This process included four activities: gathering researchers' observations, reading a broad range of theories, working systematically with observations and actively constructing through dialogue understanding of the data. The process can also be

seen as dialogical participation, which helped to reconstruct the theoretical claims and relevance of the research.

4.3.2 Design-based Implementation Research Approach

In third sub-study, the case study research design (Yin, 2009) was combined with Design-based Implementation Research (DBIR) approach (cf. Fishman, Penuel, Allen, Cheng, & Sabelli, 2013, p. 137). DBIR approach fits with aims that address and explore the problems of implementation from a design-based perspective (Fishman et al., 2013). DBIR has links to education research and evaluation-orientated programme development, such as community-based participatory research (Chevalier & Buckles, 2013), implementation research (Fixsen, Naoom, Blase, Friedman, & Wallace, 2005), design-based experimentation (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003), social design experimentation (Gutiérrez & Vossoughi, 2010), and evaluation research (Fitzpatrick, Sanders, & Worthen, 2016). As a research approach, DBIR is relatively new in the field of education and was originally developed as method for fostering organisational change and quality improvement (LeMahieu, Nordstrum, & Potvin, 2017). According to Penuel, Fishman, Haugan, and Sabelli (2011), the approach embodies focusing on persistent problems of practice and committing to an iterative process and collaborative design, and is concerned with developing theory-related implementation through systematic inquiry (p. 332). In the educational research field, there has been discussion about DBIR being an extension of Design Based Research (DBR). The main differences are in focus: DBIR forms design research that focuses on the implementation of sustainable educational change, and design based research creates new knowledge about learning (Crowley, 2016). DBIR is closely linked to collaborative and team-based design methodologies (Fishman, Cheng, & Penuel, 2014).

In DBIR, the main aim is to make decisions on how to make adjustments in the learning process (Cobb et al., 2003) and solve practical problems (Fishman et al., 2013). To summarise, DBIR organises research and development intended to promote improvements in education. These issues make the DBIR approach meaningful for researchers and practitioners to work collaboratively to find problems in practice by asking, "What works, what activities, when and which tools" (Fishman et al., 2013).

In a DBIR-based process, research questions are posed broadly (Fishman et al., 2013, p. 146). As LeMahieu et al. (2017) have noted, the DBIR process does not have literature-supported guidance on what specific stages or steps to follow. However, the method should follow four guiding principles: 1) a focus on collaboratively-defined problems of teaching and learning practice, 2) a joint commitment to iterative and collaborative design, 3) an interest in developing knowledge and 4) theory through disciplined inquiry, and the goal of and concern about developing capacity for sustaining change (Fishman el al., 2013, pp. 142–143). However, Supovitz (2013,

p. 381) has suggested that the DBIR process has several implications regarding the researcher's role in creating useable knowledge for improvement. In addition, learning comes in multiple ways and from multiple sources, and Supovitz (2013) has further divided the DBIR process into four phases according to different implications and interventions.

In this study, the research process is based on iteration cycles in order to support the implementation. For this study, I adopted Fishman et al.'s (2013, pp. 142–143) design principles. Figure 6 describes the process in more detail.

The design commenced by identifying the practical problems and forming aims for the process. The second phase focused on analysing the online questionnaire (n = 63) and implementing useful web tools for PLEs. The third phase focused on gathering online learning activities in one table in order to combine both processes, the DIANA and Five-stage models, in the same learning process. The fourth phase involved a fifth implementation group (n = 13) of the study in spring 2016. The data regarding the scaffolding practices were collected during the learning process by way of four questionnaires, each following a cornerstone of the DIANA model. Furthermore, the researcher's role as a teacher-researcher in the study involved implementing both practical and theoretical aspects within a collaborative research team. This agrees with the design-based implementation research process.

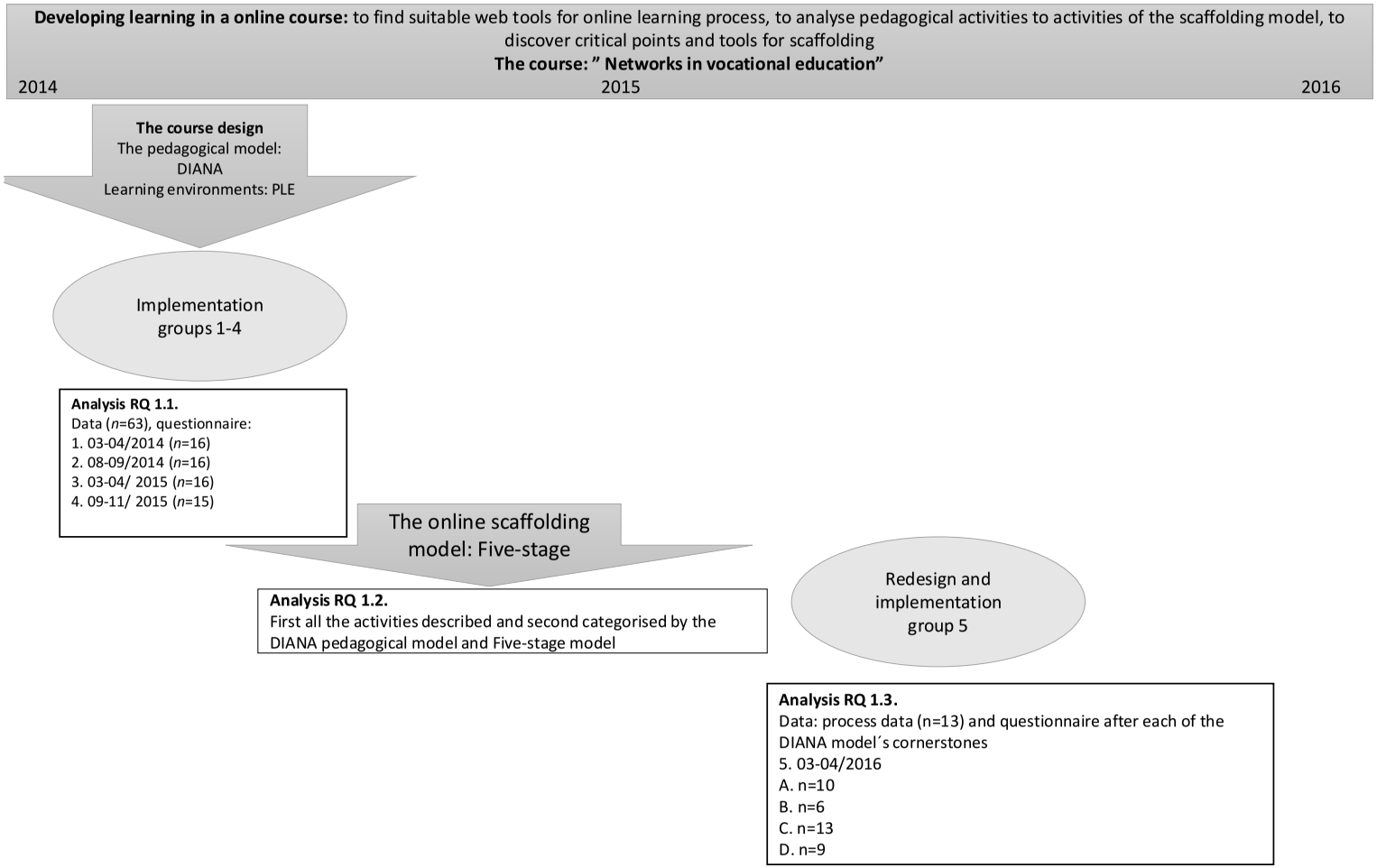


Figure 6. The research design following the Design-based Implementation Research (Fishman et al., 2013, pp. 142–143).

5 Overview and Evaluation of the Studies

This chapter provides summaries and evaluations of the sub-studies comprising this thesis, as well as an account of my learning process. I introduce the sub-studies on their roles and contributions to the research.

5.1 Sub-study I: Dialogical Collaborative Knowledge Construction in mOOC

Related publication
Ruhalahti, S., Korhonen, A.-M., & Ruokamo, H. (2016). The dialogical authentic netlearning activity (DIANA) model for collaborative knowledge construction in mOOC. *The Online Journal of Distance Education and e-Learning, 4*(2), 58–67.

This sub-study was a starting point in gaining an initial perspective of how the DIANA model construes the learning process in an open online format. The research article focused on the realisation of a practical pedagogical process and showed how the DIANA model supports collaborative knowledge construction in the international mOOC context.

The context of the study was an international course, designed for vocational and further education teachers who wished to deepen their knowledge of individualisation and individual study plans. I co-created and implemented the mOOC. This 2 ECTS course proceeded from one module to the next according to the course topics. The seven-week course was carried out in the Canvas learning environment. This environment was also used as the course platform, but the study circles were free to choose from various social media platforms that foster dialogical and collaborative knowledge construction (e.g. Facebook, Google Drive, Padlet, and Hackpad). The first two modules were designed according to the DIANA model.

Considering the learning process that took place in the study, I examined the significance of group formation for a learning community in a learning process. The analysed questionnaire administered to international vocational teachers (n = 14) and their in-depth interviews (n = 4) revealed that a clear representation of the pedagogical model at the beginning of the learning process was important to understanding the path of dialogical and authentic learning and to promoting collaborative knowledge construction. Findings also indicated that group formation processes might have been more successful had the participants been given more

freedom when forming the groups and if the tutoring provided in the online environments had been timed more efficiently (see also Keskitalo et al., 2011).

On the basis of the study's results, it is recommended that the key factors in learning authenticity ought to be made more transparent, in order for students to understand the significance of authenticity at the very beginning of the learning process. In this study, challenges for authentic activity sprang from the innovative nature of the model, the strict schedule of the course, and the difficulties that online studies created for understanding the concept of authenticity. Especially, learners' authentic questions form a basis for dialogical knowledge construction (Aarnio & Enqvist, 2002), and at this point, a tutor has a significant role in ensuring that the learning process is based on authenticity (Herrington et al., 2010).

The study also measured how dialogical participation worked in a micro open online course. The findings showed that dialogical actions and dialogical participation were regarded as a difficult approach in this online course. In this context, the model requires a genuine dialogical learning community, a commitment on the part of learners and the teacher, and a solid presence on the net (Aarnio & Enqvist, 2001; 2002). The DIANA model was considered to be a motivating feature, but as collaborative knowledge construction entails inquiring skills and addressing meaningful issues, the entire learning community must be involved. The implementation faced many challenges. Of note, there was a discrepancy between the number of students who had enrolled on the course and those who actually commenced the course.

To sum up the study's results, authentic learning, and dialogical collaborative knowledge construction require more practical scaffolding (McAuley et al., 2010). The DIANA model is challenging because it is precisely the authentic, dialogical, and collaborative knowledge constructions which are in danger of being lost in the process if the required activities and support structures remain inadequate. A model such as DIANA requires a learning environment which is coherent and comprehensible, functions well, and fosters collaborative knowledge construction. Moreover, the pedagogical model itself provided no solutions to the main problem typical of MOOCs, namely, the substantial drop-out percentage. The key question is one of the underlying pedagogy, which inevitably will affect the learning experience and the learning itself.

As a qualitative case study, it does not suggest generalisable results as the study consisted of a relatively small number of participants. When evaluating the trustworthiness of the study, attention must be paid to the relationship between the first and second authors and the research topic. The authors were involved in designing and implementing the course and in interpreting the data; therefore, assumptions made and actions taken as teacher-researchers might have influenced the research process. Familiarity with the research context allowed the researchers to position themselves; however, trustworthiness could have been improved by

allowing participants to comment on interpretations of the in-depth interviews. However, this study provided motivation to continue the research process in the context of national teacher education to explicitly identify additional elements of the pedagogical model that would achieve the aims of this study.

Through the sub-study, I acquired an understanding of how important group formation is for dialogical collaborative knowledge construction. In addition, it was clear that authenticity should be established in the beginning of the process through a process of scaffolding. Dialogical skills and knowledge should also be integrated transparently in the learning process, and this understanding has been highly influential in my redesign of a pedagogical model. Through the writing process, I became familiar with the MOOC concept and with the key elements of the DIANA model.

5.2 Sub-study II: Authentic and Dialogical Collaborative Knowledge Construction in a Mobile Learning

Related publication
Ruhalahti, S., Korhonen, A.-M., & Rasi, P. (2017). Authentic, dialogical knowledge construction: A blended and mobile teacher education programme. *Educational Research, 59*(4), 373–390.

This study represents a study module in vocational teacher education which created opportunities for authentic, dialogical collaborative knowledge construction, with experiences of integrating mobile learning technologies with a structured learning design. The main aim was to identify challenges and opportunities inherent in the adoption of the DIANA model and to examine student teachers' reflections concerning authentic and dialogical knowledge construction.

The empirical data was collected from 63 student teachers, who were following the four implementations of the study module 'Networks in Vocational Education' between 2014 and 2015. The data for this study was drawn from an online questionnaire. The research data also included self-reflective accounts of students (n = 16) enrolled in the third implementation of the study module. During the final face-to-face meeting of the study module, students were asked to write a self-reflective evaluation of their learning activities and outcomes regarding their roles and contributions to the authentic and dialogically constructed knowledge construction process. Qualitative deductive content analysis (Schreier, 2012) was used to discern relationships amongst the data, existing theory, and the elements of the DIANA model.

This study showed some students had difficulties in achieving an understanding of the concept of authenticity. The results of the sub-study suggest that it is

important to enhance learner-centred scaffolding, particularly at the outset of the learning process (see also Aarnio & Enqvist, 2016; Ruhalahti et al., 2016; Teräs, 2016). Sharing experiences, skills, and knowledge with members of the study circle was considered to be important for authentic learning and expanding one's perspectives. Student teachers also agreed that mobile applications brought new and enriching aspects to collaborative knowledge construction. As a pedagogical model, DIANA proved to be demanding for students, and this is a problem that has been closely connected to a lack of dialogical competence (Aarnio & Enqvist, 2016). Findings further indicated that deep-orientated learning through dialogical actions was the most challenging aspect of using the DIANA model (see also Enqvist & Aarnio, 2003). Therefore, methods which develop dialogical skills and knowledge (Aarnio, 2012) should be integrated into vocational teacher education as extensively as possible, in order to make collaborative work genuinely dialogical and equal. Although dialogical collaboration is challenging, when done effectively, it helps students to create a shared whole through shared understanding. Inquiry skills were shown to be the most important dialogical skills and knowledge, but listening, reciprocity, and symmetrical participation were also considered to be key issues.

The study offered an example of educational openness (Iiyoshi & Kumar, 2008) for vocational teachers who wish to design, teach, and integrate new open technologies into education, use open content, and transparently construct their knowledge. The results of this study are in line with Aarnio's (2006) findings, which indicate that the learning process requires skilful structuring. Similarly, when working within the principles of the DIANA model, teaching in digital environments should be skilfully structured.

Overall, collaborative learning requires a community which, through the skills, knowledge, and responsibility of its members, aims to achieve a certain goal (Lave & Wenger, 1991; Wenger, 2009). The outcome of the learning process is presented as an artefact and a synthesis of the course themes which have been collaboratively created by the study circle.

The limitations of the sub-study are related to the researcher's positioning and its potential impact on the research (see Yin, 2009). The two primary authors of this study were involved in the design and implementation of the module, as well as in the data analysis. The analysis process was conducted collaboratively to deepen analysis and to strengthen coding reliability. The trustworthiness of the study would be enhanced by having participants interpret the analysed data. Moreover, face-to-face or online interviews may have benefitted the study (see Williams, 2005).

The study deepened my understanding and knowledge of student teachers' experiences concerning authenticity and dialogical knowledge construction in a learning process. I do agree that the role of teachers is central in promoting and scaffolding a dialogical knowledge construction and learning culture. Furthermore, the sub-study confirmed the importance of integrating dialogical activities. The

study suggests that the sub-skills of dialogical activities (see e.g. Aarnio, 2012) should be integrated more deeply into the processes of teacher education, so that they become deep-orientated skills and competences. The study's findings motivated us to continue our research on how to combine the DIANA model as a learning design and scaffolding model, particularly when students are using open learning environments during their learning process and where teacher scaffolding is needed. It was seen that whilst scaffolding must be improved by utilising new possibilities in digital environments, it is not simply enough to increase the use of different web tools.

5.3 Sub-study III: Scaffolding Digital Personal Learning Environments

Related publication
Korhonen, A.-M., Ruhalahti, S., & Veermans, M. (2019). The online learning process and scaffolding student teachers' personal learning environments. *Education and Information Technology, 24*(1), 755–779.

The aim of this article was to continue the research process undertaken as a result of the findings of sub-study II. This article looked to uncover what scaffolding is needed when PLEs are used as a part of an online learning environment and process. This study also aimed to find the tools, place, and time for scaffolding activities during a learning process which followed the DIANA model. The study context, implementation group, and student teachers ($n = 63$) were the same as those featured in the second sub-study, with the addition of student teachers ($n = 13$) from the fifth implementation group which was included as the last part in the DBIR process. The study module was designed using the DIANA model (Aarnio & Enqvist, 2016, p. 44). During this study, the DIANA model was compared with Salmon's (2011, p. 32) Five-stage model in order to discover how scaffolding could support deep learning (Table 5). The teacher's role was to ensure that students were progressing in their learning processes and to provide scaffolding with the help of Web 2.0 tools and other mobile applications (i.e. WhatsApp, Blogger, Google Drive, and Facebook).

Table 5. Comparing the DIANA (Aarnio & Enqvist, 2016, p. 44) and the Five-stage models (Salmon, 2011, p. 32).

DIANA model	Five-stage model
A. Creating a common ground for collaborative learning	1 Access and motivation 2 Online socialisation 3 Information exchange
B. Enabling authenticity in learning	1 Access and motivation 2 Online socialisation 3 Information exchange 4 Knowledge construction 5 Development
C. Increasing deep-orientated learning through dialogical actions	2 Online socialisation 3 Information exchange 4 Knowledge construction 5 Development
D. Integrating theory and practice in learning situations	2 Online socialisation 3 Information exchange 5 Development

Comparison of the two models demonstrates a need for general, whole-group scaffolding as well as individual scaffolding. While the DIANA model concentrates on deep learning using certain dialogical activities, the Five-stage model focuses on the teacher's online activities in general. The DIANA model includes all scaffolding activities present in the Five-stage model. A comparison of the activities in these two models shows that the DIANA model actually includes all the same activities as the Five-stage model for the scaffolding process. As the findings of the first and second sub-studies indicated, more scaffolding is needed during the learning process that implemented the DIANA model. The study showed that elements of scaffolding were found in the DIANA model (Aarnio & Enqvist, 2016). A comparison of activities in these two models shows that the DIANA model includes the same activities as seen in the Five-stage model scaffolding process. The study indicated that the Five-stage model for scaffolding gives general instructions for the role of an online teacher. It seems that these activities should be moved to the beginning of the learning process, and this is where they occur in the DIANA model. The Five-stage model elements are already completed during the DIANA model's cornerstones A and B.

Personal learning environments often utilise Web 2.0 tools (Bassani & Barbosa, 2014; Wheeler, 2015). During the learning process which followed the DIANA model, it was found that the most important and productive way to scaffold was by use of the teacher's help with comments and assessment in the personal learning environments which were formed by the study circle blogs. The findings of the study also indicate that a general scaffolding process is necessary for the whole study group, because the whole group is working collaboratively during cornerstones A

and D. The teacher's blog is seen as a central facet of the learning process, for example for material sharing, general instructions, and the teacher's reflections on the study group. On the basis of the findings of the study, it was noticed that learning activities and the teacher's scaffolding produce collaborative knowledge construction in the student's personal learning environments.

The sub-study found that blogs served as a tool for supporting dialogical collaborative knowledge construction (Bassani & Barbosa, 2014; Özkan & McKenzie, 2008) and were very popular as part of the PLEs (Quadir & Chen, 2015; Sahin & Uluyol, 2016; Yang et al., 2016). The study' findings are in line with those of previous research, and the blog tool seems to be appropriate to achieve learning purposes, even in collaborative learning situations. The results also revealed that student teachers found the teacher's blog to be a significant asset and sufficiently supportive for their learning purposes.

The findings crystallised into three suggestions for improving scaffolding activities and practices: indicating a need for general online scaffolding for the whole study group, a need to increase scaffolding in study circle–based environments, and a need to strengthen scaffolding for study circles at each cornerstone of the DIANA model.

The study was somewhat limited by the small sample sizes, and the collected data could have addressed wider viewpoints, such as those related to the student teachers' assumptions and expectations of the Personal Learning Environments. Due to the small scale of the study, the results cannot be generalised. It was important to discover how to design a learning process based on the DIANA model for PLEs. DBIR requires that researchers take multiple roles, which raises a fundamental question about the credibility of the research results (Barab & Squire, 2004). However, the study motivated continued research until the end of the learning process. This would be especially important in order to investigate what kind of learning results from dialogical collaborative knowledge construction.

5.4 Sub-study IV: Evaluation of Deep Learning in Vocational Teacher Education

Related publication
Ruhalahti, S., Aarnio, H., & Ruokamo, H. (2018). Evaluation of deep learning in vocational teacher education: conducted on the principles of authentic and dialogical collaborative knowledge construction. *Nordic Journal of Vocational Education and Training, 8*(2), 22–47.

The study sought to discover what kind of authentic and dialogical collaborative knowledge construction the DIANA model directs students ($n = 76$) towards. One of the aims of the study was to define what kind of learning questions ($f = 350$) are

formulated collaboratively in study circles ($f = 19$). In addition, the work enquired as to what kind of learning activities and results does authentic and dialogical collaborative knowledge construction prompt in three superficial and three deep learning-orientated study circles. The case study's data analysis unit was a study circle.

The findings of the study indicated that using authenticity as the basis for a learning process enables each study circle to define questions which are meaningful to them (Shaffer & Resnick, 1999) and produces knowledge about the learners' current competence (Aarnio, 2006). Authenticity in learning was seen through the perspectives defined by Aarnio and Enqvist (2016), in which knowledge is constructed from authentic sources and based on students' current competence. The results further indicated that scaffolding is necessary, especially to create a firm basis for authenticity, so that dialogical collaborative knowledge construction can produce and direct learners towards learning activities that are deep learning orientated, such as analysing, interpreting, inquiring, comparing, evaluating, producing, and creating (see also Anderson et al., 2001). It should be noted that the authentic learning questions defined at the beginning of the process mainly directed the learners towards superficial learning-orientated activities, which can be considered as a natural outcome when the topic is new to the learner. However, in the study circles which mainly created superficial learning questions, the results indicated that dialogical collaborative knowledge construction still directed the learners towards deep learning during the process, and as stated by Paavola et al. (2002), learning changes and becomes enriched during the process. This tendency was further reinforced by the number of questions which helped learners direct themselves towards deep learning activities. The results are consistent with the results of previous studies (Blumenfeld et al., 1991; Eklund et al., 2011; Muukkonen et al., 2011) that suggest that solving complex open inquiries and constructing shared artefacts demonstrates an achievement of deep learning. The study did not focus on the role of digital environments, although open learning environments were used and are typical of a learning process based on the DIANA model (Aarnio & Enqvist, 2016).

The results crystallised the need and requirement for individual learning spaces. In practice, this means familiarising oneself with the involved theory and the topic to be studied in advance. The findings are supported by the three metaphors of learning: learning as individual knowledge acquisition, as participation in dialogue in a community (Sfard, 1998) and as knowledge creation (Paavola et al., 2002). This study drew up understanding of deep learning process; it deepens through dialogue and through participation in a community, and knowledge is constructed collaboratively in digital learning environments. The study concluded that the central elements of deep learning are a learning community which has committed to a common goal, an authentic starting point for learning, and dialogical skills and knowledge which enable collaborative knowledge construction. As a part of this

sub-study, a framework for evaluating deep and superficial learning was created and introduced. This was redesigned specifically for this study but will help others to examine learning activities in the future from a practical viewpoint.

The study's main limitation was the researchers' roles and their potential impact on the research (see Yin, 2009). As the first author of this study, I was involved in designing and implementing the module, as well as conducting the data analysis. The second author was one of the developers of the original DIANA model which may have led to a deeper understanding of the concepts involved. These positions helped the teacher–researcher shape assumptions about the process. One limitation was that qualitative data were gathered from study circle blog entries, in which processes were not documented in full. Thus, it is possible that meaningful element were missed. The trustworthiness of the study could be enhanced if abductively analysed data were read by participants.

Concerning the process of defining the authentic learning questions which direct learning, the reliability of the study would have been enhanced with teacher scaffolding concerning the number of questions and how they could be categorised by themes. The study module's content was extensive, high goals were set, and the majority of the student teachers studied alongside their work. The data were gathered from implementation groups taught by two teacher educators, which means the teaching varied between groups. According to the principles of the DIANA model, teaching ought to involve dialogical scaffolding. In this respect, the data were insufficient as the material gathered from the blogs did not include coverage of this aspect. Instead, scaffolding and dialogical collaborative knowledge construction took place in many different digital and online learning environments.

The study suggests several practical implications which will strengthen future implications when the goal is achieve deep learning and the learning design is based on the DIANA model.

However, this study indicates that deep learning activities in authentic and collaborative knowledge construction offer a promising approach for developing learning processes in vocational teacher education. In addition, the evaluation framework for deep learning activities featured in the study creates a basis for re-designing the curriculum of teacher education, as well as module learning objectives and learning processes, and the way I evaluate deep learning activities. As a conclusion, it can be seen that authentic and dialogical collaborative knowledge construction engages student teachers in the development of deep learning competences that enhance their own vocational teaching.

6 Results: Redesigning the Pedagogical Model and Deep Learning Evaluation Framework through Theories and Studies

The aim of this chapter is to amalgamate theoretical insights concerning sociocultural learning, the diverse digital environments and the empirical studies undertaken as part of the dissertation regarding redesigning a pedagogical model. Teaching and learning are undergoing significant changes. The world has become more socially connected, and accessible technology offers new opportunities for the design of learning processes. Against this backdrop, the role of vocational teacher education has never been so demanding, and in future, vocational teachers must be qualified and agile users of pedagogically meaningful models, and able to seamlessly integrate new and diverse digital environments into their learning processes.

This study indicates that deep learning activities in authentic and dialogical collaborative knowledge construction offer a promising approach for developing learning processes in vocational teacher education. The redesigned, more pragmatic evaluation framework for deep learning activities may form a foundation for renewing the curriculum of teacher education, as well as the learning objectives and learning processes of modules, and the evaluation of deep learning outcomes.

6.1 Dialogical, Digital, and Deep Learning Activity

Too often, we assume that learning is a social process, but how often do we pause to reflect on how we support the formation of dialogical collaborative knowledge construction, especially in diverse digital environments, and which leans towards deep learning? I approached the pedagogical model redesign through three learning metaphors: learning as individual knowledge acquisition, learning as participation in dialogue in a community (Sfard, 1998) and learning as knowledge creation and construction (Paavola et al., 2002). A well-structured learning process creates the basis for students to work in their zone of proximal development (ZPD) (see e.g. Vygotsky, 1978; Wenger, 1998). Sub-studies II, III and previous research (Aarnio, 2015; Enqvist & Aarnio, 2004) have shown that there is a need for improvement in dialogical participation to achieve deep learning. Overall, the missing competence of dialogue has been the main reason for unsuccessful DIANA learning processes. One of the goals of this study was to explicitly identify additional elements of the DIANA model used in these processes to scaffold deep learning and to redesign a more accurate pedagogical model. Figure 7 describes in detail explicitly both identified and changed elements.

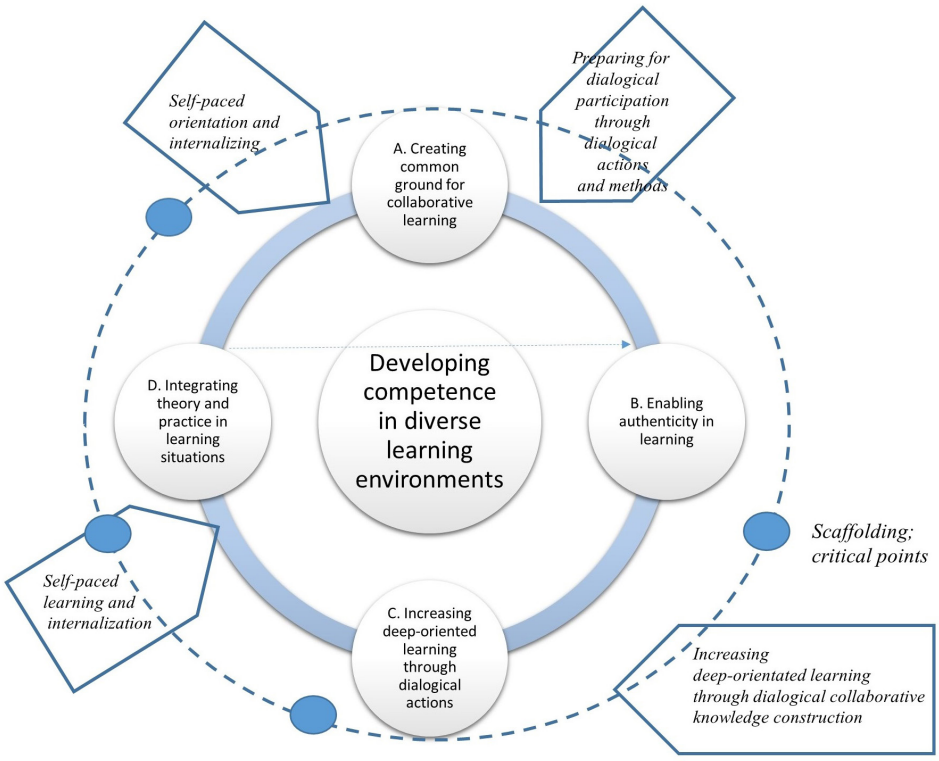


Figure 7. Explicitly identified additional elements of the DIANA model needed to scaffold deep learning.

One of the main outcomes was an improved understanding of *self-paced learning* as an important part of authentic and dialogical collaborative knowledge construction, in the beginning and throughout the learning process when looking to achieve deep learning.It supports knowledge acquisition as an individual activity (Sfard, 1998). Individual learning is scaffolded, and each student is able to proceed on her or his own actual development level (ADL). Thus, students have the freedom to learn from their own ZPD. The significance of others in the process of scaffolded individualisation is highlighted within the concept of commognitive development (Ben-Zvi & Sfard, 2007), and a unique form of thinking develops when a student turns discourse-for-others into a discourse-for-oneself. Self-paced learning is implicitly included in the DIANA model, but it is not featured prominently enough. According to the findings of this dissertation, student teachers' learning in teacher education is dependent on collaborative knowledge construction. Individually worked-out contributions are minimal, and dialogical collaboration is missing. This forms the reason for including self-paced learning as a part of the learning process. A blended learning approach will combine the student own pace with a process of

collaborative knowledge construction. The results indicate that self-paced phases are necessary to achieve deep learning namely, that it builds a foundation for authenticity in learning, and students are more capable of targeting deep learning achievements when they have familiarised themselves with the underlying theory and the topic to be studied in advance.

As noted earlier in the study, technology is seen as a possibility which enhances collaborative knowledge construction, and learning through dialogue can result in better engagement and collaboratively-shared artefacts (Aarnio & Enqvist, 2016; Enqvist & Aarnio, 2004; Wegerif, 2006). Scaffolding deep learning activities requires a teaching and learning process which involves curriculum restructuring and requires *scaffolding* to be improved through the new possibilities that are afforded by digital environments (Ruhalahti et al., 2016; Ruhalahti et al., 2017; Korhonen et al., 2019).

The foundation of the DDD pedagogical model is based on the DIANA model and scripts the learning process into six phases (Aarnio & Enqvist, 2016; Figure 8). These phases can help the teacher structure the learning process in digital environments. In the DDD model, critical points for scaffolding activities are explicitly detailed. However, it is not simply enough to increase the use of diverse digital environments. Careful consideration needs to be given as to what kind of pedagogical choices and communicative competences are required to create deep learning in the students' competence and personal development and in the teacher's professional growth. The developed DDD model combines the theoretical framework with previous study findings, and all of the sub-study results which are presented here. Key strengths of the presented pedagogical model are as follows. First, it strengthens the knowledge-acquisition metaphor throughout the learning process by adding a self-paced phase (Sfard, 1998). According to literature, self-paced learning can be seen as individual, self-paced online learning but also as a collaborative learning process with peers (Tullis & Benjamin, 2011). Second, it increases knowledge among students by allowing them to work within their ZPDs more consciously, especially on their ADL. Third, by following the participation metaphor (Sfard, 1998), it integrates dialogical methods (Aarnio, 2012) more transparently and explicitly into the beginning of the learning process. Fourth, it strengthens the artefacts that mediate dialogical collaborative knowledge construction within cultural settings (see Aarnio & Enqvist, 2016; Paavola & Hakkarainen, 2005). Fifth, it highlights important elements of and critical places for scaffolding activities as part of learning design. Sixth, it utilises agile digital environments during the blended learning process, and finally, it provides scaffolding throughout the learning process that promotes deep learning activities.

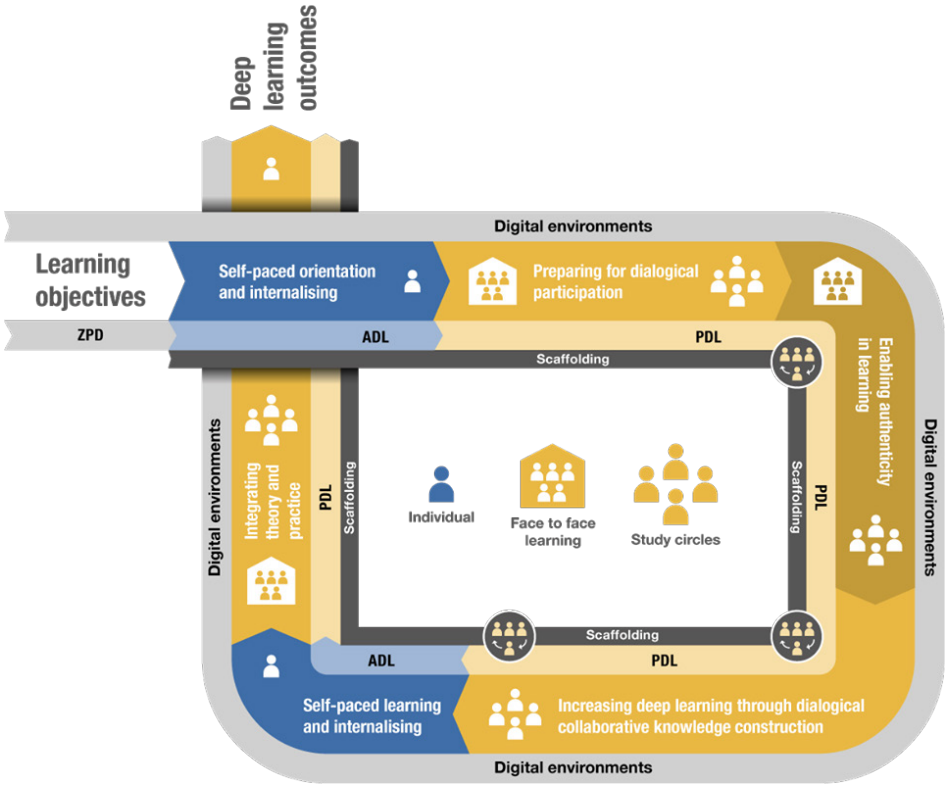


Figure 8. The DDD pedagogical model.

As Figure 8 shows, the DDD pedagogical model conforms to the idea that the learning process forms a looped cycle. During the case studies, various qualitative data were collected preparatory to redesigning the pedagogical model. In the following paragraphs, I present the main phases of the DDD pedagogical model in more detail.

Self-paced orientation and internalising: The learning process starts with a self-paced, individual orientation phase and students work on their actual development level (ADL). Students will have an individual learning assignment to accomplish. The assignment includes supplied theoretical sources (e.g. video and online materials). The self-paced individual assignment has three aims: to scaffold student teachers in their orientation to the learning themes through provided materials, to help in a reflection on their own experiences, and to add internalising (Palincsar, 1998) according to the study module's learning objectives (Ruhalahti & Aarnio, 2018). It has become obvious that self-paced, individual knowledge acquisition is a crucial element of achieving deep learning. Self-paced learning outside of the classroom means freedom for the student to start and complete learning assignments in their own time (Sub-study IV).

Preparing for dialogical participation: When proceeding to the students' potential development level (PDL), dialogical actions and methods are integrated into the learning process (see also Wegerif, 2018). Dialogue is seen as a key factor in supporting and encouraging deep learning in a learning community (Aarnio, 2006; Enqvist & Aarnio, 2004; Mercer & Howe, 2012; Ruhalahti et al., 2017; Smith & Colby, 2007). Dialogical collaborative knowledge construction is challenging. The teacher will assemble a variety of potential dialogical methods (Aarnio, 2012) to develop students' dialogical skills and knowledge. For example, increasing awareness of dialogical attitudes in students could exercise methods such as *Symmetrically*, *As equals* and *Reciprocally* and then continuing to make dialogue non-fuzzy though methods such as *Dialogue tickets* and *Word-for-word listening*. These are just examples, and the selection of methods will vary in each situation (sub-studies I, II, and IV). The phase leans on the participation metaphor (Sfard, 1998), in which participation represents the dialogical view.

Enabling authenticity in learning: Students create authentic learning questions individually and collaboratively from the study module's learning objectives. Authentic questions allow students to integrate their competence development with real-life contexts and personal experiences, which promotes engagement and responsibility. The teacher's role is to scaffold the students in their study circles, for example in helping them to find relevant questions and learning themes which cover the learning objectives and steer the students towards deep learning activities (Sub-studies I, II, III, and IV).

Increasing deep-orientated learning through dialogical collaborative knowledge construction: This phase is based on the earlier set of authentic learning questions and depends theoretically on the knowledge creation metaphor (Paavola & Hakkarainen, 2005). The study circles inquire about and construct knowledge online through dialogical actions in diverse digital environments. Dialogical actions and participation are the key elements during this phase, in which students are on the higher level of their PDL. Each study circle designs and constructs an artefact that offered a theoretical and practical combination of the study module's issues. At the beginning of the fourth phase, each study circle has an online scaffolding and feedback session with the teacher. Afterwards, each study circle will write a reflective letter/post to the teacher, detailing how they have implemented their collaborative working and artefact concretely into their working context (Sub-studies I, II, III, and IV).

Self-paced learning and internalisation: During this phase, students work individually to complete an individual learning assignment that supported students' work on their own ADL by internalising constructed knowledge (see Palincsar, 1998). This internalisation phase was important to achieving deep learning outcomes. The type of assignment could vary, from essay to gamification, to achieve deep learning (Sub-study IV).

Integrating theory and practice: This phase integrates theory and practice in learning situations, and each study circle presents their own constructed artefact. The artefacts show an achievement of deep learning when the student presents his or her own contribution of how the theory he or she has gained can be linked to practice. *A dialogical evaluation and reflection* summarise the process in the study circle and help the student to continue his or her own development in his or her specific area. The teacher will evaluate the study circle's resulting shared artefact through the evaluation framework, mirroring it to each study circle's authentic starting point. The evaluation must be in line with authentic evaluation settings (Sub-studies I, II, III, and IV).

The redesigned pedagogical model is demanding and has some limitations. Its deep integration into vocational teacher education requires skilful learning design. First, an understanding of sociocultural learning and the ZPD is necessary (see also Palincsar, 1998). Second, authenticity challenges teachers' own thinking and must be adapted to competence-based learning settings. Dialogical collaborative knowledge construction requires a deep understanding of the model when designing the learning process. Despite these limitations, the model has potential for use in sociocultural-oriented competence-based education both nationally and internationally.

6.2 Design Principles for Developing Dialogical, Digital and Deep Learning

Previous research has indicated that it would be more useful to create design principles (DPs) rather than a fixed pedagogical model (Keskitalo, 2015; Lakkala, Toom, Ilomäki, & Muukkonen, 2015). DPs provide more flexible teaching and learning processes in diverse situations and environments (Keskitalo, 2015); therefore, six main DPs were created to support the initialisation of the DDD pedagogical model. The set of dialogical, digital and deep learning DPs are as follows.

Table 6. Design Principles for Developing Dialogical, Digital and Deep Learning.

Design principles (DPs)	Meaning	Implementation	References
DP1: Supporting the development of dialogical competence in the learning community.	To develop dialogical competence in the learning community and to strengthen the participation and knowledge creation metaphors.	Using a variety of dialogical methods (e.g. increasing awareness of dialogical attitudes). Continuing to follow methods, from making dialogue non-fuzzy to furthering the dialogical moment. The variety of methods will vary in each situation.	Aarnio, 2012; Ben-Zvi & Sfard, 2007; Paavola & Hakkarainen, 2005; Phillipson & Wegerif, 2017; Sfard, 1998; Wegerif, 2018; Wegerif & Major, 2018
DP2: Opening the learning objectives collaboratively on the basis of an authentic learning and deep-learning evaluation framework.	To enable authentic learning settings and to scaffold students toward deep-learning outcomes.	Scaffolding the students in their study circles to find relevant open questions and then creating bigger learning themes that cover the learning objectives and steer the students toward deep-learning activities.	Aarnio, 2006; Fleer & Canhill, 2001; Czerkawski, 2014; Ruhalahti, Aarnio, & Ruokamo, 2018; Tillema, 2006
DP3: Emphasising knowledge acquisition and self-paced learning at students' actual development levels (ADLs).	To learn individually at students' ADLs and to support individual knowledge acquisition and internalisation.	Designing self-paced and internalised learning assignments throughout the learning process (e.g. in the beginning and final stages). The types of assignments can vary from essays to gamification.	Palincsar, 1998; Sfard, 1998; Tullis & Benjamin, 2011; Turkle, 2015; Vygotsky, 1978
DP4: Scaffolding dialogical collaborative knowledge construction.	To scaffold a study circle´s dialogical collaborative knowledge construction at its potential development level (PDL) and to strengthen the participation and knowledge creation metaphors.	Structuring instructional scaffolding to support students' understanding of dialogical collaborative knowledge construction at the community level. Scaffolding study circles in their artefact construction toward deep-learning outcomes and learning in blended learning settings in diverse digital environments.	Aarnio & Enqvist, 2002; Brown & Palincsar, 1989; Lave & Wenger, 1991; Paavola & Hakkarainen, 2005; Rogoloff, 1990
DP5: Providing meaningful, personalised digital environments.	To integrate meaningful, personalised digital environments to support both individual learning activities and those based on learning communities.	The students create both personal digital environments and those based on study circles (e.g. blogs, shared cloud-based folders, mobile applications) for three types of purposes: sharing artefacts, self-paced and internalised learning and dialogical collaborative knowledge construction.	Adams Becker et al., 2017; Rahimi et al., 2012; Wegerif et al., 2017
DP6: Intertwining the deep-learning evaluation framework with the dialogical evaluation process.	To combine the deep-learning evaluation framework with dialogical evaluation.	Dialogically evaluating the learning process at the individual and community levels. Evaluating artefacts through the deep-learning evaluation framework, mirroring it to each study circle's authentic starting point.	Aarnio & Enqvist, 2016; Ruhalahti & Aarnio, 2018; Ruhalahti, Aarnio, & Ruokamo, 2018

DPs describe the features of DDD to promote these concepts theoretically, in pedagogical use and in learning design. The first principle is key to supporting the development of dialogical competence in the learning community because it creates a foundation for dialogical collaborative knowledge construction and fosters community building (Aarnio, 2012; Sfard, 1998; Paavola et al., 2002; Wegerif, 2018). The second design principle enables learning authenticity and scaffolds deep learning outcomes (Aarnio, 2006; Fleer & Canhill, 2001; Czerkawski, 2014; Tillema, 2006). The third principle focuses on designing activities in the students' ZPD throughout the learning process (Tullis & Benjamin, 2011; Vygotsky, 1978), while the fourth principle emphasises scaffolding to support student understanding of knowledge and development of complex competences through cognitive apprenticeships at the individual and community levels (Brown & Palincsar, 1989; Lave & Wenger, 1991 Rogoloff, 1990). The fifth principle takes into account digital environments that should be integrated into the learning process to support learning activities (see also Adams Becker et al., 2017; Rahimi et al., 2012). Finally, the sixth principle stresses the importance of combining the deep learning evaluation framework with dialogical evaluation.

6.3 An Evaluation Framework for Deep Learning Activities in Digital Environments

As a part of the study and as a synthesis of deep learning evaluation, as an adaptation of Bloom's (1956) framework (revised by Anderson et al., 2001, p. 31), I co-created a framework for evaluating deep learning activities (Fig. 9). The redesigned framework uses Bloom's taxonomy as a reference point but diverges from it in applying information that I consider part of the construction of deep-oriented dialogical collaborative knowledge in learning communities. Unlike Bloom, I believe that in the context of vocational teacher education, the level of knowledge application already demonstrates a deep-learning activity. Learners get to apply their understanding of the concepts and practices by using models they have discovered during the course. In practice, it has become evident that student teachers from various fields must proceed from their own cognitive schema to entirely different, new ways of thinking, and applying information as deep-orientated knowledge construction in the various phases of the learning process. In addition, the framework is based on the cognitive knowledge construction approach, which regards knowledge as being formed through one's own interpretations, observations, and constructions (see Ausubel, 1968; Novak & Gowin, 1984, pp. 106–107). The developed framework is also based on principles where students commit to modifying and extending information through understanding, social interaction, and sharing, as well as context dependency. When the learning process specifies higher-order thinking

outcomes, it should be aligned with the learning outcomes, as well as authentic evaluation settings.

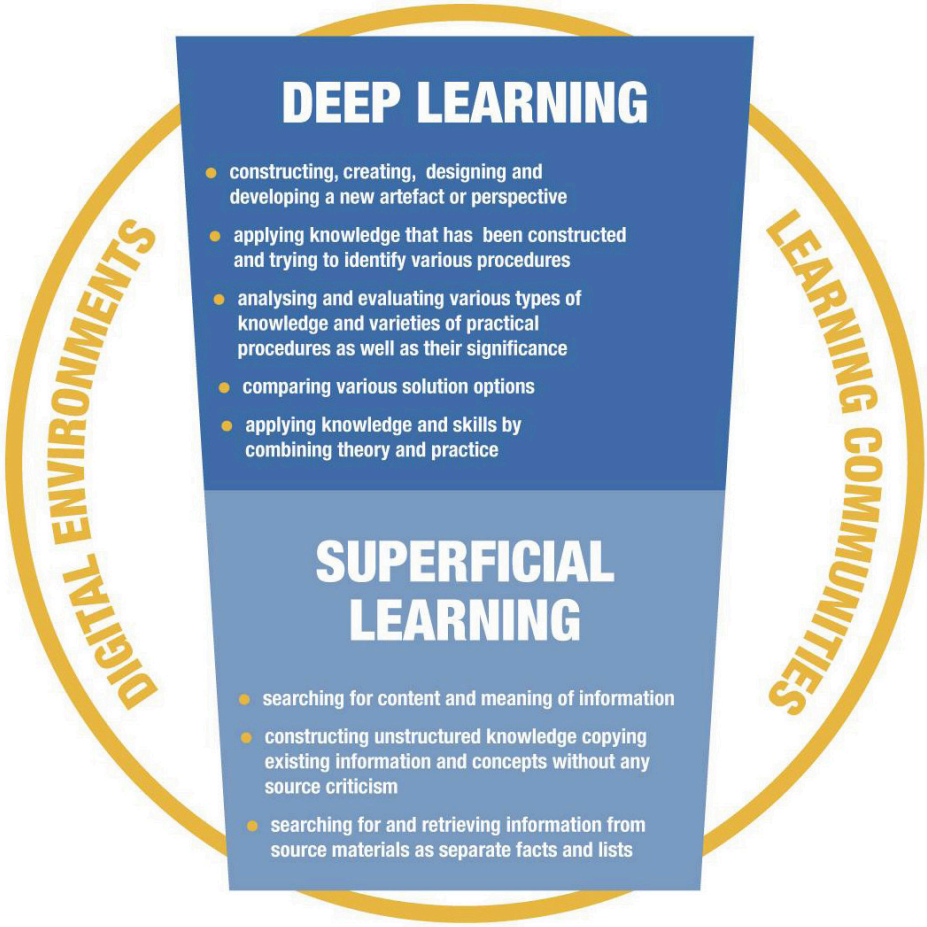


Figure 9. A redesigned evaluation framework for learning outcomes through authentic and dialogical collaborative knowledge construction (Ruhalahti, Aarnio, & Ruokamo, 2018).

The framework describes the nature of learning in pragmatic levels through authentic and dialogical collaborative learning activities of knowledge construction in a learning community (cf. Andersson et al., 2001, p.31; Bloom, 1956). In this framework, superficial learning activities are understood as retrieving separate, already existing, and unstructured knowledge and transferring it to the group's virtual learning environment (Lucas 2001; Marton & Säljö, 1976). Deep learning activities require knowledge to be applied, compared, analysed, and evaluated; procedures are identified and constructed; and new knowledge and skills are

developed (Nelson Laird et al., 2014; Paavola et al., 2002; Schraw et al. 2001). Figure 9 describes collaborative knowledge construction as a deepening learning process and categorises the learning activities in a learning community. The funnel depicts how the activities of collaborative knowledge construction deepen and expand.

When the learning process is based in an authentic setting, evaluations should address the entire process (Herrington et al., 2010, p.1; Shaffer & Resnick, 1999). Authenticity is the construction of meaningful knowledge from authentic settings related to the real world and based on existing competences of the learning community (Aarnio & Enqvist, 2016). When a learning process is based on the DDD model, knowledge is constructed in diverse environments typical of the digital age. This process connects the students, and they construct authentic, dialogical collaborative knowledge by creating something new for themselves in a way that is more transparent. These factors comprehensively scaffold and steer the learner toward deep learning activities.

The practical use of this pragmatic evaluation framework can work in three ways: as a deep-learning design guideline, as a tool included in the DDD model that helps educators to assess deep-learning activities and as a means of steering students to achieve more deep-orientated learning outcomes.

7 General Discussion

In the final chapter of this study, I discuss the main findings and offers an overall evaluation as well as a discussion of the methodical choices employed. I also provide details of the ethical considerations involved. I conclude the study by providing some implications for practice and future research, as well looking towards the future of deep learning through authentic and dialogical collaborative knowledge construction in diverse digital environments.

7.1 Summary of the Research Results

The aim of the present study was to explore what kind of pedagogical model scaffolding of dialogical collaborative knowledge construction in digital environments toward deep learning in vocational teacher education. A more specific aim was the redesign of a pedagogical model that includes additional elements explicitly based on study findings and enhances students' potential to achieve deep learning. Thus, the DDD model combines a theoretical framework with all sub-study findings. To answer the research questions, a critical analysis of my own pedagogical learning design practice as a teacher educator was conducted.

The primary outcome of this study is a redesigned pedagogical model. The findings showed two main elements that influenced the deep learning design: through authentic and dialogical collaborative knowledge construction. The process clearly and structurally integrates a self-paced phase at the beginning of the learning process that creates a foundation for authentic learning and promotes deep learning. To further support students' ADLs, this phase was placed after the intensive dialogical collaborative knowledge construction phase. Then, competences in dialogical participation were improved through the integration of dialogical methods, especially as students became more skilful in constructing knowledge through dialogical means. Additionally, the importance of a student's ZPD, internalisation of skills and knowledge and critical scaffolding activities were implemented to ensure flexibility in the learning process in diverse digital environments. The second outcome was the development of DPs that support the use of the DDD pedagogical model while being flexible for use in DDD in sociocultural-oriented disciplines. Third, in Sub-study IV, an evaluation framework for deep-learning activities in digital environments was redesigned from a more practical viewpoint.

The authentic learning questions defined at the beginning of the process directed learners towards superficial learning activities, which were natural outcomes when the subject topic was new to the learners. In regard to the study circles that completed superficial learning activities, the results indicate that dialogical collaborative knowledge construction directed learners towards deep learning, with agrees with Paavola et al.'s (2002) observation that learning changes and becomes enriched during the learning process. This was further reinforced by questions that helped learners during deep learning activities. These results are consistent with those of previous studies, suggesting that solving complex questions and building artefacts demonstrates deep learning (Blumenfeld et al., 1991; Eklund et al., 2011; Muukkonen et al., 2011). In summary, DDD pedagogical model requires a learning design that facilitates this process and an evaluation framework that provides supportive elements to achieve deep learning outcomes.

Based on the results of the sub-studies, the contribution of diverse digital environments to teacher education is that it responds to the practices of student teachers and present and future students. Using a blog and mobile applications promoted a positive attitude toward ICT use in education (see Goktas & Demirel, 2012). Agile, mobile-based learning is in line with current vocational education practices, which capitalise on collaboration and networking beyond organisational boundaries (Ruhalahti & Kentta, 2017). The results showed that as part of a blended learning setting, blogging and mobile applications brought new, enriching and empowering aspects to collaborative knowledge construction (see also Bassani & Barbosa, 2018; Wheeler, 2015; Özkan & McKenzie, 2008). The teacher's open blog as a central hub was clearly seen as a supportive, inclusive element in the students' learning and scaffolding. The results also indicate that teachers' comments on the study circle's blogs were the most useful way to advance and scaffold collaborative knowledge construction. In sum, the use of diverse digital environments served as an example of how to use a blog and mobile applications as a teaching tool. However, compared to the mOOC implementation in the Canvas, it must be noted that the open online environment was neither easy to use nor well organised. Thus, to provide an appropriate learning environment, a platform that supports dialogical collaborative knowledge construction ought to be used.

7.2 Methodological Considerations

All of the sub-studies were qualitative, which provided a deeper understanding of the phenomena and issues related to the main aims of the study. The detailed methodological limitations of each sub-study have been provided in Chapter 5. The study´s trustworthiness was evaluated based on four criteria: credibility, transferability, dependability and conformability (Guba & Lincoln, 1994).

According to Lodico et al. (2006), qualitative research provides an in-depth understanding of a limited setting, group or individual, and it is often employed in educational research. When considering the study's credibility, a degree of sensitivity and objectivity was maintained during data interpretation through the use of multiple sources to ensure a broad understanding of the phenomenon of interest from the participants' perspective. The time spent observing and analysing the data increased study credibility, but the use of an external analyst was most beneficial. The study describes the research settings consistently and in detail, which increases transferability of the findings and allows readers to decide whether similar processes are suitable for application in their own educational field or culture (Guba & Lincoln, 1994; Lodico et al., 2006). To improve dependability, the analysis was reviewed by two researchers and triangulated to ensure consistent results. Data collection and analysis processes were also described in detail and strengthened during Sub-studies II–IV by implementing a teacher–researcher reflective diary. To enhance conformability, data-checking procedures were documented, and for all sub-studies at least two researchers analysed and interpreted the data.

Close co-operation with another researcher during the collection and analysis of data ensured the objectivity and validity of the study, and various qualitative methods, the use of many data sources and researcher triangulation provided a better understanding of the phenomenon. Each sub-study has been evaluated using iterative processes, and the feedback received in each cycle was implemented to improve the overall study and deepen the researcher's own understanding. In qualitative research, the researcher assumes an active role, and as Brinkmann (2007) argued, the key characteristic for a qualitative researcher's objectivity is the ability to let the object of study show its nature and steer interpretations. In this study, my position as a teacher educator and researcher posed certain objectivity challenges, although was considered during all of the research stages, and potential objectivity bias was limited by ensuring collaboration with co-authors and supervisors. Trustworthiness was ensured by using participants to confirm written interpretations and by implementing a reflective research diary to develop dual role awareness. The teacher–researcher role is useful for achieving professional development and improving both teaching and learning practices (Xerri, 2018). Moreover, research conducted by teachers in their own teaching contexts allow them to better understand their practices. Despite the limitations of the study, it broadened my understanding of DDD, and most importantly, it resulted in the redesign of a pedagogical model, DPs and an evaluation framework to support sociocultural-oriented teachers. All sub-studies were assessed multiple times and constructive reviews were developed, which also aided the researcher's understanding.

7.3 Ethical Considerations

The study was conducted according to the Finnish Advisory Board on Research Integrity's (2012) guidelines for educational research. The research followed principles which have been endorsed by the research community, namely, integrity, meticulousness and accuracy in conducting research and in recording, presenting, and evaluating the research results. In all of the studies, the data were gathered by the two authors who were familiar with the student teachers involved and who participated and were well-immersed in the study setting as long-standing members of staff. As the Finnish Advisory Board on Research Integrity (2012) has further guidelines, the research follows the research community's principles throughout the process and used methods which are ethically sustainable, respect other researchers' work, and have research permits and agreements with all parties.

HAMK, as a research organisation, adheres to good administrative practices and takes into account data protection legislation. Data collection was conducted in keeping with ethical principles and stored on a secure server, and only the authors of the current study had access to the data files. Study participants were informed of how their data would be used and that their participation was entirely voluntary (see the individually published works for details). Ethical considerations were negotiated with vocational student teachers, and they had the right to withdraw from the study at any stage without prejudice. The study was integrated into their curricula at the appropriate stage of their teacher education. The anonymity of all individuals participating in the research was ensured and explained on the administrated questionnaires. All communication related to the study was conducted with honesty and transparency.

This study has inspired me to integrate research with work as a teacher educator because ethical considerations should be part of all methodological decisions. The research process has provided an opportunity to reflect on personal work and recognise personal objectivity, which has strengthened the researcher's competence in supporting a research-engaged vocational teacher education organisation and the teacher educators' learning community.

7.4 Implications and Future Research

The study presents a variety of implications for educational learning design practice in vocational teacher education. However, these implications may be adopted on all educational levels to develop deep learning activities in diverse digital environments. Although the study was conducted in a Finnish context, the results can be localised to Finland and to digitally developed and sociocultural-oriented countries. The DDD pedagogical model and DPs may help teacher educators design learning that

results in deep learning outcomes, and the application of this model is defined by its teaching and learning culture. Deep learning outcomes vary between disciplines, which may influence the application of the DDD pedagogical model as well (Nelson Laird et al., 2008). This pedagogical model can be transferred to various disciplines, especially those with a sociocultural theory orientation.

A dialogical learning community is crucial for achieving deep learning in a digital environment. The learning community must be committed to a shared goal, an authentic starting point for learning and the construction of dialogically collaborative knowledge. The community, through the skills, knowledge and responsibility of its members, must aim to achieve this shared goal (Lave & Wenger, 1991; Wenger, 2009). The results of this study indicate that a sense of community is crucial for creating shared deep learning activities. One of the study implications suggests that *dialogical competences* ought to be integrated more deeply into the processes of teacher education (Aarnio, 1999; Ruhalahti et al., 2016; Ruhalahti et al., 2017; Ruhalahti et al., 2018) to ensure acquisition of deeply oriented skills rather than disconnected add-on elements, and such competences should be principle among teachers. Furthermore, dialogue is seen as a crucial element in promoting global dialogue through educational technologies (Wegerif, 2018) to foster the soft skills needed for the future. According to Wegerif and Major (2018), in a more digitalised world, dialogue and dialogic space are seen as mediating tools to help understand what it means to be human.

A learning design based on authentic and dialogical collaborative knowledge construction should be created to prevent students from simply transferring and copying information to a digital environment. The use of digital environments (e.g. blogs with better solutions and more applications) to support dialogical collaborative knowledge construction needs to be considered.

Authentic learning settings are also important but requires more effort than standard lectures. However, learners should be given opportunities to construct meaningful knowledge from authentic settings related to the real world and based on existing competences. Thus, learning assignments should be formulated in a manner that aids deep learning activities, and the learning process should be clearly structured (i.e., one theme per study week). In addition, the learning goals in vocational teacher education ought to be reconsidered to include study modules that scaffold deep learning. The evaluation framework for deep learning activities offers structure for redesigning curricula for vocational teacher education and study module learning objectives and learning processes.

Deep learning activities are reinforced by a *self-paced phase*, during which each student familiarises himself or herself with the topic (Paavola et al., 2004; Sfard, 1998; Turkle, 2015, p. 61). This particular phase lays a foundation for students to generate authentic learning questions individually and within a learning community and directs students towards deep learning. It has become obvious that vocational

student teachers from various professional fields must proceed from their substantial cognitive schema towards new pedagogical thinking about learning and teaching. Resources should be assigned to give it at various stages of the process. Therefore, including self-paced phases in the learning process supports students in achieving deep learning outcomes. Strengthen *scaffolding activities* at various stages of the process. Real-time online scaffolding sessions should be structured into the process as dialogical collaborative knowledge construction sessions, during which each student shares his or her knowledge with others. A teacher's presence and scaffolding are necessary components of the various phases of the learning process.

In *future studies*, it would be interesting to investigate how DPs support DDD practices in vocational and higher education and in the context of global teacher education. Although the present study continued the work of previous researchers (Aarnio, 2006; Aarnio & Enqvist, 2002, 2007, 2016), more research on how to achieve deep learning through authentic and dialogical collaborative knowledge construction is needed. Thus, the results and implications of this study should be explored further and the individual motivational factors of students to achieve active deep learning outcomes should be investigated.

To conclude, the study indicates that deep learning activities in authentic and dialogical collaborative knowledge construction offer a promising approach to developing learning processes for vocational teacher education, especially in the digital context. The study produced new knowledge about scaffolding deep learning in vocational teacher education in both Finland and internationally. The study summarises Finnish insights of vocational and teacher education expertise, and the result strengthen the on-going Teacher Education Development Programme, which emphasises teachers' competences development throughout their careers (Ministry of Education and Culture, 2017b) and supports vocational teachers' digital competence development (Koramo, Brauer, & Jauhola, 2018; Ruhalahti & Kenttä, 2017). When considering HAMK SPTE's teacher education development activities, this study has a strong connection to curricula redesign and further education for vocational teachers. Vocational student teachers ought to gain positive experiences in dialogical collaborative knowledge construction, which requires deep learning in digital environments. In this way, expertise on designing learning processes will expand to answer the complex competence demands of vocational education and today's working world.

"One of my signature strengths is the love of learning, and by teaching, I have built it into the fabric of my life. I try to do some of it every day." (Seligman, 2002, p. 4)

References

Aaltio, I., & Heilmann, P. (2010). Case study as a methodological approach: From locality to understanding the essence. In A. J. Mills, G. Durepos, & E. Wiebe (Eds.), *Encyclopedia of case study research* (pp. 66–76). Thousand Oaks, CA: Sage.

Aarnio, H. (1999). *Dialogia etsimässä: Opettajaopiskelijoiden dialogin kehittyminen tieto- ja viestintäteknistä ympäristöä varten* [In search of dialogue: Developing dialogue for communication and information technological environment] (Doctoral dissertation). University of Tampere, Tampere, Finland.

Aarnio, H. (2006). *Oppijalähtöisyyttä ja yhteisöllisyyttä tietoverkkoja ja verkostoja hyödyntävään oppimiseen: Tutkimustuloksia DIANA-klinikalta* [Enhancing learner-centredness and collaboration in learning online and in networks: Results from a DIANA clinic]. Saarijärvi, Finland: Saarijärven Offset.

Aarnio, H. (2012). *Dialogical methods*. Retrieved October 26, 2017, from http://www3.hamk.fi/dialogi/diale/index_eng.htmlhttp://www3.hamk.fi/dialogi/diale/methods/

Aarnio, M. (2015). *Collaborative knowledge construction in the context of problem-based learning: Exploring learning from conflicting ideas and knowledge* (Doctoral dissertation). University of Helsinki, Helsinki, Finland.

Aarnio, H., & Enqvist, J. (2001). *Dialoginen oppiminen verkossa: DIANA-malli ammatillisen osaamisen rakentamiseen* [Dialogic learning on the net: DIANA model for the construction of professional competence]. Helsinki, Finland: Hakapaino.

Aarnio, H., & Enqvist, J. (2002). DIANA-toimintamallin soveltaminen ja kehittäminen [Development and application of the DIANA model]. In H. Aarnio, J. Enqvist, & M. Helenius (Eds.), *Verkkopedagogiikan kehittäminen ammatillisessa koulutuksessa ja työssäoppimisessa: DIANA-toimintamalli* [Developing net pedagogy for vocational education and for on-the-job learning: The DIANA model] (pp. 5–272). Helsinki, Finland: Hakapaino.

Aarnio, H., & Enqvist, J. (2007a). "Koulunpitoa" verkossa: Oppijakeskeisen ja yhteisöllisen verkko-oppimisprosessin strukturointi ["Schooling" on the net: Structuring of the learner-centred and collaborative online learning process]. *Ammattikasvatuksen aikakauskirja, 9*(2), 5–14.

Aarnio, H., & Enqvist, J. (2007b). Miten virtuaaliympäristöissä tapahtuvassa opettajan-koulutuksessa rakennetaan ammatillisen opettajan asiantuntijuutta? [How does teacher education in virtual environments develop a professional teacher's expertise?]. In S. Saari & T. Varis (Eds.), *Professional growth* (pp. 145–164). Keuruu, Finland: Otava kirjapaino.

Aarnio, H., & Enqvist, J. (2016). Diana-mallistako kehys digiajan oppimiselle [DIANA model: A framework for learning in the digital age?]. *Ammattikasvatuksen aikakauskirja, 18*(3), 39–48.

Aarnio, H., Enqvist, J., Sukuvaara, T., Kekki, M., & Kokkonen, M. (2008). *Dialogilla syvätehoa oppimiseen web-palvelu* [Deep learning through dialogue web-service]. Retrieved November 8, 2017, from http://www3.hamk.fi/dialogi/

Adams Becker, S., Cummins, M., Davis, A., Freeman, A., Hall Giesinger, C., & Ananthanarayanan, V. (2017). *NMC horizon report: 2017 Higher education edition*. Austin, TX: The New Media Consortium.

Al-Emran, M., Elsherif, H., & Shaalan, K. (2016). Investigating attitudes towards the use of mobile learning in higher education. *Computers in Human Behavior, 56*(C), 93–102.

Anderson, L. W. (Ed.), Krathwohl, D. R. (Ed.), Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., . . . Wittrock, M. C. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. New York, NY: Longman.

Archambault, L., & Kennedy, K. (2014). Teacher preparation for K-12 online and blended learning. In R.E. Ferdig & K. Kennedy (Eds.), *Handbook of research on K-12 online learning* (pp. 225–244). Pittsburgh, PA: ETC Press.

Asghar, M. (2016). Staff and student experiences of dialogue days, a student engagement activity. *Innovations in Education and Teaching International, 53*(4), 435–444.

Attwell, G. (2007). Personal learning environments: The future of learning? *eLearning Papers, 2*(1), 1–7.

Ausubel, D. P. (1968). *Educational psychology. A cognitive view*. New York, NY: Holt, Rinehart and Winston.

Bachmair, B., & Pachler, N. (2015). Sustainability for innovative education: The case of mobile learning. *Journal of Interactive Media in Education, 1*(17), 1–12.

Bakhtin, M.M. (1986). *Speech genres and other late essays*. Austin, TX: University of Texas Press.

Barab, S., & Squire, K. (2004). Design-based research: Putting a stake in the ground. *The Journal of the Learning Sciences, 13*(1), 1–14.

Barkley, E., Major, C. H., & Cross, K. P. (2014). *Collaborative learning techniques: A handbook for college faculty*. San Francisco, CA: Jossey-Bass.

Bassani, P., & Barbosa, D. (2014). *Experiences with the use of personal learning environments in school settings: Mobility and Web 2.0 in the final grades of elementary education.* Paper presented at the PLE Conference Tallinn, Estonia. Retrieved April, 1, 2017, from http://pleconf.org/2014/files/2014/06/paper-10.pdf

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report, 13*(4), 544–559.

Ben-Zvi, D., & Sfard, A. (2007). Ariadne's string, Daedalus' wings, and the learner's autonomy. Éducation *et Didactique*, *1*(3), 117–134.

Bereiter, C. (2002). *Education and mind in the knowledge age*. Mahwah, NJ: Erlbaum.

Biggs, J. B. (1987). *Student Approaches to Learning and Studying*. Melbourne, Australia: Australian Council for Educational Research.

Biggs, J. B. (1992). Modes of learning, forms of knowing, and ways of schooling. In A. Demetriou, M. Shayer, & A. Efklides (Eds.), *Neo-Piagetian theories of cognitive development: Implications and applications for education* (pp. 31–51). London, UK: Routledge.

Biggs, J.B., & Collis, K. (1982). *Evaluating the quality of learning: The SOLO taxonomy*. New York, NY: Academic Press.

Biggs, J. B., & Moore, P. (1993). The process of learning. New York, NY: Prentice Hall.

Biggs, J. B., & Tang, C. (2011). *Teaching for quality for learning at university*. New York, NY: Open University Press.

Bloom, B. S. (1956). *Taxonomy of educational objectives. Handbook I: The cognitive domain.* New York, NY: McKay.

Blumenfeld, P., Soloway, E., Marx, R., Krajcik J., Guzdial, M., & Palincsar, A.S. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist, 26*(3&4), 369–398.

Bohm, D. (2004). *On dialogue*. London, UK: Routledge.

Bound, H. (2010). Developing online dialogue: Dialogical inquiry. *International Journal of Teaching and Learning in Higher Education, 22*(2), 107–119.

Brinkmann, S. (2007). The good qualitative researcher. *Qualitative Research in Psychology, 4*(1&2), 127–144.

Brookhart, S. (2010). *How to assess higher-order thinking skills in your classroom*. Alexandria, VA: ASCD.

Brown, A. L., & Palincsar, A. S. (1989). Guided, cooperative learning and individual knowledge acquisition. In L. B. Resnick (Ed.), Knowing, learning, and instruction: Essays in honor of Robert Glaser (pp. 393–451). Hillsdale, NJ: Erlbaum.

Brush, T., & Saye, J. (2014). Guest Editors' Introduction: Special Issue on Technology-Supported Problem-Based Learning in Teacher Education. *Interdisciplinary Journal of Problem-Based Learning, 8*(1), 39–50.

Burbules, N. C. (1993). *Dialogue in teaching: Theory and practice.* New York, NY: Teachers College Press.

Byman, A., Järvelä, S., & Häkkinen, P. (2005). What is reciprocal understanding in virtual interaction? *Instructional Science, 33*(2), 121–136.

Chapman, C., Ramondt, L., & Smiley, G. (2005). Strong community, deep learning: Exploring the link. *Innovations in Education and Teaching International, 42*(3), 217–230.

Chevalier, J. M., & Buckles, D. J. (2013). *Participatory action research. Theory and methods for engaged inquiry*. Abingdon, UK: Routledge.

Cho, M.-H., & Rathbun, G. (2013). Implementing teacher-centred online teacher professional development (oTPD) programme in higher education: A case study. *Innovations in Education and Teaching International, 50*(2), 144–156.

Christensen, R., & Knezek, G. (2017). Validating a mobile learning readiness survey: Assessing teachers' dispositions toward adoption. *Journal of Digital Learning in Teacher Education, 33*(4), 148–159.

Cobb, P., Confrey, J., diSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher, 32*(1), 9–13.

Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior, 11,* 671–684.

Cramp, A., Lamond, C., Coleyshaw, L., & Beck, S. (2015). Empowering or disabling? Emotional reactions to assessment amongst part-time adult students. *Teaching in Higher Education, 17*(5), 509–521.

Creswell, J. W. (2013). Qualitative inquiry and research design: Choosing among five approaches. Thousand Oaks, CA: Sage.

Crowley, K. (2016). Design-based research and design-based implementation research. Retrieved March 30, 2018, from http://www.informalscience.org/news-views/design-based-research-and-design-based-implementation-research

Czerkawski, B. (2014). Designing deeper learning experiences for online instruction. *Journal of Interactive Online Learning*, *13*(2), 29–40.

Dalziel, J. (2016). *Learning design: Conceptualizing a framework for teaching and learning online*. New York, NY: Routledge.

Daniel, J. S. (2012). *Making sense of MOOCs: Musings in a maze of myth, paradox and possibility*. Retrieved November 23, 2017, from https://linc.mit.edu/linc2013/proceedings/Plenary-Presentations/Daniel.pdf

Deng, L., & Yuen, A. (2011). Towards a framework for educational affordances of blogs. *Computers & Education, 56*, 441–451.

Dillenbourg, P. (1999). What do you mean by collaborative learning? In P. Dillenbourg (Ed.), *Collaborative learning: Cognitive and computational approaches* (pp. 1–19). Oxford, England: Elsevier.

Dillenbourg, P. (2002). Over-scripting CSCL: The risks of blending collaborative learning with instructional design. In P. A. Kirschner (Ed.), *Three worlds of CSCL. Can we support CSCL* (pp. 61–91). Heerlen, Netherlands: Open Universiteit Nederland.

Dillenbourg, P., & Fischer, F. (2007). Basics of Computer-Supported Collaborative Learning. *Zeitschrift für Berufs- und Wirtschaftspädagogik, 21*, 111–130.

Donato, R. (1994). Collective scaffolding in second language learning. In J. P. Lantolf & G. Appel (Eds.), *Vygotskian approaches to second language research* (pp. 33–56). Norwood, UK: Albex.

Downes, S. (2012). *Connectivism and connective knowledge. Essays on meaning and learning networks*. Retrieved August 23, 2017, from https://pdfs.semanticscholar.org/4718/ee3c1930820e094552f0933cbc3b86548dbc.pdf

Doyle, W. (2000). *Authenticity*. New Orleans, LA: AERA.

Dueñas, F. A. (2013). Incorporating critical pedagogy in the EFL classroom. *Enletawa Journal, 6*, 83–94.

Eklund, A.-C., Mäkitalo, Å., & Säljö, R. (2011). Noticing the past to manage the future: On the organization of shared knowing in IT-support practices. In S. Ludvigsen, A. Lund, I. Rasmussen, & R. Säljö (Eds.), *Learning across sites: New tools, infrastructures and practices* (pp. 122–137). Abingdon, UK: Routledge & EARLI.

Elo, S., Kääriäinen, M., Kanste, O., Pölkki, T., Utriainen, K., & Kyngäs, H. (2014). Qualitative content analysis: A focus on trustworthiness. *SAGE Open, 4*(1), 1–10.

Engeström, Y., & Toiviainen, H. (2011). Co-configurational design of learning instrumentalities: An activity-theoretical perspective. In S. R. Ludvigsen, A. Lund, I. Rasmussen, & R. Säljö (Eds.), *Learning across sites: New tools, infrastructures and practices* (pp. 33–52). Abingdon, UK: Routledge & EARLI.

Enqvist, J. (1999). *Oppimisen intoa verkkotyöskentelyssä: Opettajaopiskelijoiden verkkotyöskentelyn kehittyminen ammatillisessa opettajankoulutuksessa* [Passion for learning in internet environment: Developing net competence in vocational pre-service teacher education] (Doctoral dissertation). University of Tampere, Tampere, Finland.

Enqvist, J., &. Aarnio, H. (2003). DIANA model- dialogical authentic learning on the net.DIANA model - Dialogical authentic learning on the net. In *Proceedings of ED-MEDIA 2003*, *World Conference on Educational Multimedia, Hypermedia & Telecommunications* (pp. 2090–2095). Honolulu, HI: Association for the Advancement of Computing in Education.

Enqvist, J., & Aarnio, H. (2004). Crucial dialogic actions in co-constructive knowledge creation in online learning environment. In L. Cantoni & C. McLoughlin (Eds.), *Proceedings of ED-MEDIA 2004, World Conference on Educational Multimedia, Hypermedia & Telecommunications* (pp. 2576–2583). Chesapeake, VA: Association for the Advancement of Computing in Education.

Entwistle, N. J., & Ramsden, P. (1983). *Understanding Student Learning*. London, UK: Croom Helm.

Finnish Advisory Board on Research Integrity. (2012). *Responsible conduct of research and procedures for handling allegations of misconduct in Finland*. Retrieved September 20, 2017, from http://www.tenk.fi/sites/tenk.fi/files/HTK_ohje_2012.pdf

Fishman, B., Cheng, B., & Penuel, W. (2014). CIRCL Primer: Design-based implementation research. *CIRCL Primer Series*. Retrieved March 30, 2018, from http://circlcenter.org/dbir/

Fishman, B., Penuel, W., Allen, A.-R., Cheng, B., & Sabelli, N. (2013). Design-based implementation research: An emerging mode for transforming the relationship of research and practice. In J. Fishman, B. Penuel, A.-R. Allen, & B. Cheng (Eds.), *Design-based implementation research: Theories, methods and exemplars* (pp. 136–156). New York, NY: National Society for Study of Education.

Fitzpatrick, J. L., Sanders, J. L., & Worthen, B. R. (2016). *Program evaluation: Alternative approaches and practical guidelines.* Boston, MA: Pearson.

Fixsen, D. L., Naoom, S. F., Blase, K. A., Friedman, R. M., & Wallace, F. (2005). *Implementation research: A synthesis of the literature*. Tampa, FL: The National Implementation Research Network.

Fleer, M., & Cahill, A. (2001). I want to know...? Learning about science. *Australian Early Childhood Association Research in Practice Series, 8*(1), 2–16.

Foulger, T. S., Waker, M. L., Burke, D., Hansen, R., Williams, M. K., & Slykhuis, D. A. (2013). Innovators in teacher education. *Journal of Digital Learning in Teacher Education, 30*(1), 21–29.

Fredriks, J. A. (2014). *Classroom insight educational psychology: Eight myths of student disengagement: Creating classrooms of deep learning.* Thousand Oaks, CA: Corvin.

Freire, P. (2001). *Pedagogy of the oppressed.* New York, NY: Continuum.

Garrison, D. R., & Cleveland-Innes, M. (2005). Facilitating cognitive presence in online learning: Interaction is not enough. *American Journal of Distance Education, 19*(3), 133–148.

Geer, R., White, B., Zeegers, Y., Au, W., & Barnes, A. (2017). Emerging pedagogies for the use of iPads in schools. *British Journal of Educational Technology, 48*(2), 490–498.

Gibson, D. (2013). Assessing deeper learning in open online learning communities. In R. McBride & M. Searson (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2013* (pp. 459–465). Chesapeake, VA: Association for the Advancement of Computing in Education.

Glahn, C. (2016). Challenges and barriers for mobile learning in security and defence organisations. In J. Traxler & A. Kukulska-Hulme (Eds.), *Mobile learning: The next generation* (pp. 179–189). New York, NY: Routledge.

Goktas, Y., & Demirel, T. (2012) Blog-enhanced ICT courses: Examining their effects on prospective teachers' ICT competencies and perceptions. *Computers & Education*, 58, 908–917.

Golomb, J. (1995). *In search of authenticity: From Kierkegaard to Camus.* London, UK: Routledge.

Graham, C. R. (2006). Blended learning systems: Definition, current trends, and future directions. In C. J. Bonk & C. R. Graham (Eds.), *Handbook of blended learning: Global perspectives, local designs* (pp. 3–21). San Francisco, CA: Pfeiffer.

Graham, C. R., Woodfield, W., & Harrison, J. B. (2013). A Framework for institutional adoption and implementation of blended learning in higher education. *Internet and Higher Education, 18*, 4–14.

Grünewald, F., Mazandarani E., Meinel, C., Teusner, R., Totschnig, M., & Willems, C. (2013). *openHPI: A case-study on the emergence of two learning communities.* Paper presented at the Global Engineering Education Conference, Berlin, Germany. doi:10.1109/EduCon.2013.6530277

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105-117). London, UK: Sage.

Gutiérrez, K. D., & Vossoughi, S. (2010). Lifting off the ground to return anew: Mediated praxis, transformative learning, and social design experiments. *Journal of Teacher Education, 6*(1-2), 100–117.

Haavind, S., & Sistek-Chandler, C. (2015). The emergent role of the MOOC instructor: A qualitative study of trends toward improving future practice. *International Journal on E-Learning, 14*(3), 331–350.

Haber, J. (2014). *MOOCs*. Cambridge, UK: MIT Press.

HAMK SPTE. (2013). *Opinto-opas 2013*– 2014 [Study guide 2013–2014]. Hämeenlinna, HAMK publications.

Heidegger, M. (1993). *Varat och tiden* [Being and time]. Göteborg, Sweden: Daidalos.
Hermida, J. (2014). *Facilitating deep learning: Pathways to success for university and college Teachers*. Toronto, CA: Apple Academic Press.
Herrington, J., Reeves, T. C., & Oliver, R. (2010). *A guide to authentic e-learning*. London, UK: Routledge.
Hiidenmaa, P. (2013). *Jos vastaus on MOOC, mikä on kysymys?* [If the answers is the MOOC, what is the question?]. Retrieved November 26, 2017, from http://ok.helsinki.fi/wp-content/uploads/2014/01/Jos_mooc_on_vastaus.pdf
Hill, J., & Woodland, W. (2002). An evaluation of foreign fieldwork in promoting deep learning: A preliminary investigation. *Assessment and Evaluation in Higher Education, 27*(6), 539–555.
Hmelo-Silver, C., & Chinn, C.A. Collaborative learning. In L.Corno & E.M. Anderman (Eds.), *Handbook of Educational Psychology* (pp. 349–363). New York, NY: Routledge.
Holley, D., & Sentance, S. (2015). Mobile 'comfort' zones: Overcoming barriers to enable facilitated learning in the workplace. *Journal of Interactive Media in Education, 1*(15), 1–9.
Howe, C., & Mercer, N. (2010). Children's social development, peer interaction and classroom learning. In R. Alexander, C. Doddington, J. Gray, L. Hargreaves, & R. Kersher (Eds.), The Cambridge *primary review research surveys* (pp. 160–192). London, UK: Routledge.
Howie, P., & Bagnall, R. (2015). A critical comparison of transformation and deep approach theories of learning. International Journal of Lifelong Education. A critical comparison of transformation and deep approach theories of learning*International Journal of Lifelong Education, 34*(3), 348–365.
Hunt, A. M. (2015). Blended online learning in initial teacher education: A professional inquiry into pre-service teachers' inquiry projects. *Journal of Open, Flexible and Distance Learning, 19*(2), 48–60.
Huttunen, R. (1995). Dialogiopetuksen filosofia [Philosophy of dialogue teaching]. *Tiedepolitiikka, 3*, 5–14.
Iiyoshi, T., & Kumar, M. S. V. (2008). *Opening up education: The collective advancement of education through open technology, open content, and open knowledge*. Cambridge, MA: MIT Press.
Isaacs, W. (1999). *Dialogue and the art of thinking together. A pioneering approach to communicating in business and in life*. New York, NY: Currency.
Johnson, B., & Christensen, L. (2008). *Educational Research. Quantitative, Qualitative and Mixed Approaches*. Los Angeles, LA: SAGE.
Jung, L., & Ling, Z. (2011). Improving flexibility of teaching and learning with blended learning: A case study analysis. In R. Kwan, J. Fong, L. Kwok, & J. Lam (Eds.), *Hybrid Learning, ICHL 2011* (pp. 251–261). Berlin, Germany: Springer.
Keskitalo, T. (2015). *Developing a pedagogical model for simulation-based healthcare education* (Doctoral dissertation). University of Lapland, Rovaniemi, Finland.
Keskitalo, T., Pyykkö, E., & Ruokamo, H. (2011). Exploring the meaningful learning of students in second life. *Educational Technology and Society, 14*(1), 16–26.
Koramo, M., Brauer, S. & Jauhola, L. (2018). DIGAM: Digitalisaatio ammatillisessa koulutuksessa. [Digitalisation in vocational education]. *National Board of education,* 2018:9.
Korhonen, A.-M., Ruhalahti, S., & Veermans, M. (2019). The online learning process and scaffolding student teachers' personal learning environments. *Education and Information Technologies, 24*(1), 755–779.
Korthagen, F., & Kessel, J. (1999). Linking theory and practice: Changing the pedagogy of teacher education. *Educational Researcher, 28*(4), 4–17.
Krippendorff, K. (2004). *Content analysis: An introduction to its methodology*. Thousand Oaks, CA: Sage.

Lakkala, M., Toom, A., Ilomäki, L., & Muukkonen, H. (2015). Re-designing university courses to support collaborative knowledge creation practices. *Australasian Journal of Educational Technology, 31*(5), 521–536.

Laurillard, D. (2012). *Teaching as a design science*. New York, NY: Routledge.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. New York, NY: Cambridge University Press.

LeMahieu, P. G., Nordstrum, L. E., & Potvin, A. S. (2017). Design-based implementation research. *Quality Assurance in Education, 25*(1), 26–42.

Ligorio, M. B., Loperfido, F. F., & Sansone, N. (2013). Dialogical positioning as a method of understanding identity trajectories in a collaborative blended university course. *International Journal of Computer-Supported Collaborative Learning, 8*(3), 351–367.

Lodico, M. G., Spaulding, D. T., & Voegtle, K. H. (2006). *Methods in educational research: From theory to practice.* San Francisco, CA: Jossey-Bass.

Lonka, K. (2015). Working document I. In European Parliament (Ed.), *Innovative schools: Teaching & learning in the digital era: Workshop documentation* (pp. 8–37). Brussels, Belgium: European Parliament.

Lucas, U. (2001). Deep and surface approaches to learning within introductory accounting: A phenomenographic study. *Accounting Education, 10*(2), 161–184.

Ludvigsen, S., Cress, U., Law, N., Rose, C. P., & Stahl, G. (2016). Collaboration scripts and scaffolding. *International Journal of Computer-Supported Collaborative Learning, 11*(4), 381–385.

Ludvigsen, S., Lund, A. Rasmussen, I., & Säljö, R. (2011). *Learning across sites: New tools, infrastructures and practices.* Abingdon, UK: Routledge & EARLI.

Lynch, R., McNamara, P. M., & Seery, N. (2012). Promoting Deep Learning in a Teacher Education Programme through Self- and Peer-Assessment and Feedback. *European Journal of Teacher Education, 35*(2), 179–197.

Marton, F., & Säljö, R. (1976). On quantitative differences in learning: Outcome and process. *British Journal of Educational Psychology, 46*, 4–11.

Marton, F., & Säljö, R. (1984). Approaches to learning. In F. Marton, D. J. Hounsell, & N. J. Entwistle (Eds.), *The Experience of Learning* (pp. 36–55). Edinburgh, UK: Scottish Academic Press.

Marzano, R. J. (2001). *Designing a new taxonomy of educational objectives*. Thousand Oaks, CA: Corwin Press.

Marzano, R. J., & Kendall, J. S. (2008). *Designing and assessing educational objectives: Applying the new taxonomy*. Thousand Oaks, CA: Corwin Press.

McAuley, A., Stewart, B., Siemens, G., & Cormier, D. (2010). *The MOOC model for digital practice.* University of Prince Edward Island.

McGee, P., & Wickersham, L. (2005). Seeking deeper learning within an online course. In P. Kommers & G. Richards (Eds.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2005* (pp. 2205–2212). Chesapeake, VA: Association for the Advancement of Computing in Education.

McLaughlin, J. E., Roth, M. T., Gharkholonarehe, N., Davidson, C. A., Griffin, L. M., Esserman, D. A., & Mumber, R. J. (2014). The flipped classroom: A course redesign to foster learning and engagement in a health professions school. *Academic Medicine, 89*(2), 236–243.

Means, B., Bakia, M., & Murphy, R. (2014). *Learning online: What research tells us about whether, when and how.* New York, NY: Routledge.

Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2010). *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies.* Washington, DC: U.S. Department of Education.

Mercer, N., & Howe, C. (2012). Explaining the dialogic process of teaching and learning: The value and potential sociocultural theory. *Learning, Culture and Social Interaction, 1*, 12–21.

Mezirow, J. (1995). Transformation theory in adult education. In M. R. Welton (Ed.), *In defense of the lifeworld: Critical perspectives on adult learning* (pp. 39–70). Albany, NY: State University of New York Press.

Miettinen, R., & Paavola, S. (2018). Beyond the Distinction between Tool and Sign: Objects and Artifacts in Human Activity. In A. Rosa & J. Valsiner (Eds.), *The Cambridge Handbook of Sociocultural Psychology* (pp. 148–162). Cambridge, UK: Cambridge University Press.

Ministry of Education and Culture. (2017a). *Vocational education and training will be reformed to meet the needs of students and working life*. Retrieved October 26, 2017, from http://minedu.fi/en/article/-/asset_publisher/ammatillisen-koulutuksen-reformi-uudistaa-koulutuksen-vastaamaan-opiskelijoiden-ja-tyoelaman-tarpeita

Ministry of Education and Culture. (2017b). *A new teacher education development programme launched: Teachers? competence must be developed methodically throughout their careers.* Retrieved April 4, from http://minedu.fi/en/article/-/asset_publisher/opettajankoulutuksen-kehittamisohjelma-julkistettiin-opettajien-osaamista-kehitettava-suunnitelmallisesti-lapi-tyouran

Morgan, K. R. (2002). *Blended learning: A strategic action plan for a new campus.* Seminole: University of Central Florida.

Muukkonen, H., Lakkala, M., & Paavola, S. (2011). Promoting knowledge creation and object-oriented inquiry in university courses. In S. Ludvigsen, A. Lund, I. Rasmussen, & R. Säljö (Eds.), *Learning across sites: New tools, infrastructures and practices* (pp. 172–189). Abingdon, UK: Routledge & EARLI.

Määttä, E., Järvenoja, H., & Järvelä, S. (2012). Triggers of students efficacious interaction in collaborative groups. *Small Group Research, 43*(4), 497–522.

Nelson Laird, T. F., Seifert, T. A., Pascarella, E. T., Mayhew, M. J., & Blaich, C. F. (2014). Deeply affecting first-year students' thinking: Deep approaches to learning and three dimensions of cognitive development. *The Journal of Higher Education, 85*(3), 402–432.

Nelson Laird, T. F., Shoup, R., Kuh, G. D., & Schwarz, M. J. (2008). The effects of discipline on deep approaches to student learning and college outcomes. *Research in Higher Education, 49*(6), 469–494.

Novak, J. D., & Gowin, D. B. (1984). *Learning how to learn.* Cambridge, England: Cambridge University Press.

Näykki, P. (2014). *Affective and effective collaborative learning: Process-oriented design studies in a teacher education context* (Doctoral dissertation). University of Oulu, Oulu, Finland.

Offir, B., Lev, Y., & Bezalel, R. (2008). Surface and deep learning in distance education: Synchronous versus asynchronous system. *Computer & Education, 51*(3), 1172–1183.

Osman, G., & Herring, S. C. (2007). Interaction, facilitation, and deep learning in cross-cultural chat: A case study. The Internet and Higher Education*, 10*(2), 125–141.

O'Toole, R. (2013). *Pedagogical strategies and technologies for peer assessment in Massively Open Online Courses (MOOCs)*. Discussion Paper. University of Warwick, Coventry, England.

Paavola, S. (2006). *On the origin of ideas: An abductivist approach to discovery*. Helsinki, Finland: University of Helsinki.

Paavola, S., Engeström, R., & Hakkarainen, K. (2012). The trialogical approach as a new form of mediation. In A. Moen, A. Mørch, & S. Paavola (Eds.), *Collaborative Knowledge Creation: Practices, Tools, Concepts* (pp.1–14). Rotterdam, Netherlands: Sense Publishers.

Paavola, S., & Hakkarainen, K. (2005). The knowledge creation metaphor – An emergent epistemological approach to learning. *Science & Education, 14*, (pp. 535–557).

Paavola, S., Lipponen, L., & Hakkarainen, K. (2002). Epistemological foundations for CSCL: A comparison of three models of innovative knowledge communities. *Proceedings of the Computer-supported Collaborative Learning 2002 Conference* (pp. 24–32). Hillsdale, NJ: Erlbaum.

Paavola, S., Lipponen, L., & Hakkarainen, K. (2004). Models of innovative knowledge communities and three metaphors of learning. *Review of Educational Research, 74*(4), 557–576.

Palincsar, A. S. (1998). Social constructivist perspectives on teaching and learning. *Annual Review of Psychology, 49*(1), 345–375.

Pearson, G. (2012). Biology teacher's flipped classroom: "A simple thing, but it's so powerful." *Education Canada, 52*(5), 1–13.

Penuel, W. R., Fishman, B. J., Haugan, C. B., & Sabelli, N. (2011). Organizing research and development at the intersection of learning, implementation, and design. *Educational Educational Researcher, 40*(7), 331–337.

Phillipson, N., & Wegerif, R. (2017). *Dialogic education*. Oxon, UK: Routledge.

Psillos, S. (2011). An explorer upon untrodden ground: Peirce on abduction. In J. Woods, D. Gabbay, & S. Hartman (Eds.), *Handbook of the history of logic. Vol. 10: Inductive logic* (pp. 115–148). North Holland, the Netherlands: Elsevier.

Quadir, B., & Chen, N-S. (2015). The Effects of Reading and Writing Habits on Learning Performance in a Blog Learning Environment. *Asia-Pacific Education Researcher, 24*(4), 635–644.

Rahimi, E., van den Berg, J., & Veen, W. (2012). *Designing and implementing PLEs in a secondary school using Web 2.0 tools.* Paper presented at the Personal Learning Environment (PLE) Conference, Melbourne, Australia.

Rahimi, E., van den Berg J, & Veen, W. (2015). Facilitating student-driven constructing of learning environments using Web 2.0 personal learning environments. *Computer & Education*, *81*, 235–246.

Rahm, J., Miller, H. C., Hartley, L., & Moore, J. C. (2003). The value of an emergent notion of authenticity: Examples from two students/teacher-scientist participation programs. *Journal of Research in Science Teaching, 40*(8), 737–756.

Rasi, P., & Vuojärvi, H. (2018). Toward personal and emotional connectivity in mobile higher education through asynchronous formative audio feedback. *British Journal of Educational Technology, 49*(2), 292–304.

Resnick, L. B. (1987). Learning in school and out. *Educational Researcher*, *16*, 13–20.

Resnick, L. B. (1991). Shared cognition: Thinking as social practice. In L. B. Resnick, J. M. Levine, & S. D. Teasley (Eds.), *Perspectives on socially shared cognition* (pp. 1–20). Washington, DC: American Psychological Association.

Reznitskaya, A. (2012). Dialogic teaching: Rethinking language use during literature discussions. *The Reading Teacher, 65*(7), 446–456.

Robertson, J. (2011). The educational affordances of blogs for self-directed learning. *Computers & Education, 57*, 1628–1644.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context*. Oxford, England: Oxford University Press.

Royle, K., Stager, S., & Traxler, J. (2014). Teacher development with mobiles: Comparative critical factors. *Prospects, 44*(1), 29–42.

Ruhalahti, S., & Aarnio, H. (2018). Self-paced and dialogical collaborative knowledge creation for promoting deep learning: A pilot case in the teacher education. *Ibero-Americana Journal of Education* Studies, *19*(1), 291–303.

Ruhalahti, S., Aarnio, H., & Ruokamo, H. (2018). Evaluation of deep learning in vocational teacher education: Conducted on the principles of authentic and dialogical collaborative knowledge construction. *Nordic Journal of Vocational Education and Training, 8*(2), 22–47.

Ruhalahti, S. & Kenttä, V. (2017). Ammatillisen koulutuksen digitalisaatio ja työelämäyhteistyö [Digitalisation and collaboration with world of work in the vocational education] *National Board of education,* 2017:18.

Ruhalahti, S., Korhonen, A.-M., & Rasi, P. (2017). Authentic, dialogical knowledge construction: A blended and mobile teacher education programme. *Educational Research, 59*(4), 373–390.

Ruhalahti, S., Korhonen, A.-M., & Ruokamo, H. (2016). The dialogical authentic netlearning activity (DIANA) model for collaborative knowledge construction in mOOC. *The Online Journal of Distance Education and e-Learning, 4*(2), 58–67.

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*, *25*(1), 54–67.

Sahin, S., & Uluyol, C. (2016). Pre-service teachers' perception and use of personal learning environments (PLEs). *International Review of Research in Open and Distributed Learning, 17*(2), 141–161.

Salmon, G. (2011). *E-Moderating: The key to online teaching and learning.* New York, NY: Routledge.

Salmons, J. (2015). *Qualitative online interviews.* Thousand Oaks, CA: Sage.

Sanchez-Gordon, S., & Luján-Mora, S. (2017). Technological innovations in large-scale teaching: Five roots of MOOCs. *Journal of Educational Computing Research, 55*, 1–22.

Sardessai, S., & Kamat, V. (2011). Using a blended approach to in-service teacher training: A case study. *Proceedings of the Technology for Education, IEEE International Conference* (pp. 266–269). Washington, DC: IEEE Computer Society.

Scanlon, E., McAndrew, P., & O'Shea, T. (2015). Designing for educational technology to enhance the experience of learners in distance education: How open educational resources, learning design and MOOCs are influencing learning. *Journal of Interactive Media in Education, 1*, 1–9.

Schraw, G., Flowerday, T., & Lehman, S. (2001). Increasing situational interest in the classroom. *Educational Psychology Review, 13*(3), 211–224.

Schreier, M. (2012). *Qualitative content analysis in practice*. London, UK: Sage.

Sedova, K., Sedlacek, M., & Svaricek, R. (2016). Teacher professional development as a means of transforming student classroom talk. *Teaching and Teacher Education, 57*, 14–25.

Seligman, M. (2002). *Authentic happiness*. London, UK: Nicholas Brealey Publishing.

Serby, T. (2011). Willing suspension of disbelief: A study in online learning through simulation, and its potential for deeper learning in higher education. *Liverpool Law Review*, *32*(2), 181–195.

Sfard, A. (1998). On two metaphors of learning and the dangers of choosing just one. *Educational Researcher, 27*(2), 4–13.

Shaffer, D. W., & Resnick, M. (1999). "Thick" authenticity: New media and authentic learning. *Journal of Interactive Learning Research, 10*(2), 195–215.

Sharples, M., Taylor, J., & Vavoula, G. (2005). Towards a theory of mobile learning. *Proceedings of the MLearn, 1*(1), 1–9.

Shuler, C., Winters, N., & West, M. (2013). *The future of mobile learning: Implications for policy makers and planners*. Paris, France: UNESCO.

Siemens, G. (2005). Connectivism: A learning theory for the digital age. *International Journal of Instructional Technology & Distance Learning, 2*(1). Retrieved January 14, 2018, from http://www.itdl.org/journal/jan_05/article01.htm

Smith, T. W., & Colby, S. A. (2007). Teaching for deep learning. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 80*(5), 205–210.

Stake, R. E. (2004). *Standards-based and responsive evaluation.* Thousand Oaks, CA: Sage.

Stokols, D. (2014). Training the next generation of transdisciplinarians. In M. O. O'Rourke, S. Crowley, S. D. Eigenbrode, & J. D. Wulfhorst (Eds.), *Enhancing communication & collaboration in interdisciplinary research* (pp. 56–81). Los Angeles, CA: Sage.

Stone, C. A. (1998). The metaphor of scaffolding: Its utility for the field of learning disabilities. *Journal of Learning Disabilities, 31*(4), 344–364.

Supovitz, J. (2013). Situated research design and methodological choices in formative program evaluation. In J. Fishman, B. Penuel, A.-R. Allen, & B. Cheng (Eds.), *Design-based implementation research: Theories, methods and exemplars* (pp. 136–156). New York, NY: National Society for Study of Education.

Säljö, R. (2004). *Oppimiskäytännöt: sosiokulttuurinen näkökulma* [Learning practices: A sociocultural perspective]. Helsinki, Finland: WSOY.

Säljö, R. (2009). Learning, theories of learning, and units of analysis in research. *Educational Psychologist, 44*(3), 202–208.

Tagg, J. (2003). *The learning paradigm college*. Boston, MA: Anker.

Tavory, I., & Timmermans, S. (2014). *Abductive analysis: Theorizing qualitative research*. Chicago, IL: University of Chicago Press.

Tay, H. Y. (2016). Investigating engagement in a blended course. *Cogent Education, 3*(1). doi:10.1080/2331186X.2015.1135772

Taylor, C. (1995). *Autenttisuuden etiikka* [The ethics of authenticity]. Helsinki, Finland: Priima-Offset.

Teräs, H. (2016). *Design principles of an authentic online professional development program for multicultural faculty* (Doctoral dissertation). University of Tampere, Tampere, Finland.

Teräs, H., & Herrington, J. (2014). Neither the frying pan nor the fire: In search of a balanced authentic e-learning design through an educational design research process. *International Review of Research in Open and Distance Learning, 15*(2), 232–253.

Tillema, H. H. (2006). Authenticity in knowledge-productive learning: What drives knowledge construction in collaborative inquiry? *Human Resource Development International, 9*(2), 173–190.

Tillema, H. H., & van der Westhuizen, G. J. (2006). Knowledge construction in collaborative enquiry among teachers. *Teachers and Teaching 12*(1), 51–67.

Timmermans, S., & Tavory, I. (2012). Theory construction in qualitative research: From grounded theory to abductive analysis. *Sociological Theory, 30*(3), 167–186.

Tomas, L., Lasen, M., Field, E., & Skamp, K. (2015). Promoting online students' engagement and learning in science and sustainability preservice teacher education. *Australian Journal of Teacher Education, 40*(11). doi:10.14221/ajte.2015v40n11.5

Toven-Lindsey, B., Rhoads, R. A., & Lozano, J. B. (2015). Virtually unlimited classrooms: Pedagogical practices in massive open online courses. *The Internet and Higher Education, 24*, 1–12.

Traxler, J. (2007). Defining, discussing and evaluating mobile learning: The moving finger writes and having writ. *The International Review of Research in Open and Distributed Learning,* 8(2), 1–12.

Traxler, J., & Kukulska-Hulme, A. (2016). *Mobile learning. The next generation*. New York, NY: Routledge.

Tullis, J. G., & Benjamin, A. S. (2011). On the effectiveness of self-paced learning. *Journal of Memory and Language, 64*(2), 109–118.

Tune, J. D., Sturek, M., & Basile, D.B. (2013). Flipped classroom model improves graduate student performance in cardiovascular, respiratory, and renal physiology. *Advances in Physiology Education, 37*(4), 316–320.

Turkle, S. (2015). *Reclaiming conversation: The power of talk in a digital age*. New York, NY: Penguin Press.

Vaismoradi, M., Bondas, T., & Turunen, H. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Journal of Nursing & Health Sciences, 15*(3), 398–405.

Van de Pol, J., Volman, M., & Beishuizen, J. (2010). Scaffolding in teacher-student interaction: A decade of research. *Educational Psychological Review, 22*(3), 271–296.

Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Wagner, E. D. (2006). On designing interaction experiences for the next generation of blended learning. In C. J. Bonk, & C. R. Graham (Eds.), *The handbook of blended learning. Global perspectives, local designs* (pp. 41–54). San Francisco, CA: Pleiffer.

Wegerif, R. (2006). A dialogic understanding of the relationship between CSCL and teaching thinking skills. *International Journal of Computer-supported Collaborative Learning, 1*(1), 143–157.

Wegerif, R. (2013). Dialogic: Education for the internet age. Oxon, UK: Routledge.

Wegerif, R. (2018). A dialogic theory of teaching thinking. In L. Kerslake & R. Wegerif (Eds.), *Theory of teaching thinking*. Oxon, UK: Routledge.

Wegerif, W., Doney, J., Richards, A., Mansour, N., Larkin, S., & Jamison, I. (2017). Exploring the ontological dimension of dialogic education through an evaluation of the impact of Internet mediated dialogue across cultural difference. *Learning, Culture and Social Interaction*.

Wegerif, R., & Major, L. (2018). Buber, educational technology, and the expansion of dialogic space. *AI & Society*.

Wells, G. (2000). Dialogic inquiry in education: Building on the legacy of Vygotsky. In C.D. Lee & P. Smagorinsky (Eds.), *Vygotskian perspectives on literacy research* (pp. 51-85). New York, NY: Cambridge University Press.

Wenger, E. (1998). *Communities of practice. Learning, meaning and identity*. Cambridge, England: Cambridge University Press.

Wenger, E. (2009). *Communities of practice: a brief introduction*.Retrieved on March 15, 2018, from http://ussc.edu.au/ussc/assets/media/docs/other/communities_of_practice.pdf.

West, D. M. (2015). *What happens if robots take the jobs? The impact of emerging technologies on employment and public policy*. Washington, DC: Centre for Technology Innovation at Brookings.

Wheeler, S. (2015). *Learning with 'e's: Educational theory and practice in the digital age*. Carmarthen, England: Crown House.

Williams, D. D. (2005). Measurement and Assessment Supporting Evaluation in Online Settings. In D. D. Williams (Ed.), *Online assessment, measurement and evaluation: Emerging practices* (pp. 1–8). Hershey, PA: Information Science Publishing.

Williams, P. (2017). Assessing collaborative learning: Big data, analytics and university futures. *Assessment & Evaluation in Higher Education, 42*(6), 978–989.

Yang, J., Quadir, B., Chen, N.-S., & Miao, Q. (2016). Effects of online presence on learning performance in a blog-based online course. *Internet and Higher Education*, *30*, 11–20.

Yin, R. K. (2009). *Case study research.* Thousand Oaks, CA: Sage.

Xerri, D. (2018) Two Methodological Challenges for Teacher-researchers: Reflexivity and Trustworthiness. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 91*(1), 37–41.

Özkan, B., & McKenzie, B. (2008). Social Networking Tools for Teacher Education. In K. McFerrin, R. Weber, R. Carlsen, & D. Willis (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference* (pp. 2772–2776). Chesapeake, VA: Association for the Advancement of Computing in Education.

Appendices

I Sub-study:

Online questionnare

What was the meaning of the grouping for you? Tick all that apply: To get familiar with other study group members/ To make collaborative learning more interesting / To get started quicker/ It was not important to me

Please rate how well you think your study group succeeded with the grouping: Excellent/ Good/ Average/Poor

If you replied average or poor, please write down what should be done differently? For example: More guidance and counselling, time commitment from all members.

One of the aims was to decide on the use of the collaborative tools. Please select the tools and applications used: Google Drive / Facebook/ Padlet/ Etherpad/ Hackpack / LinkedIn

Module 1, Basics of individualisation

How easy it was to formulate authentic questions of individualisation and personalisation? Very easy/ Easy/ Neutral / Difficult/ Very difficult

Based on your authentic questions how did your study group identify themes? One of the group member did it / We discussed the themes and questions collaboratively/ Each of us made our own questions and we didn't discuss them as a group/ Other:

How was your study group´s synthesis (the way you formed as a group) created? All active members were working with it/ One or two members were doing the work/ I was the only person who participated/ Other:

What did you learn about individualised and personalised learning approaches?

If you reflect your own contributions on this Module, how would you describe your dialogical participation? Self-reflection.

Module 2, Dialogical guidance and scaffolfing

How easy it was to formulate authentic questions of dialogical guidance and scaffolding? Very easy/ Easy/

Neutral/ Difficult/ Very difficult

How was your dialogical online meeting with the study group?

Please state the extent to which you agree or disagree with the following statements, where 5 is Strongly Agree and 1 is Strongly Disagree (tick one per statement).

The meeting was relevant for me

The meeting was meaningful for the learning process

The meeting has given me ways to become more knowledgeable about dialogical guidance and scaffolding

The meeting made me think about my own dialogical attitude and actions

We had a reflective and dialocial athomosphere

If you reflect your own contributions on this Module 2, how would you describe your dialogical participation? Self-reflection

Additional feedback from Module 2

In-depth interview

1) What was the role of grouping (study group, begin of the course) for your learning process?

2) How the idea of authentic learning was realized (making authentic learning questions from the module´s learning objectives)?

3) How the idea of dialogical learning was realized (learning dialogically, dialogical attitude)?

4) How the dialogical learning suits for (massive) open online course?

5) What improves collaborative online learning and knowledge creation (based on your own opinion, experience)?

6) Free opinions of the DIANA pedagogical model (used in modules: Individual study plan and Dialogical scaffolding and guidance)