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A continuous learning perspective in the vocational teacher education context

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To my loved ones
Aleksi, Iida and Lauri.

To the teacher trainers, student teachers and teachers who enhance students' personalised development.

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ABSTRACT

The present dissertation examined how to scaffold students when they study in their Personal Learning Environments (PLEs). PLEs give students the freedom to choose their learning environments by themselves and the ability to support their continuing professional development throughout their career once their studies are complete. The examination also concerned what kind of competence vocational student teachers demonstrate in their ePortfolios as a part of their PLEs during their teacher studies in order to design scaffolding. The data was collected from several groups of vocational student teachers. Various pedagogical learning designs, scaffolding models, digital tools and definitions and evaluations of competences were examined. The data analyses were conducted using the qualitative content analysis approach.

The results of the study revealed that the Dialogical Authentic Netlearning Activity (DIANA) pedagogical model contains several scaffolding activities and is the most effective when it is presented with students' personal web tools integrated in the learning process. The study presents a detailed framework for evaluating and studying vocational teachers' competence and provides instructions for scaffolding the content of ePortfolios. The study revealed that the open badge-driven learning structure provides a method and digital tools for scaffolding students via their PLEs. The results indicate that scaffolding via PLEs is successful when there are several scaffolding providers, such as a lecturer, a workplace training mentor and students, instructions in digital environments and peer-students. Vocational student teachers are motivated to study and make their competences visible through ePortfolios because they are interested in promoting their teaching career and they wish to continue their personal growth. Using an ePortfolio in their studies also enables student teachers see the potential of using ePortfolios with their own students. This dissertation reveals three aspects with practical features which may be used to designing scaffolding PLEs: personal web tools, content and methods. Although the dissertation deals specifically with vocational teacher education, it is hoped that the results will be implemented in every educational sector.

KEYWORDS: personal learning environment, continuous learning, ePortfolio, pedagogy, scaffolding, digital tools

TURUN YLIOPISTO
Kasvatustieteiden tiedekunta, Opettajankoulutuslaitos
ANNE-MARIA KORHONEN: Ohjauksen suunnittelu henkilökohtaisiin oppimisympäristöihin. Jatkuvan oppimisen näkökulma ammatillisen opettajankoulutuksen kontekstissa.
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TIIVISTELMÄ

Tässä väitöskirjassa tutkittiin, miten opiskelijoita ohjataan, kun he käyttävät henkilökohtaisia oppimisympäristöjään. Opiskelijat saavat itse valita nämä ympäristöt, joiden on tarkoitus tukea ammatillista kehittymistä myös opintojen jälkeen koko työuran aikana. Jotta ohjaamista voidaan suunnitella, tutkimuksessa tarkasteltiin myös, millaista osaamista ammatilliset opettajaopiskelijat tekevät näkyväksi ePortfoliossaan, joka on osa henkilökohtaista oppimisympäristöä. Tutkimusaineisto kerättiin useasta opettajaopiskelijaryhmästä. Pedagogisia opetuksen toteutussuunnitelmia, ohjauksen malleja, digitaalisia työvälineitä ja opettajan kompetenssin määritelmiä tutkittiin. Aineisto analysoitiin laadullisen sisällönanalyysin menetelmillä.

Tutkimustuloksista havaittiin, että pedagoginen DIANA-malli (Dialogical Authentic Netlearning Activity) sisältää useita ohjauksen menetelmiä ja siihen kytkettyjen henkilökohtaisten digitaalisten työvälineiden kautta ohjaus on tehokkaimmillaan. Tutkimus antaa yksityiskohtaisen ja käytännöllisen arviointikehyksen ammatillisen opettajan kompetenssin tarkasteluun. Tämä antaa edelleen ohjeita ePortfolion sisällön tuottamisen ohjaukseen. Tutkimuksessa havaittiin, että osaamismerkein ohjautuva oppimisprosessi sisältää menetelmän ja digitaaliset työvälineet opiskelijoiden ohjaukseen heidän henkilökohtaisten oppimisympäristöjensä kautta tapahtuen. Tutkimustulosten perusteella voidaan sanoa, että ohjaamisvastuuta henkilökohtaisten oppimisympäristöjen kautta voidaan jakaa eri tahoille, kuten esimerkiksi opettajalle, opetusharjoittelun ohjaajalle työpaikalla, opiskelijoille, ohjeisiin digitaalisissa ympäristöissä ja vertaisoppijoille. Ammatilliset opettajaopiskelijat ovat motivoituneita opiskelemaan ja tekemään osaamistaan näkyväksi ePortfolioidensa kautta, koska he ovat kiinnostuneita oman opettajauransa edistämisestä ja henkilökohtaisen kasvunsa havainnoinnista. Kun he käyttävät ePortfolioita omissa oppimisprosesseissaan, he havaitsevat niiden hyödyntämismahdollisuudet omien opiskelijoidensa kanssa. Väitöstutkimuksen perusteella löytyi kolme elementtiä perusteluineen, joiden avulla voi suunnitella ohjausta henkilökohtaisiin oppimisympäristöihin: henkilökohtaiset digitaaliset työvälineet, sisältö ja menetelmät. Vaikka tämä väitöstutkimus on ammatillisen opettajankoulutuksen kontekstissa, tuloksien implementointia voi suositella kaikille koulutussektoreille.

AVAINSANAT: henkilökohtainen oppimisympäristö, jatkuva oppiminen, ePortfolio, pedagogiikka, ohjaus, digitaaliset työvälineet

Acknowledgements

I started my research in the year 2015. The main focus of my journey in the dissertation was to develop myself as a teacher trainer by focusing on the matters I found to be most relevant in the era we are now living in—that is, to find what learning meant personally to each student and to use this knowledge to tailor learning to the individual in the digital environments. At the very moment I am writing these words of acknowledgement in order to offer my sincere gratitude to those many important people that helped me with my work, we are living with COVID-19 pandemic. This crisis has highlighted the necessity of the competence to use digital environments in educational work tasks as well as how to provide this digital competence to all students in order to support their personal growth from a distance.

First, I sincerely thank my first supervisor, Professor Marjaana Veermans, for her constant guidance from the very beginning until I wrote the final words. You gave me your professional advice in such a way that required me to develop myself to be able to solve all my research problems. I thank you warmly for always trusting and supporting me when I doubted my ability to complete this dissertation. It makes me very happy that we have had opportunities to work together also as colleagues. Secondly, my sincere thanks are due also to my second supervisor, Adjunct Professor Minna Lakkala of the University of Helsinki, for her precise, caring and constant advice during the entire time I worked on my dissertation. Your professional insights into all aspects of the articles and the summary provided me a valuable learning experience. You followed your own teachings when you scaffolded me through all my uphill struggles. Third, I would like to thank my third supervisor, Professor Mari Murtonen, for her forward-thinking comments on my first and forth studies. Please allow me to express my deep appreciation for all the time and effort you three supervisors have given me during this dissertation process.

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Kaarina, May 2020
Anne-Maria Korhonen

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List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals:

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

Korhonen contributed to this study's design, data collection, analysis, interpretations of the results and writing the manuscript. Ruhalahti contributed to study design, data collection and analysis. Veermans revised the theoretical background and results of the analysis, gave methodological advice and participated in the revision of the manuscript.

II Korhonen, A.-M., Lakkala, M. & Veermans, M. Identifying vocational student teachers' competence using an ePortfolio. *European Journal of Workplace Innovation*, 2019; 5(1).

Korhonen contributed to this study's design, data collection, analysis, interpretations of the results and writing the manuscript. Lakkala and Veermans contributed to analysis and theoretical background.

III Brauer, S., Korhonen, A.-M. & Siklander, P. Online Scaffolding in Digital Open Badge-Driven Learning in Vocational Teacher Education. *Educational research*, 2019; 61(1): 53–69.

Korhonen contributed to the analysis, interpretation of the results and writing the manuscript. Brauer contributed to the study design, data collection, interpretation of the results and writing the manuscript. Siklander contributed to theoretical background, analysis and the revision of the manuscript.

IV Korhonen, A.-M., Ruhalahti, S., Lakkala, M. & Veermans, M. Vocational student teachers' self-reported experiences in creating ePortfolios. *International Journal for Research in Vocational Education and Training*, (in press).

Korhonen contributed to the study design, data collection, analysis, interpretations of the results and writing the manuscript. Ruhalahti contributed to the study design and analysis. Lakkala and Veermans contributed to theoretical background, analysis and the revision of the manuscript.

1 Introduction

Since 1994, when competence-based qualifications in vocational education and training (VET) were created, competence development and skills demonstration in Finnish vocational education and training have been personalised to each student. The VET system has been widely studied by vocational teachers and has adapted to other school levels. Finland's VET system underwent significant reform in 2018 and personalised learning has come under particular scrutiny since competence- and curriculum-based qualifications were merged (Vocational Education and Training Act 531/2017). Today all educators are implementing personalised learning processes into their study programs at all school levels. The current digital era requires personal solutions for learning environments that are student-centred and tailored to every student. Furthermore, personalised learning environments (PLEs) are designed for learning in many kinds of environments, not only classrooms, and support lifelong (continuous) learning. This dissertation was started in order to discover what kind of teacher support is needed when students are learning in multifaceted situations and environments, including personalised learning, digitalisation and continuous learning. The concept of the PLE is a useful approach to better understand these concerns, as it combines the PLEs enabled by digital environments and provides room to accept that learning happens in many kinds of environments, not only in schools. The concept of PLE recognises that students learn in formal and informal learning environments and from a variety of learning providers (Attwell, 2007; Wheeler, 2015). Wheeler's (2015) definition of the PLE relates to the discussion of continuous learning and how it is supported by formal, informal and nonformal education and personal web tools (PWTs) as well as personal networks.

PLEs include technical aspects as well as ethical and pedagogical considerations (Attwell, 2007; Castaneda & Adell, 2013) and are strongly connected to personalised learning. Nowadays learning management systems (LMSs) and Web 2.0 tools, such as blogs, Facebook groups and WhatsApp, are utilised as learning environments accessible via laptops and other mobile devices. However, which of these tools are used and how are very often at the discretion of the lecturer or educational institution, so the PLE concept is not fully applied. The primary disadvantage of such cases is

that students' artefacts remain in education providers' systems and do not follow the student after graduation. One of the topics reviewed was the use of ePortfolios for learning and making competences visible in digital formats; however, these studies are often based on a single digital tool selected by the educational institution being studied (Cheng & Chau, 2013; Chittum, 2018; Roberts, 2018), so again the idea of the PLE is not being fully implemented. When a teacher is designing a learning process for student teachers' consideration, the content of PLEs and ePortfolios must also be considered in order to determine what kind of material students should provide to express their competences in the relevant subjects. In the case of this dissertation, vocational teacher education itself is being studied. There is little extant research on how to make competences visible in ePortfolios, or on what kind of content vocational teachers' ePortfolios should contain—e.g., how to describe pedagogical competences and digital competences in a digital format. As Toom (2017) explained, teachers' competences are a combination of knowledge and skills and are acquired and expanded upon throughout a teacher's entire career, not only during their initial training program. The aim of using PLEs in education should be to encourage students to take an active interest in their own development and continuing study, as well as to make competences visible to wider audiences, which will be an advantage in searching for career opportunities. Students need to be prepared for continuous learning during their studies, but practical methods to support this have not yet been studied in the context of vocational teacher education.

This dissertation is focused on scaffolding through PLEs, because PLEs are now essential in education and student teachers must to consider how to scaffold their own students in such a way that they feel a sense of ownership over their personal learning journey and learn to identify and use the learning environments they feel best suited to themselves. Scaffolding is understood to be synonymous with support (Puntambekar & Hübscher, 2005). It is usually a means for teachers to support students according their individual needs, enabling them to achieve learning objectives that they would not be able to obtain otherwise (Wood et al., 1976). Scaffolding is not seen as a permanent support and assumes that the student will be a self-regulated learner (Stone, 1998; Puntambekar & Hübscher, 2005). The term scaffolding is widely used in all educational levels and contexts. When students utilise PLEs in their learning activities, teacher implement the PLE concept by designing personal and group scaffolding to be used alongside other pedagogical activities. Scaffolding learning through PLEs can be designed by using a scaffolding model, such as the five-stage model for online scaffolding (Salmon, 2018). The five-stage model explains stages for online scaffolding at a very general level (Lakkala, 2010). Some pedagogical models also include instructions for supporting students and can be utilised in designing scaffolding. In the present study the activities incorporated in the DIANA pedagogical model (Aarnio & Enqvist, 2016) and those

used in the five-stage model (Salmon, 2018) were compared in order to discover the most effective means of scaffolding online. The five-stage model activities (Salmon, 2018) were also studied by comparing the stages to the open badge-driven learning concept which provides structure for independent learning online (such as Massive Open Online Courses) and is helpful in making competences visible (Brauer, 2018). Open badge-driven learning itself provides tools and methods for online scaffolding (Brauer & Siklander, 2017; Brauer, 2018). Studying via the open badge concept utilises students' PLEs: Students construct knowledge and create artefacts in their PLEs which reflect activities they engage in real work and life situations. Scaffolding is also understood as being provided by several actors, including teachers, digital instructions and environments, and peers (Tabak, 2004; Lajoie, 2005). The present study explored scaffolding activities and methods in a more detailed and practical way, assessing scaffolding providers from a wider perspective than Tabak's (2004) explanation of distributed scaffolding. In addition to discussing scaffolding, the present study explores student teachers' motivation to apply ePortfolios in their studies as a part of a PLE. Motivation was studied as a part of Ryan and Deci's (2000) self-determination theory, in order to find how to direct scaffolding in such a way as to interest student teachers in creating and learning through ePortfolios.

The present study of PLEs contributes to the current debate over Education 4.0, which is now being implemented in various educational contexts. Today learning is understood to take place at any time and in any place, and can be personalised to students, who are given a choice as to how they want to learn. Education 4.0 also emphasises project-based learning, including more practical learning activities—student assessments are conducted in practical work situations, and students are trained to be more independent learners while teachers are becoming better facilitators (Hussin, 2018). Operating System (OS) 4.0 in education means that students can directly connect with the sources of creativity (Scharmer, 2018), which is required when using PLE in education. Scharmer's (2018) educational evolution is discussed as Education 4.0, which developed from OS 1.0 (a system based on input- and authority-centric operations with a traditional teacher-centric approach) to the cooperative OS 4.0, which activates deeper sources of learning (Scharmer, 2018). The digital tools and learning environments are used in various ways depending on the field of education—for instance, virtual labs in engineering education (Grodotzki et al., 2018), teaching engineering with Artificial Intelligence (Ciolacu et al., 2017), art education implementing the World Wide Web (Gonzales, 2010) and the combination of digital English and Education 4.0 (Hariharasudan & Kot, 2018) all play a big role in Education 4.0 discussions. All of these disparate disciplines rely on digitally facilitated modern methods of teaching and support learning. Massive Open Online Courses, one platform produced by Education 4.0, have become a resource for independent and personal learning (Ruhalahti et al.,

2016, Sangra & Wheeler, 2013). ePortfolios as a part of PLEs in particular have proven to be a specific digital arena for making one's competences visible during learning activities (Terkowsky et al., 2013). When learning can take place at any time and anywhere it becomes a continuous, lifelong process (Laal & Laal, 2012; Ministry of Education and Culture, 2019). Learning is personalised and modern technology can now be implemented in various ways (Laal et al., 2014). Finland's Ministry of Education and Culture (2019) has developed a national continuous learning initiative, pointing out that occupations are changing and digital disruption is demanding new skills from all citizens. This program promotes the development of flexible educational programs (formal education), continuing education programs attached to workplaces and careers provided by educational institutions, workplace training provided by the professional world, and other methods and arenas which will recognise competences and make them visible in digital format via techniques such as by open badges and other methods for competence descriptions. In the present study ePortfolios are suggested as an effective way to make competences visible and recognisable. The Finnish Government (Oosi et al., 2019) has published a study, Structures to Support Continuous Learning, which calls for the development of a long-term national strategy for continuous learning and an accompanying implementation strategy. They defined continuous learning as being attached to formal learning, informal learning and nonformal learning. These concepts—Education 4.0 and continuous learning—have inspired this study in the context of vocational teacher education. Vocational teachers are key actors in bringing these concepts to vocational students' education, which is why this study is relevant.

This dissertation studies PLE phenomena from the perspective of a teacher trainer who utilised the above-mentioned theoretical frames of pedagogy in order to apply Education 4.0 and continuous learning in teaching and learning practices. Using PLEs during learning activities is explored in the context of the discussion of continuous learning as a concrete practice. The present study is in the context of Finnish vocational teacher education, where vocational student teachers study in blended learning settings while also beginning or already progressing in their professional teaching career. The research question of the dissertation is: How to design scaffolding when students use their PLEs in the learning process to make their competences visible? This question was broken down into three more specific questions: How should scaffolding be provided alongside the use of digital PLEs and PWTs; what is the content of PLEs, and more specifically, ePortfolios of vocational student teachers; and how should scaffolding methods be implemented with PLEs?

Sociocultural theory, the framework on which the present study is based, views learning as occurring in social interactions between humans in cultural settings (Vygotsky, 1978; Lave & Wenger, 1991). The specific cultural settings discussed are dialogues and collaborations between students and teachers and the use of

material artefacts in various environments. In the four studies conducted, theoretical frameworks were implemented in student teachers' learning activities in order to study the phenomena, to help student teachers better understand their own experiences, and to appreciate how the chosen methods work from the students' point of view.

Chapters 2–4 of this dissertation describe all of the theoretical frameworks used in the research. Chapter 5 introduces the research design of the thesis, explaining the aim of the study, research questions, research context and participants and the data collection and methodological approaches. Chapter 6 provides an overview of the four preceding component studies; Chapter 7 presents the main results of the preceding studies in the framework of the present study; and Chapter 8 discusses the theoretical and methodological implications, as well as future directions.

2 Vocational teacher's competence

This study evaluates teachers' competences in order to determine which are suitable for making visible through ePortfolios in a vocational teacher education context, with the intention that doing so will benefit teachers' future careers. A vocational teacher's competence is a combination of many skills that are needed in teaching in the vocational education and training sector. Grollmann (2008) stated that teaching in vocational education is important because it is related to the welfare, maintenance, and progress of society. Knowledges related to technological developments and specific production processes in professional contexts are challenging vocational teachers who are required to teach their vocational students (Grollmann, 2008). Köpsén (2014) stated that the basic requirements of the vocational teacher are to guide students in social practices and how to be a member of society; she stated that these processes formulate the identity of the vocational teacher. Vocational teacher education is often defined as a complex combination of several competences, such as pedagogical content knowledge and teaching practices, substantive knowledge, and situational performance (Oser et al., 2009).

Teachers' competencies are often defined as student teachers' learning outcomes in the teacher education context (Toom, 2017, p. 806). However, according to Toom (2017) and Uusiautti (2016), competences cannot be learned only in formal teacher education; they must also be acquired in practical teacher work during the whole teacher career. Vocational teachers are very interested in developing their career and expanding their work responsibilities, which supports the possibility of improving teacher's own competences after teacher studies (Wenström et al., 2018). This chapter reviews teacher competences in general, pedagogical competences, and digital competences, which are framing the competences of teachers working in the field of vocational education and training and in universities of applied sciences.

2.1 Teacher's competence

Several studies of teacher competences are based on Shulman (1986, 1987), who explored knowledge-based teaching with pedagogical actions. He pointed out that teachers are expected not only to understand that something is so but also why it is so and why a given topic is important to learn: A teacher's ability to transfer

knowledge to students is a test of his or her understanding of the topic in question (Shulman, 1986). He divided teachers' content knowledge into three categories: a) subject matter content knowledge; b) pedagogical content knowledge; and c) curriculum knowledge (Shulman, 1986). Toom (2017) argued that teachers' competences are characterized by 1) theoretical challenges and a subject matter, and 2) pedagogical methods and strategies, explaining that these dimensions allow teacher competences to be assessed in relation to theoretical substance matter, pedagogical knowledge, and how to apply these in practice.

Teacher competences have been categorised in several ways in the twenty-first century, including as aspects of modern technology and globalisation (Kerluik et al., 2013). For example, policymakers in European Commission have formulated sets of both teacher competences (Caena, 2011) and digital competence frameworks for educators (Redecker, 2015). Both of these agendas include competences related to subject matters as well as pedagogical competences. Tapani and Salonen (2019) recently defined Finnish vocational teachers' competences as pedagogical, guidance and counselling, interaction, pedagogical leadership, partnership, innovation, and assessment, pointing out that vocational teachers' competences are fragmented. Each of these competences encompasses several skills. Vocational teachers' competences are a complex combination of pedagogical competences and occupational skills that are taught to students (Papier, 2019). Vocational teachers advise collaborating with the professional world by creating connections and creating an interface between workplaces and students which serves the needs of both through negotiating, developing and promoting learning (Lehtonen et al., 2018). Studies of workplaces have revealed that vocational teachers are the most important developers in collaboration between workplace and educational institutions, and now they are also expected to reorganise their job description because more will be learned in workplaces in future (Airila et al., 2019). Constantly improving collaboration between educational institutions and workplaces requires altering individual work culture to enhance networking with more versatile work methods and new pedagogies (Töytäri et al., 2019). Vocational teachers' competence is based largely on their ability to collaborate with workplaces, as well as their pedagogical and digital competences. In the next section pedagogical and digital competences will be introduced from a vocational teacher's perspective.

2.2 Pedagogical competence

Recent studies of vocational teachers' pedagogical competences have assessed whether they encompass related skills such as teaching, innovative teaching methods, curricula knowledge, counselling, understanding student life, educational skills, understanding individual learning possibilities, facilitating, subject matter

knowledge and the skills they need to be innovative facilitators (Tapani & Salonen, 2019). The list of the requirements is long. Vocational teachers' pedagogical competence involves the practices they use when they teach and how they apply theoretical approaches in practical and authentic learning (Ruhalahti, 2019). This means that the theories are implemented in real-life occupations and professions during the learning process. Pedagogical competences implemented in vocational education equips students with the skills they will need for the world outside of school and teaches them to think in ways that are tailored to specific professions (Aarnio, 2006).

The present study assessed the pedagogical competence of vocational student teachers using the so-called 'pedagogical infrastructure framework' (Lakkala et al., 2008; Lakkala, 2010; Lakkala et al., 2010), which was designed for educational settings and collaborative knowledge creation. It defined a pedagogical infrastructure framework to help teachers create learning designs. The central elements of the framework are technical, social, epistemological, and cognitive structures. The framework can also be used to evaluate a design for learning when digital tools in collaborative knowledge creation are implemented in education practices (Lakkala et al., 2010). In Table 1 below the components of the pedagogical infrastructure framework are defined and the means of promoting knowledge creation practices are explained.

Table 1 The pedagogical infrastructure framework and recommended features of each component for educational settings aiming at collaborative knowledge creation (Lakkala, Ilomäki & Kosonen, 2010)

Component	Definition	Features promoting knowledge creation practices
Technical	The providing of technology and technical advice to the participants; organizing and orchestrating the use of technology; the functionality of the tools provided; and their appropriateness for the desired activity	a) Providing of technology that enables and facilitates co-construction and elaboration of shared knowledge artifacts and coordination of the collaborative process; b) Easy acces to technology in all phases of the process; c) Face-to-face and technology-mediated activities are highly integrated; d) Availability of guidance for using technology for expert-like knowledge practices.
Social	The combination of designed individual or collaborative student activities and required outcomes and actual arrangements to organize students' collaboration and social interaction	a) The whole process is openly shared between the participants; b) Students' assignments aim at truly collaborative co-construction of knowledge objects; c) A supportive and constructive communication atmosphere is deliberately promoted; d) Students may have direct collaboration with professionals in the target field.

Component	Definition	Features promoting knowledge creation practices
Epistemological	The ways of operating with knowledge and the nature of knowledge processing that the assignments promote; nature of knowledge resources used; and the role of participants and information resources while working with knowledge	a) Students are engaged in solving comlex, ill-defined problems through practices that explicitly and purposefully aim at creating new knowledge; b) Students use various knowledge sources; c) Knowledge is produced also for subsequent use; d) Students may be engaged in the real practices of a target field.
Cognitive	Designed tasks and artifacts or tools performing a modelling and reflective function for promoting students' self-regulative competencies to work in an intended way	a) Explicit modelling of expert-like knowledge practices through concrete models and templates; b) Methods used to promote self-reflection; c) Guidance provided for students about effective working strategies; d) Explicit scaffolding for collaborative knowledge creation process embedded in tools.

Seitamaa-Hakkarainen et al. (2017) argued that the pedagogical infrastructure framework supports teachers in designing successful learning activities in a teacher education context. However, using this kind of technology-enhanced pedagogical infrastructure requires that student teachers master specific digital skills; those who have such skills benefit the most from pedagogical training and learning at work (Lakkala & Ilomäki, 2015). The pedagogical infrastructure framework is also useful for teachers themselves as a means of self-assessment.

Lakkala (2010) explored a pedagogical infrastructure framework that helps to manage the complexity of educational settings because such a framework is needed for designing teaching practices. However, Lakkala (2010) and Lakkala et al. (2010) recommended that more detailed and specific guidelines and examples are needed for teachers to create designs for learning. Study II used various examples to define different levels of using the pedagogical infrastructure in the ways suggested by the authors of the pedagogical infrastructure. The learning designs created as a part of Study II were a way to evaluate vocational student teachers' pedagogical competence by studying the pedagogical approaches they used.

2.3 Digital competence

Digital competence is now an essential skill for all citizens and has become a key concept in educational settings (Tammaro & D'Alessio, 2016). Many studies, reports, and recommendations have summarised digital competence as encompassing skills related to information handling, communication, content creation, safety, and problem-solving (Redecker, 2015). The digital competence

framework for educators (DigCompEdu), created by Redecker (2015), requires that teachers' digital competence be included in teachers' resources to facilitate learners' digital competence. Redecker's (2015) framework also includes educators' pedagogical and professional competences and defines learners' competences. DigCompEdu is quite widely used in Finnish educational settings, including the context of the present study: Specifically, the vocational teacher education provider evaluated in the course of this research used it to frame its personnel's digital competences.

UNESCO (2011) defined the information and communication technology (ICT) competency framework as comprising three different approaches: technology literacy, knowledge deepening and knowledge creation. Very often the way teachers implement digital and pedagogical learning processes depends on how good their ICT skills are (Krumsvik 2014; Tammaro & D'Alessio 2016). This requires that each teacher be familiar with digital tools which can be used in pedagogical processes (Tammaro & D'Alessio, 2016). Röknenes and Krumsvik (2016) found that student teachers need to focus on ICT integration in didactics rather than general digital skills. Vocational teachers are now required to be able to use ICT efficiently in order to achieve successful professional development (Ruhalahti & Kentta, 2017). These studies have revealed that vocational teachers have mastered the basic skills they need for teaching and guidance but more professional development is required.

According to Ilomäki et al. (2016) there is no overall consensus on the definition of digital competence because technology and society are rapidly changing. They argued that there is a need to find a common ground to use the same concept in educational contexts by different users. Ilomäki et al.'s (2016) definition of digital competence included four elements: (a) technical skills and practices to use digital technologies; (b) the ability to use and apply digital technologies in a meaningful way for work and study; (c) the ability to understand ethical issues relating to limitations and challenges, the critical use of various technologies, and understanding computational thinking and robotics; and (d) the motivation to participate and engage in digital culture. They suggested that digital technologies should be integrated seamlessly as a didactic approach in all educational practices so that teachers can themselves learn while they teach. This idea fits with the present pedagogical study of digital tools and environments. Vocational teachers' digital competence is explored in Study II as an element of vocational teachers' competence.

3 Designing learning for Personal Learning Environments

Learning is blended in various different learning environments, playing a significant role in both formal and informal learning according to Wheeler (2015). Marsick et al. (2006) asserted that 70 per cent of a person's learning happens in informal contexts and occurs incidentally. UNESCO (1996) defined lifelong learning as continuing throughout one's lifetime and the European Commission (2001) declared that it should include formal, informal, and nonformal learning. UNESCO (1996) asserted that learning is not dependent on time or place but on the contexts and different actors involved in learning process. Laal and Laal (2012) offered three approaches for education, as follows: Formal education is designed and planned in such a way that learning occurs in school or in the workplace with the aim of achieving formal certification; nonformal education is provided by educational institutions but is more adjustable for student's needs and does not always lead to certification; and informal education utilises daily experiences at home, in society and at work. These approaches rely on PLEs to provide a platform for continuous learning. Continuous learning—synonymous with lifelong learning—requires many different forms of learning which occur outside of classrooms as well as within them (Laal & Laal, 2012). Learning varies according to individuals' needs and is now constantly accessible thanks to modern technologies (Laal et al., 2014). PLEs are very useful for personal development which continues from formal learning processes to informal and nonformal learning (Fiedler & Väljataga, 2013).

3.1 Personal Learning Environment

There is no consensus of conceptualisations of PLE and the tools that support learning in PLEs (Fiedler, 2012; Rahimi et al., 2015). Two specific approaches have been used to study PLEs: 1) As a technological system and means of collecting pedagogical tools; and 2) as a means of development for personal learning (Attwell, 2007; Fiedler & Väljataga, 2011; Fiedler & Väljataga, 2013). Attwell (2007) pointed out that the concept of the PLE recognises that learning is a continuing process and that suitable tools are necessary to support that learning. PLEs are relevant in both

formal and informal learning and recognise that students learn from a variety of learning providers (Attwell, 2007; Wheeler, 2015). These aspects are combined in Wheeler's (2015) definition of PLE (Figure 1 below), which connects to the discussion of continuous learning and how it is supported by formal, informal, and nonformal education and personal web tools as well as personal networks.

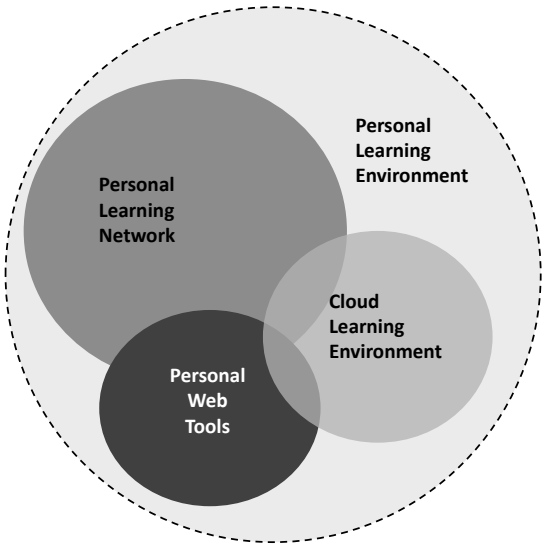


Figure 1 The Personal Learning Environment (Wheeler, 2015)

Attwell argued that the use of PLEs is 'not technical but rather is philosophical, ethical and pedagogic' (2007, 7). However, most PLE studies approach the concept from a technical perspective (Fiedler & Väljataga, 2013). Discussions of PLEs often include debates over personal web tools (PWTs), which are owned by students rather than chosen by educational institutions. Learning management systems (LMSs) are seen as tools belonging to the educational institution which provides them: All of the artefacts produced using LMSs remain with the institution rather than the student. Even though LMS are widely used in educational institutions, they do not offer optimal solutions for PLEs which support continuous learning, so students are encouraged to choose and establish their own digital environments as part of their PLEs (Vuojärvi 2013; Fiedler 2012; Wheeler 2015). Students expect to use their PLEs to engage in collaboration and discussion, as an experiential learning strategy and as an effective digital tool which supports learning (Dabbagh & Fake 2017). Learning how to do this requires guidance and instructions from lecturers. Wheeler (2015) argued that a kind of bridge (the cloud learning environment) is needed as an interface between educational institutions and students for content management

purposes and to facilitate communication between students and teachers. Such an environment could be built in various ways: For example, there is ongoing research related to Application Programming Interface (API) which aims to build a bridge between social media applications and LMS (Melo Filho et al., 2018). However, it has also been argued that API institutionalises PLEs (Casquero et al., 2010). Institutionally chosen technology can be customised and personalised for educational purposes, but this is seen as a situation where students are guided to use digital tools controlled by the educational institution (Millard et al., 2011).

Massive Open Online Courses (MOOCs) are an example of a PLE capable of filling a person's educational needs from his or her own perspectives. In a nonformal learning context MOOCs have become a modern way to organise learning processes online and to independently study topics relevant to individuals' own interests (McAulau et al., 2010; Haber, 2014; Oosi et al., 2019; Ruhalahti et al., 2016). MOOCs offer various knowledge in theory and in practice and do not require any dedicated technology or applications to use, although they are conducted online in digital format. Some MOOCs are designed with specific pedagogical approaches, or with instructions to use one's personal digital tools to learn collaboratively (Ruhalahti et al., 2016). They can often be used without collaborative learning activities but remain an important way to master personally meaningful topics. It is possible to integrate MOOCs in broader learning content as a part of the studies. Online activities train students to become autonomous and take responsibility for their own learning (Fonseca et al., 2016), which makes them a useful means of study.

Only a few studies have assessed the development of personalised learning when discussing PLEs (Fiedler & Väljataga, 2013). Valtonen et al. (2012) studied 'what kind of personal learning environments…students produce, for what purposes and functions': Pedagogically they were concerned with students' ability to be aware of their own learning while understanding how to choose the appropriate tools and content that support their learning. Valtonen et al. (2012) asserted that choosing these kinds of tasks and preparing students have usually been considered the responsibility of teachers, so if students are expected to take a more active role in this process they require support and orientation. Castaneda and Soto (2010) found that only some students were able to establish 'complex relationships between tools, contents, tasks, and themselves'. Further study of this process is required, and the present study explores answers to questions regarding pedagogical approaches to PLEs. It covers not only the digital tools students use as personal web tools but also pedagogical models, digital learning structures, digital tools, content of PLEs and teachers' competence during vocational teacher studies where PLEs are a focus of personal competence development. ePortfolios are assessed in two of the studies (II and IV), as they are integral to PLEs (Attwell, 2007). The present study examines the context of developing a person's competences using PLEs and the significance of scaffolding to successful

learning. As Dabbagh and Kitsantas (2012, 2013) discovered, PLEs and their various elements are a promising pedagogical approach which support self-regulated learning by combining formal and informal learning and utilising social media (Web 2.0) tools. These studies encourage the use and study of PLEs in vocational teacher education. PLE is implemented in various ways in all of studies (I–IV).

3.2 ePortfolios

ePortfolios offer a possibility to make all kind of competences visible in a digital format. The portfolio is not a new concept in education, but modern ePortfolios are visual collections of text, pictures, photos, videos, figures, etc., which allow individuals to make their competence visible in a multifaceted way using the multimodal artefacts and materials (Jewitt et al., 2016). Several studies have suggested that in order to follow the concept of PLE, ePortfolios need to be chosen by student themselves (Fiedler, 2012; Vuojärvi, 2013; Wheeler, 2015: 119) rather than by using software chosen by an educational institution or teacher to be used by all their students (Le 2012; Oakley et al., 2013).

Barret (2010) used two different phases for creating an ePortfolio: a workspace and a showcase. She explained that students first create their own workspace to create and save artefacts and other materials related to the learning process. Workspaces are thus repositories rather than a means of directly demonstrating one's competences to a wider audience (Barret, 2010). Secondly, the repositories are needed to compose a showcase ePortfolio which can be made visible to a wider audience. Barret (2010) explained that some artefacts may remain the same in different stages, while others can be edited to more convenient format for external audiences. ePortfolio documentation should be an ongoing learning process and constantly reassessed; however, the end product, as a showcase portfolio, must be a summative assessment of what has been learned (Barret, 2010). Barret's (2010) definition of ePortfolios is used in the present study.

ePortfolios are seen as a reflective tool in a learning process (Kankaanranta et al., 2007), but they are too often used in a narrow way, such as a learning diary (Awouters et al., 2007; Kankaanranta, 2007; Viksted, 2007). ePortfolios can also form part of a learning process focused on the entire learning journey. This includes ownership of an ePortfolio that is reciprocal and reflective (Huges, 2010). Cambridge (2008) wrote that ePortfolios are not just for learning but can also improve a candidate's employability when presented to 'career advisors, employers, personal associations, family members, communities, and portfolio owners themselves'. ePortfolios are used to express one's competences, and creating an ePortfolio can be understood as a skill itself. By presenting their skills in an ePortfolio, students can better understand their professional development and their

needs for future development, thus narrowing the boundary between education and work and integrating formal and informal learning (Korhonen et al., 2007).

Previous research has shown that composing an ePortfolio is not an easy task for student teachers (Parker et al., 2012; Plaisir et al., 2011). Parker et al. (2012) discovered that ePortfolio process is meaningful if there is a place to discuss scope, guidance, timing, alignment with standards, reflection and growth, and sharing ePortfolio with a wider audience. It is obvious that more scaffolding is needed to train student teachers to use ePortfolios to develop and display their competences: in competence-based teacher education the portfolio is a potential tool for both development and assessment (Struyven et al., 2014). ePortfolios should be organised around competencies (Rico, 2017) and the use of portfolio requires that it is integrated with learning practices using a curriculum design (Imhof & Picard, 2009; Lewis, 2017; Rico, 2017). Composing an ePortfolio helps student teachers better understand the competence and practices of the teaching profession (Berrill & Addison, 2010) and ePortfolios offer students a means of developing their competence in progressing and planning their own careers (Lumsden et al., 2007).

Few studies have examined how vocational teacher's competence can be made transparent in a digital format. ePortfolios are much studied from different aspects, such as development planning (Daunert & Price, 2014) and technology (Milman & Kilbane, 2005). It is also relevant to consider what kind of competences ePortfolios are best suited to. Teachers' competences are often defined by learning outcomes in teacher education programs, regardless of the fact that teaching competences are not learned just in school but throughout one's entire career (Toom, 2017). Therefore, support for ePortfolios is recommended to look forward and to promote continuous learning. ePortfolios are tools that follow individuals after their studies and will be used to introduce the best a person can do in their professional field. They may later be able to review their achievements, reflect on what else they need to learn and continue their learning journey with their ePortfolio.

The present study explores ePortfolios as a part of PLEs in studies II and IV. Students' use of the tool as both a workspace and a showcase are evaluated and the content, methods of scaffolding, and students' motivation regarding to activities in ePortfolios are explored. The study also contributes to the wider discussion of the value of ePortfolios to continuous learning and vocational teacher's competences.

3.2.1 Motivation to work with ePortfolios

Ryan and Deci (2000) asserted that human beings can either be proactive and engaged with their work or passive and alienated. Motivation is highly valued in the real world in any situation where one person is trying to make others act in a way that satisfies psychological needs, such as competence, autonomy and relatedness

(Ryan & Deci, 2000). When these psychological needs are satisfied, self-motivation and wellbeing are achieved (Ryan & Deci, 2000). Motivational considerations are widely used among teachers in designing processes for learning and motivational scaffolding has proven to be an opportunity to enhance learning (Lajoie, 2005). Self-determination theory (SDT) is used to investigate people's inherent growth and psychological needs, which constitute the basis for their self-motivation, personality integration and the conditions that foster these positive processes (Ryan & Deci, 2000). It highlights that inner resources for personality development and behavioural self-regulation are important (Ryan et al., 1997). SDT is also used to examine environmental factors which damage self-motivation, social functioning and personal wellbeing (Ryan & Deci, 2000).

Motivation can be either internal or external, or a combination of both. Ryan and Deci (2000) studied both types as forms of intrinsic and extrinsic motivation, explaining that intrinsic motivation is the pursuit of inherent satisfaction in an achievement which brings interest and joy. In intrinsically motivated learning activities there is no expectation of external rewards. Extrinsic motivation refers to activities driven by external rewards and pursued to attain separable outcomes. Students are expected to be self-determined and motivated to learn, and therefore their orientation must be examined and taken into account when designing learning plans and tools. According to Ryan and Deci (2000), this orientation is reached in three levels: impersonal, controlled and autonomous orientated.

Jacobi (2018) found that SDT is useful in understanding online learners' needs and challenges, which allows teachers to differentiate their teaching practices accordingly. Instructional strategies which promote relatedness and motivate students include collaborative activities, meaningful feedback and immediacy (Jacobi, 2018). Martin et al. (2018) found similar results in their study of MOOCs: Students seemed to be more interested in their studies when SDT was taken into account in designing learning plans (Martin et al., 2018), and intrinsic dimensions were found to positively impact students' motivation (Irvine, 2018). Motivation has also been studied with new learning concepts, such as open badge-driven learning. The study revealed that representing achieved skills with badges confirmed students' belief in their current abilities and builds an expectation that they will succeed (Brauer et al., 2017). SDT helps researchers understand students' motivation and how engagement arises from that motivation (Reeve, 2012); it can be used to identify and recognise students' inner motivational resources and to provide recommendations as to how teachers can cultivate these resources (Niemiec & Ryan, 2009). SDT specifies the conditions that tend to support students' natural activity by avoiding their vulnerability to passivity (Ryan & Deci, 2000). However, it is not always sufficient to explain their motivation (Irvine, 2018), which is complex and sensitive as well as situational (Hartnett et al., 2011).

In the present study motivation is studied (Study IV) in the use of ePortfolios in learning activities and in how students make their competences visible. This was studied in order to discover how to provide scaffolding to students that will motivate them to work with ePortfolios and find ways to continue to develop their competences as vocational teachers once their formal studies are complete.

3.3 Web 2.0 tools

As a part of PLE, Personal Web Tools (PWT) are used individually and collaboratively. Web 2.0 tools make use of the human instinct for collaborative and dialogical interaction, which includes creating and sharing via technologies such as blogs, wikis, streaming videos, social networks and open-access sites (Abram, 2007). Sharma and Fiedler (2007) discussed this phenomenon with regard to online publishing, where tools and practices can be used to engage learners in learning conversations and develops skills for independent and self-organised learning. Web tools can themselves be considered social networks, distribution channels and media archives all at the same time (Beetham, 2013). These kinds of open social software can be used in learning processes, such as collaboration, interaction and creating online communities among students (Özkan & McKenzie, 2008). Students should choose their preferred tools themselves so as to promote collaborative and independent self-directed learning activities (Väljataga & Fiedler, 2014). Students have some criteria for selecting PWT, such as gratuity, age, hybrid access mode, communication type and visibility (Bassani & Barbosa, 2018).

Blogs and wikis are examples of tools that combine several functions, including content creation and sharing (Wheeler, 2015; Bassani & Barbosa, 2018). They can also include several functions in a single platform, e.g. a blog, wiki, website, and discussion forum (Bassani & Barbosa, 2018). Blogs are said to be a good environment for collaborative knowledge construction (Deng & Yuen, 2011; Aramo-Immonen et al., 2015; Sahin & Uluyol 2016; Yang et al., 2016), although cognitively effective learning by blogs requires active dialogue between students and a teacher (Yang et al., 2016). Using blogs in learning processes also develops student teachers' awareness and positive attitude towards using ICT in education (Goktas & Emirel, 2012). Goktas and Emirel (2012) also found that scaffolding and using blogs improved students' higher-level thinking skills. Wang and Woo's (2010) and Robertson's (2011) studies indicate that blogs provide opportunities for students to become self-directed learners: They learn to generate learning objectives, evaluate whether these have been met and redesign them if necessary. In addition, according to Tang et al. (2014), blogs increase intention to learn continuously. Blogs can also be used as a collaborative tool in small study group activities established and monitored by the groups themselves; in such instances, these groups are also considered PLEs.

While blogs are a good tool for learning, they require more tools to be integrated in the learning process to ensure that a short instant messaging feature is available. Quick questions and answers assist with learning activities, and messaging tools such as WhatsApp or closed Facebook groups can be used to enable collaborative interaction with private groups of students. Bouhnik and Deshen (2014) studied WhatsApp in a learning context, finding that the tool promoted a social atmosphere and dialogue and made students more likely to share their views with one another. Synchronic communication also is needed: Conference calls can make it possible for students and their teacher to have a collective dialogue and make it possible for teachers to provide further scaffolding for their students. According to Bower and Hedberg (2010), meeting online in web-conferences to share teachers' comments and scaffolding prompted students to participate in collaborative work.

If student teachers are given several opportunities to become familiar with various methods and implementing various digital tools in their learning processes it may inspire them to test digital tools themselves in their own teaching work and during their teacher training period. Collaboratively used blogs and other Web 2.0 tools were chosen in order to support student teachers' ability to test themselves and to evaluate how they incorporated these digital tools in their teaching activities. This was studied in Study I. Particularly blogs as individual ePortfolio tools is evaluated in Studies II and IV.

3.4 The pedagogical DIANA model

Every pedagogical model is based on a learning theory and is used as a theoretical framework to design and organise students' learning activities. Following a pedagogical model enables teachers deconstruct learning actions, provide sufficient practice exercises and give feedback to guide students' learning (Laurillard, 2012). Beetham and Sharpe (2007) used the term 'pedagogy' to refer to learning in the context of teaching with the goal of promoting learning.

In Study I the pedagogical DIANA model (Aarnio & Enqvist, 2016) was chosen as one approach to study how PLEs can be applied in learning activities with a pedagogical model. The DIANA model combines authentic, dialogical and collaborative learning in various digital environments and blended learning settings (Aarnio & Enqvist, 2016). As Ruhalahti (2019) found in her studies, the DIANA model is a promising framework for online studies and other learning environments, and it is well implemented in PLE settings, providing deep learning activities during the construction of authentic and dialogical collaborative knowledge construction. The DIANA model includes three different theoretical frameworks: the sociocultural theory of learning (Lave & Wenger, 1991), authentic learning (Herrington & Oliver, 2000) and dialogical collaborative knowledge construction (Isaacs, 1999). Aarnio

and Enqvist (2004) examined the context of vocational teacher education and concluded that the DIANA model provides several skills, such as innovative problem-solving skills sharpened using known facts and new information and collaborative problem-solving skills. The DIANA model is developed in two dissertation studies (Aarnio, 1999; Enqvist, 1999) and developed further with piloting in higher and teacher education settings, as well as in vocational education and the training sector (Aarnio, 2006; Aarnio & Enqvist, 2004). The DIANA model has proven to be suitable in the Finnish vocational teacher education setting for providing opportunities for authentic, dialogical and collaborative learning, and it promotes deep-oriented learning (Ruhalahti et al., 2017; Ruhalahti et al., 2018).

The DIANA model (Aarnio & Enqvist, 2016) comprises four cornerstones, labelled A to D. Cornerstone A creates a common ground for collaborative learning, B enables authentic learning, C provides an opportunity for deeper-orientated learning through dialogical actions, and cornerstone D is the integration of theory and practice (Aarnio & Enqvist, 2016). If possible, the learning process continues by starting over again from cornerstone B. Table 2 provides more detailed explanations of the operative dimensions of each cornerstone.

Table 2 The structure of the revised DIANA model (Aarnio & Enqvist, 2016)

CORNERSTONES 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 the 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

The DIANA model focuses on the pedagogical aspects of learning and scaffolding was not its original focus. The DIANA model requires to be followed carefully to ensure that dialogue and authenticity are not discouraged (Aarnio, 2006). In the present study the DIANA model was carefully followed in Study I in order to determine whether it could provide methods of scaffolding. Whether it is possible to apply it to the concept of the PLE was also considered.

3.5 Open badge-driven learning

The completion of formal education entails a discussion of competences and whether they are adequately represented by certifications. Some form of detailed information on a person's competence is required in cases where official guidelines and standards are not enough to identify his or her competences. A relevantly new approach is to utilize open badges, which are digital microcredentials and which may be used to identify and promote competences (Abramovich et al., 2013; Brauer & Ruhalahti, 2014). The open badge infrastructure enables open badge earners to collect badges from different issuers into a personal repository, such as an Open Badge Passport or Mozilla Backpack, and badges can be shared digitally in various social media environments (Brauer & Ruhalahti, 2014) or by embedding them in ePortfolios. Open badges are information stored in a digital format. They are represented by a visual image, graphic or icon and include the name of the badge and issuer, a description of the competence, assessment criteria and evidence of the earner's competence (Bowen, 2018). These are all displayed when someone views the digital open badge. Badges are assessed based on a badge application which may include several types of information in a digital format (Casilli & Hickey, 2016). Badges are 'opened' by providing information on an individual's achievements to all viewers and anyone can recognise the competence again (Mozilla Open Badges, 2017). To be able to conduct any kind of process based on open badges, a badge management system is needed where badges are created and applications are provided, scaffolded and assessed (Brauer & Siklander, 2017). Brauer and Siklander (2017) described the management process of open badges as 'instructional badging'. Open badges make it possible to compose personalised learning paths by providing various badge families and constellations, which usually comprise various levels of competences inspiring students to progress through a learning process by following competence-based tasks; the process can also be gamified (Brauer et al., 2018). A scaffolding process using open badges is quite a new approach, but a number of practices are considered. Gamrat et al. (2016) suggested providing feedback or guidance when student applies a second time for the same badge. Brauer and Siklander (2017) explored whether students appreciate lecturers' feedback during the open badge

application process. It was found that advanced students wanted more guidance and feedback from their peers while engaging in communal learning (Brauer et al., 2018).

The open badge-driven learning offers systematic tools and methods for teachers to provide their students scaffolding in their PLEs. Scaffolding organized by open badge-driven learning process is explored in Study III. The aim was to investigate the scaffolding structure in open badge-driven learning process by examining the stages of online scaffolding process and instructional badging. Study III gave an additional perspective to scaffolding PLEs.

4 Scaffolding models for Personal Learning Environments

To understand how to scaffold through PLEs two approaches have been used in the present study as theoretical frameworks: the five-stage model (Salmon, 2011; 2018) and the distributed scaffolding frame (Tabak, 2004). Moore (2000: 19) viewed scaffolding as a pedagogical technique wherein a teacher guides students' thinking and choses which lines of thought are most useful in promoting productive learning. Moore felt that this was detrimental to a student's own choices and decision-making. However, Määttä and Uusiautti (2013) emphasised that a teacher's pedagogical activities should acknowledge each student as a person and respect his or her abilities as an active learner. Scaffolding techniques are a type of pedagogical activities which emphasise teacher's role as a supporter rather than a leader (Määttä & Uusiautti, 2013).

Lave and Wenger (1991) suggested a sociocultural theory of learning as a form of social participation in different contexts. Wenger (2009) explained that learning includes social components as a way of talking about our individual and collective abilities, a way of talking about shared historical and social resources, a way of talking about the social configurations in which our enterprises are defined and our participation is recognised as a competence, as well as a way of talking about how learning changes who we are in the context of our community. Lave and Wenger (1991) concluded that learning happens in communities. From a scaffolding perspective this notion is essential to support learning in a such a way that it happens in communities together with lecturers and peers and in workplaces and digital environments.

4.1 Scaffolding

Adapting scaffolding so widely in educational practices has diluted and obscured the concept (van de Pol et al., 2010). The frequency with which the subject is studied has revealed a need to improve student-centred scaffolding and guidance (Aarnio, 2006; Ruhalahti et al., 2016; Teräs, 2016). Scaffolding is usually explained as the guidance a teacher provides to a student according to his or her individual needs in

order to achieve learning objectives he or she otherwise would not be able to (Wood et al., 1976). Turned in another way round individuals have learning potential that can be achieved with scaffolding providers (Lajoie, 2005). Scaffolding is also synonymous with support (Puntambekar & Hübscher, 2005). Successful scaffolding entails teachers providing the right amount of structure to students by recognising their different needs, from those who need no structure to those who prefer a great deal of it. Teachers need to understand students' prior knowledge in order provide the right amount of scaffolding (Dabbagh, 2003). Scaffolding is not seen as a permanent support and it should fade when a student becomes a self-regulated learner (Stone, 1998; Puntambekar & Hübscher 2005).

The term scaffolding was introduced by Wood et al. in 1976 in the context of educating children. However, today it is widely used in all educational levels and contexts. A concept of scaffolding relates to Vygotsky's (1978) formulation by which a teacher is a more knowledgeable learner assisting students in problem solving in their zones of proximal development (ZDP). Vygotsky (1978) formulated the ZDP model as comprising two parts, the actual and potential levels of development. The actual level is what a student can perform independently and in the potential levels of development a student is assisted by more knowledgeable like teacher or peers (Palincsar, 1998). Teacher is responsible to design and organise the learning activities within the student's zone of proximal development, provide assistance and give feedback in a way that improves performance (Laurillard, 2012). Like Dabbagh (2003) described the scaffolding process of 'just-in-time, just-enough-assistance' forms a learning experience where 'novice learners get enough basic support and information to successfully engage in learning without slowing down advanced learners'.

Stone (1998) concluded that the concept of scaffolding includes an assumption that learning objectives are understood and valued by students, that teachers provide assistance based on their diagnosis of each student's skill level and the nature of the tasks, and that they know it is temporary. Stone (1998) also argued that the core of scaffolding is the view of it as a process. Walqui (2006) raised the question of how to structure scaffolding in such a way that it is effective in developing students' skills. He suggested that this is achieved in learning tasks, classroom activities, learning processes and collaborative interaction. He referred to Vygotsky (1978) and Van Lier (2004) in explaining that sources of scaffolding are experts (e.g. teachers), peers in collaborative knowledge construction, the peer learning that occurs while assisting less accomplished learners and working alone by utilising 'internalized practices and strategies, inner speech, inner resources and experimentation' (Walqui, 2006,161). De Olivieira and Athanases (2017) explained Walqui's (2006) process by suggesting that the framework for scaffolding is composed of the domains of

whom to scaffold, for what purposes, and how. The purpose of scaffolding is also to train students to be self-regulated learners (Zimmermann, 1990).

Malik (2017) criticised several interpretations of scaffolding, arguing first that scaffolding was originally intended to involve only two persons, an instructor and a student, and therefore it cannot be conducted in a classroom for many students at the same time. Secondly, he asserted that scaffolding cannot be two students scaffolding each other in order to have different continuum to build a relationship with each other than the case is with instructor and student. Third, he insisted that scaffolding cannot be provided via tools such as media, technology or software (Malik, 2017). He based his argument on Kim and Hannafin's (2011) definition that technologically conducted aid for students should be understood as 'technologically enhanced scaffolding', not scaffolding in and of itself. Kim and Hannafin (2011), however, asserted that technology is a valuable means of supporting students. Some scaffolding models include digital learning environments as a part of scaffolding process instructions, such the distributed scaffolding described by Tabak (2004). In the present study scaffolding is understood as a broad concept defined by two models, Salmon's (2018) five-stage model for scaffolding online learning and Tabak's (2004) distributed scaffolding, which acknowledges that scaffolding is not a static concept but has various dimensions.

4.2 The five-stage model for online scaffolding

The five-stage scaffolding model is created for online learning processes by Gilly Salmon (2003; 2011). She started her action research with scaffolding in the 1990s, examining online learning processes (Salmon, 2003) and using the terms e-moderator and e-activities designer (Salmon, 2013) to describe teachers who conduct their work online and offer scaffolding via digital tools. Salmon's (2011) five-stage model is based on various dimensions of asynchronous online learning (Figure 3).

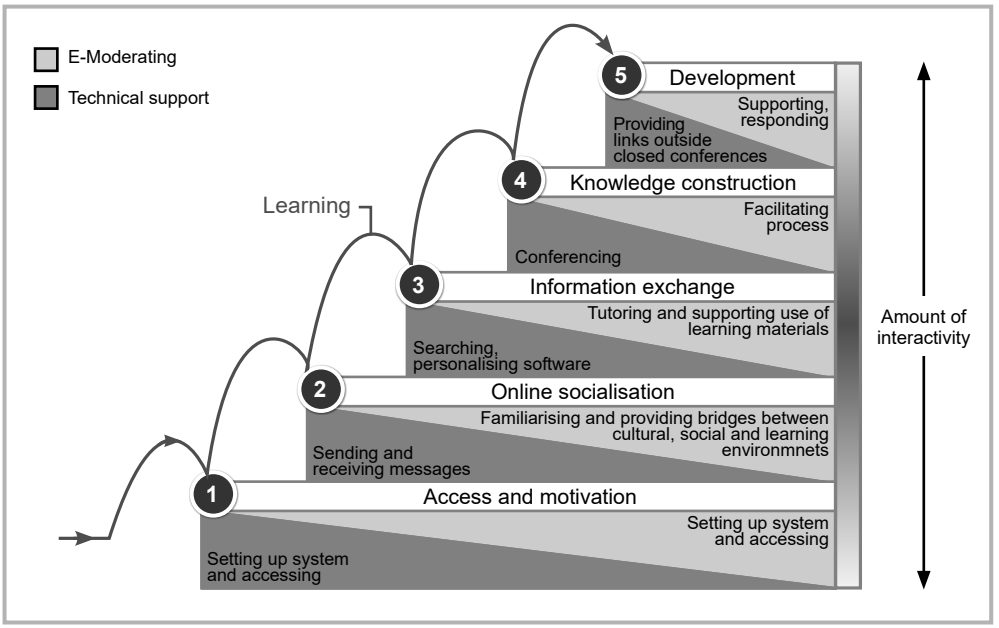


Figure 2. Salmon's Five Stage Model (2018).

The Five-stage model (Salmon, 2018) includes social interaction, motivation and learning by using digital tools. It explains to teachers how to provide scaffolding to students during online collaborative learning processes. The model is also designed to support and encourage students' self-directed learning (Salmon, 2003).

The first step of Salmon's model (2003, 2011, 2018) is to set up a digital system which is easy to access, welcoming and encouraging students to join and the online learning process. This affects students' attitude towards the new learning process and motivates them to continue. The second stage is to become familiar with peer-students. Teachers can send supportive messages to build bridges between the cultural, social and learning environments. The third stage is to exchange knowledge, personalise software, facilitate tasks and provide learning materials. The fourth stage is knowledge construction. Teachers facilitate the continuing learning process by asking questions, enhancing discussion and motivating and encouraging students. Finally, the fifth stage is giving further information to students about individual development and resources for learning. When students progress, they become more independent and more responsible for their own development and learning.

Models such as this provide a list of very basic scaffolding activities (Lakkala, 2010), but Salmon's (2018) model is easy to implement in online teaching practices. It has been implemented at several school levels and with various approaches, such as Second Life with university students (Salmon et al., 2010), wiki-based collaborative writing for university English language learners (Chao & Lo, 2009),

mobile learning practices in undergraduate language studies (Abdullah et al., 2013) and collaborative technologies with adult learners (Johnson, 2017). The before mentioned studies indicate that collaboration among students was present and affected positively their learning when the five-stage model was implemented.

As the five-stage model has been closely studied by Salmon herself (2018) and is regularly applied in practice, it was used as a scaffolding framework in the present study in an evaluation of scaffolding methods suitable for PLEs. The five-stage model was tested with the DIANA pedagogical model in Study I and with the structure for open badge-driven learning process in Study III.

4.3 Distributed scaffolding

It is worth taking a closer look at how scaffolding is used by different providers. To understand how to scaffold PLEs—or any educational method—one needs to know what to scaffold, the necessary steps involved and who will be providing the scaffolding (de Oliveira & Athanases, 2017). Distributed scaffolding by Tabak (2004) incorporates multiple forms of assistance for different and complex learning needs. It is possible to identify scaffolding provided by teachers, peer-students and instructions in a digital environment (Lajoie, 2005; Tabak, 2004). Puntambekar and Kolodner (1998) defined these providers as various agents that play a role in a learning process. As known collaborative knowledge construction is a successful way of learning and it utilises peer-students in small groups (Michaelsen & Sweet, 2011). Learning complicated skills needs collaborative knowledge construction (Aarnio, 2006, 11; Lave & Wenger, 1991). Scaffolding may also be collaborative while peer-students guide and assist each other (Donato, 1994) in collaborative knowledge construction processes. From teacher's perspective this is a meaningful resource to be utilised and is worth planning carefully. Tabak (2004) studied patterns of distributed scaffolding, defining three different approaches based on issues that she hoped to encourage educators to consider: 1) developing deep conceptual understanding and producing knowledge requires innovative and complex support; 2) multiple ZPDs in study groups, meaning that different learners are familiar with different cultural tools and to different degrees; and 3) various material and social means can provide different possibilities for how to proceed and give students relevant suggestions as cultural tools. Tabak's (2004) three approaches of scaffolding are differentiated scaffolds, redundant scaffolds and synergistic scaffolds, each of which serve a different pattern. Differentiated scaffolding is a basic pattern which responds to the need for a large variety of different methods while one single method of support cannot provide (Tabak, 2004). According to Tabak (2004), the goal is to discover the agent or material that best supports each need. Multiple ZDPs in a classroom require multiple support for the same need

(Palincsar, 1998), which is achieved by a redundant scaffolding pattern (Tabak, 2004). Redundant scaffolding is said to maximise the possibilities of students benefitting from the support (Puntambekar & Kolodner, 1998), recognising that some students need more scaffolding than others and allowing students to 'hear' instructions in several ways—thus allowing them to choose the one easiest for them to understand (Tabak, 2004). Synergistic scaffolds offer different complementary forms of support which do not all address the same need; this pattern is a combination of software and human scaffolding (Tabak, 2004).

Although there are several means of providing scaffolding, it should be emphasised that teachers are responsible for designing the learning process and must carefully plan their learning designs and scaffolding activities. As Lakkala et al. (2005) discovered that scaffolding alone does not help students achieve learning objectives; but appropriate pedagogical designs and structuring preconditions are also required. Ustunel and Tokel (2018) found that technology-based scaffolds with teaching activities support students create an effective learning environment which is difficult to create in a classroom. Instructional materials are insufficient to support all students; scaffolding activities are required to determine how much support each student needs (Martin et al., 2019).

The present study utilises several approaches for scaffolding, such as learning which takes place in communities, with peers and lecturers and in workplaces. Digital learning environments are seen as a tool and place for scaffolding where learning materials and instructions as well as collaborative learning tasks and interactions between lecturers and peers are implemented. These aspects are explored in Study IV by exploring to which providers scaffolding is divided and what kind of methods it includes while ePortfolios are used in learning processes.

5 Research design

5.1 Aim and research questions

The aim of the study is to investigate how to design scaffolding for students using PLEs in the learning process and making their competences visible. The study comprises four smaller-scale studies which form a continuum of the four different approaches to organising scaffolding discussed in the preceding chapter. Each of the four studies is an individual case study conducted to achieve a detailed analysis of the phenomenon in question (Johnson & Christensen, 2008). The present study used a multiple-case design and a holistic approach (Yin, 2003, 46). The cycle of the studies and the relationship between theories are illustrated in Figure 4 and the research questions, data and analyses of the four studies are summarised in Table 3 below.

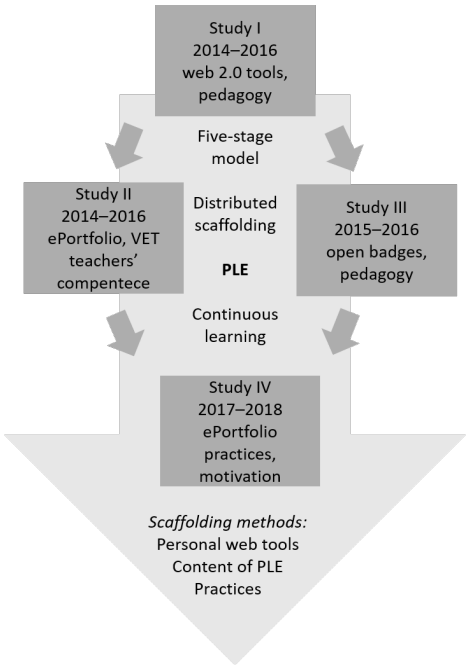


Figure 3 The cycle of the studies and relationships between theories.

Study I explored online learning using the DIANA pedagogical model and examined how the model reflected the scaffolding activities provided in the implementation of the five-stage model (Salmon 2018). In Study I, during a course online digital PLEs were in use collaboratively by peer groups (study circles) that students chose themselves. Study I prompted the question of what kind of artefacts were used and why students shared them via their digital PLEs. ePortfolio contents were studied as a part of PLE concept in Study II. The next stage after Study I was also to explore what other kinds of modern aspects there are that fulfils the PLE requirements in line with ePortfolios. In Study III the structure for open badge-driven learning process was explored from the perspective of how scaffolding activities were represented in the open badge-driven learning process. Finally, the last approach was to study what kind of practices student teachers used with ePortfolios and which forms of scaffolding they recommended. This was studied during the ePortfolio process implemented throughout the teacher education program. In addition, Study IV explored student teachers' motivation to learn and make their competences visible in ePortfolios.

The main research question of the dissertation is: How to design scaffolding when students use their PLEs in the learning process to make their competences visible?

This is answered by the research questions of the present study as follows:

- RQ1: How should scaffolding be provided alongside the use of digital PLEs and PWTs?
    - Digitalization and technology-enhanced learning offer several opportunities to organise learning processes but it might be relevant to consider what kind of environments are useful in each case and how to make competences visible in a way that it can be shared with a wider audience. Most of the different approaches to digital environments and personal web tools are presented in Study I, although Studies III and IV provide additional answers.
- RQ2: What is the content of PLEs, and more specifically, ePortfolios of vocational student teachers?
    - This question clarifies what kind of ePortfolio content is relevant to vocational student teachers and how to assess the contents of ePortfolios. The results are given mainly in Study II; Study IV provides additional insights.
- RQ3: How should scaffolding methods be implemented with PLEs?
    - Methods for scaffolding PLEs are approached from the following perspectives: the DIANA pedagogical model, the five-stage model for online scaffolding, distributed scaffolding and open badge-driven

learning. Students' motivation to use PLEs and ePortfolios is studied in order to improve methods of scaffolding. It is expected that if students are motivated to use ePortfolios they will see their own development and what they need to develop as vocational teachers, including their understanding of continuing learning. These practices are introduced as the results of Studies I, III and IV.

Table 3 Overview of the Research Themes and methods used in the four studies

Aims	Research questions	Time of data collection	Participants and tools for data collection	Methods of data analysis
Study I to study activities of pedagogical model comparing to a scaffolding model and used tools of ple during an online learning process	1 How and by what means can learning through personal learning environments (PLE) 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 the scaffolding described in the diana model, and accordingly, what are the critical points in an online learning process?	2014 - 2016	Online questionnaire: vocational student teachers (n=63) Additional online questionnaire during the third phase by the process data four times (n=13)	Design-Based Implementation Research approach: Qualitative deductive content analysis
Study II to study how eportfolios as ple are individual learning environments and for making competence visible	1. What kind of artifacts and sections are the eportfolios composed of? 2. What kind of competence is visible through student teachers' eportfolios? 2a. What kind of digital quality eportfolios represent? 2b. What kind of content quality eportfolios represent?	2014 - 2016	Vocational student teachers' online ePortfolios (n=36)	Qualitative approach: abductive content analysis
Study III to explore scaffolding in digital open badge-driven learning process	How do students experience scaffolding in badge-driven learning?	2016	Group online interviews (n=6), vocational teacher education / pre-service teachers (n=12) and in-service teachers (n=17)	Qualitative approach: Data-driven content analysis and inductive thematic analysis

Aims	Research questions	Time of data collection	Participants and tools for data collection	Methods of data analysis
Study IV to explore vocational student teachers' practices and recommendations of supportive methods for making eportfolios as well as their motivation	1. What kind of practices student teachers describe to have applied in making an eportfolio? 2. What kind of scaffolding they recommend to be important during an eportfolio process? 3. What motivates student teachers to compose an eportfolio?	2018	Focus group discussions (n=4), vocational student teachers (n=20)	Qualitative approaches: 2 abductive content analysis and 1 deductive content analysis

5.2 Research context and participants

All four studies assessed vocational teacher education in Finland and vocational student teachers enrolled in the vocational education department of a Finnish university of applied sciences. The curriculum of the vocational teacher education was competence-based and the learning outcomes will give to student teachers future competences to work in the field of vocational education and training as well as in the universities of applied sciences. The vocational teacher studies take approximately one year and comprise a total of 60 ECTS (European Credit Transfer System). Teacher students study part-time while working mainly as vocational teachers. The teacher studies are conducted as blended learning process; there are contact lessons, online studies in many ways, and a workplace (school) teacher training period. The studies I, II, and IV are made in this context. Study III is partly in this context and partly it is conducted with vocational teachers that are updating their competence during the continuing education program.

Study I examined the university of applied sciences and teacher education module called 'Networks in Professional Education', which was offered five times, from 2014 to 2016. The learning design was developed first for the four student teacher groups and took from four to five weeks each. Before the course began student teachers had studied some digital tools to utilise during their studies. The concept of the PLE was also explained to the student teachers, who were given an opportunity to choose their web tools for learning independently and in groups. All students used voluntary open Web 2.0 tools; however, they were also given a chance to use digital tools provided by the university. The course design followed the four cornerstones of the DIANA pedagogical model (Aarnio & Enqvist, 2016). Student teachers studied in the study circles collaboratively and dialogically constructing knowledge. The lecturer's instructions and the course materials (readings and videos) were provided via the teacher's open blog, which was called the 'teacher's

blog'. It was for sending messages to students, such as instruction of learning activities, knowledge sharing, and reflection of the students' progress. The mobile application WhatsApp was used between the entire study group for instant and brief messages and instructions, such as reminders of practices. In addition, study circles used their own groups for messaging, such as WhatsApp or Facebook closed group. The course was conducted the fifth time with fifth teacher student group in order to focus more on the course design by finding out scaffolding points and tools. The fifth student group was conducted with the same principals than earlier groups. The interest was in this time in the process of the pedagogical DIANA model. The participants of Study I represented different disciplines that are introduced in Figure 5.

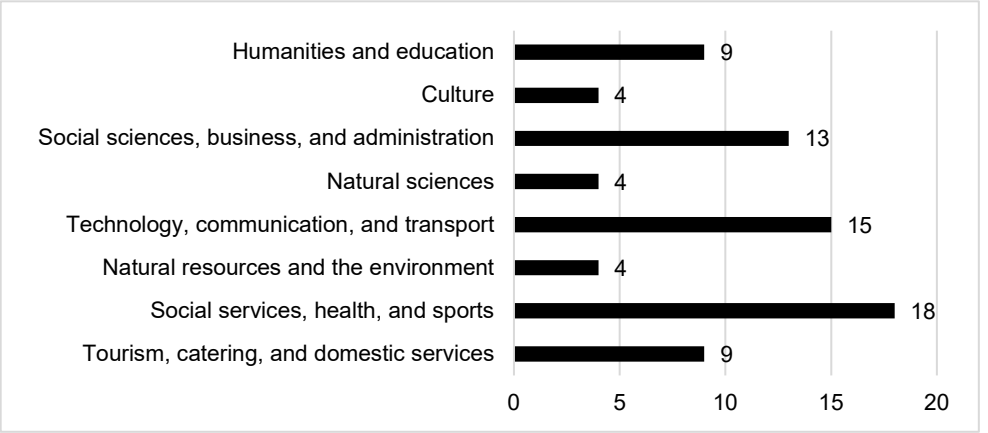


Figure 4. Study I: student teachers' (n=76) disciplines

Study II was conducted with two teacher student groups enrolled from 2014 to 2016. The groups worked in a blended learning setting throughout the program. They chose their own PWTs during the study program (worth 60 ECTS). PLEs were used in the form of ePortfolios, a workspace to collect all learning outcomes (e.g. a project work report, learning design plans, a learning diary, personal information such as a development plan and important personal educational learning materials). The lecturer instructed student teachers to provide artefacts such as text, pictures, figures and videos as evidence of their competences. Student teachers were guided to choose Web 2.0 tools or a portfolio tool provided by the university which was based on Mahara software. Digital tools were both a part of learning to create an ePortfolio and a way to demonstrate competences through an ePortfolio. Lecturers provided scaffolding with the first group using the Mahara software for instructing and messaging the student teachers; for the second group Moodle, the learning

management system of educational institution, was used. Substance-related and technological scaffolding was provided. The participants represented different disciplines, which are outlined in Figure 6.

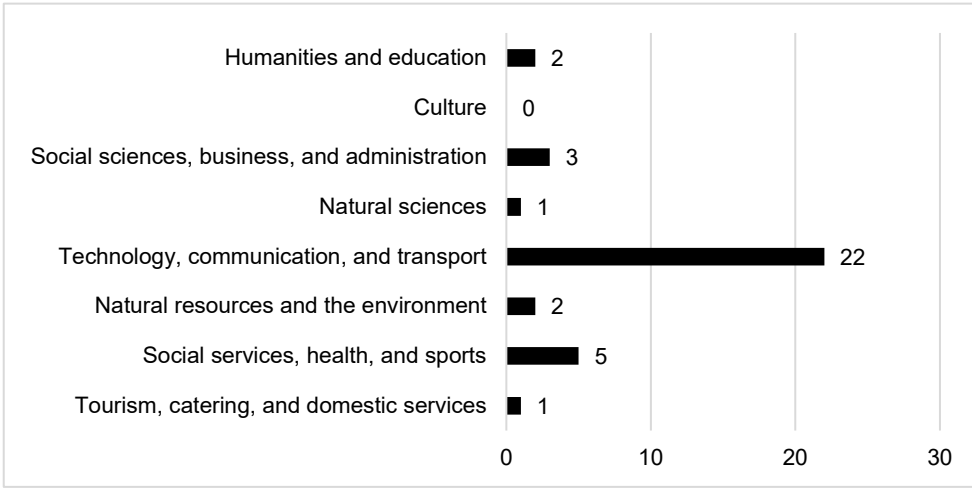


Figure 5. Study II: Student teachers' (n=36) disciplines

Study III examined vocational teacher programs where some participants were enrolled in a vocational teacher education program (60 ECTS) referred to as pre-service teacher training. The rest of the students attended continuing education program and were called in-service teachers. Both groups participated in an open badge-driven learning process designed to support vocational teachers' digital skills. The studies were organised as a MOOC-style course where open badges represented each digital pedagogical expertise achieved. Open badges helped participants plan and customise their PLEs to meet their personal and professional development and needs. The MOOC Learning Online (Oppiminen Online in Finnish) included 50 different badges to choose from, divided into three levels of requisite skill sets which corresponded to Finland's national ICT-competency guidelines from the year 2014, which were themselves based on UNESCO's (2011) ICT Competency Framework for Teachers. The three levels were I) SoMe-Novice; II) SoMe-Expert; and III) SoMe-Developer (the abbreviation 'SoMe' refers to 'Social Media'). The students demonstrated their mastery of each level with a certain number of open badges, such as SoMe-Novice 10, SoMe-Expert 25 and SoMe-Developer 45. Students automatically received level badges for non-assessed milestones.

The studies were conducted in two ways. The first path was for in-service teachers, who were offered two days of in-person lessons at the beginning of the course. Teachers collected badges individually as they had planned in order to

accomplish each of the three levels of the requisite skills set. They were provided easy-access learning materials and instructed how to demonstrate their competence using the open badge management system. All issued badges were counted and published on the leader board on the MOOC website. The learning process for in-service teachers was gamified. The second path involved pre-service teachers' qualification program (60 ECTS) for vocational teacher education in two different teacher education institutions in Finland. These participants studied independently via the MOOC as a curriculum requirement for digital pedagogical competence for vocational teachers. They used the online materials provided on the MOOC web page and applied open badges from the open badge management system. Their lecturers provided scaffolding. Participants were grouped by educational path and program level as follows: Pre-service teachers from Institution I (9); Pre-service teachers from Institution II (3); In-service teachers who achieved level I SoMe-Novice (4); In-service teachers who achieved level I SoMe-Expert (5); In-service teachers who achieved level I SoMe-Developer (8).

Study IV was conducted with the teacher student group enrolled during the 2017–2018 academic year and studying the vocational teacher education program (60 ECTS). The group was utilising PLE concept by using ePortfolios as a workspace and a showcase. The lecturers used an open-source digital environment WordPress to share learning assignments, instructions, and relevant learning materials. The student teachers were instructed to produce the following content in their ePortfolios: a learning diary (only in workspace), learning outcomes as artefacts focusing on vocational teachers' competence, and other relevant information they preferred related their own competence (showcase). The lecturers gave more generalised instructions related to showcase ePortfolios because the idea was that it should reflect its creators' personality as well as the discipline that they represented. Feedback and assessment was provided for each learning outcome and entered directly into the ePortfolios, and at the end of the course the showcase ePortfolios were presented. The participants represented upper secondary vocational education and training and universities of applied sciences. The disciplines of the participants are illustrated in Figure 7. Their experience of vocational teacher's work varied from no experience to five years' experience while eight participants were working as teacher and five were employed in other positions in educational institutions, seven worked outside the educational field. Fourteen participants had master's degrees, and six had bachelor's degrees.

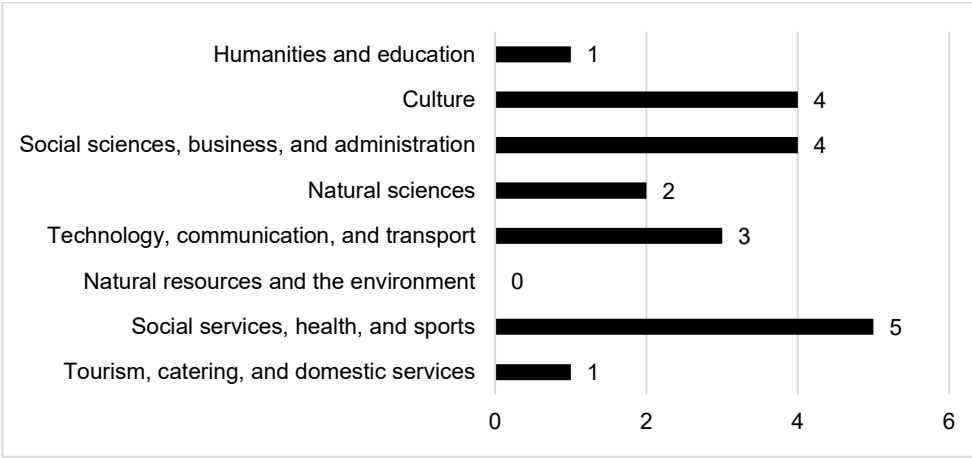


Figure 6 Study IV: Student teachers' (n=20) disciplines

5.3 Methods

5.3.1 Case-study

There are several ways to study cases, such as analytically or holistically, repeating measures or hermeneutically, organically or culturally, and by mixed methods (Stake, 2000: 435). Johnson and Christensen defined case studies as 'research that provides detailed account and analysis of one or more cases' (2008, p. 406). There are three kind of case studies, according to Stake (2000, p. 437): 1) the intrinsic case study, used when a researcher wants to better understand a particular case; 2) the instrumental case study, when a researcher wants to understand a particular case as well as a more general phenomenon; and 3) the collective case study, when researchers study many cases together in order to explore a particular phenomenon, population or general condition. The cases in a collective case study are studied instrumentally rather than intrinsically (Johnson & Christensen, 2008 p. 408).

The purpose of research design for case studies is to collect and analyse data that is addressing the evidence for initial research questions, such as 'where', 'what, and 'how' (Yin, 2009: 27). This requires staying in the context that the cases are set (Yin, 2009: 27). The case study is answering to the requirements of methodology when multiple data is needed to be able to answer to research questions (Yin, 2003: 4). However, during the case study the data can be collected in various ways as well as analysed in multiple ways (Yin, 2003: 4). Yin's (2009) case study design types are as follows: single-case design with holistic single-unit of analysis, single-case design with embedded multiple units of analysis, multiple-case designs with holistic single-unit analysis, and multiple-case designs with embedded multiple units of analysis.

The present study represents multiple-case design by holistic approach that is defined by Yin (2003, 46). Each study has its' own data and the aim is to study deeply the selected new phenomena, not aiming to a generalised knowledge. Each case is one study that were in the context of the vocational teacher education but participants varied between several student groups. The several dimensions of scaffolding PLEs were studied in four cases (studies). The research questions were set as instructed by Yin (2009) by asking 'where', 'what' and 'how' in order to explain the phenomena. The data of each study was analysed using qualitative methods with the research questions presented in Table 3.

To design and collect data for case studies rely on theoretical concepts based on research literature that guide the case study process (Yin, 2003: 3). Theoretical triangulation of the study is on many theoretical frameworks that were chosen (DIANA model, Five-stage model, PLE, ePortfolio, open badge-driven learning process, distributed scaffolding, motivation theories) to study the phenomena of scaffolding PLEs in order to explain it from different perspectives (Johnson & Christensen, 2008). Rigorous control on documenting the conducted cases ensures that the same cases are possible to conduct over again (Yin, 2009: 45). The processes regarding each case are written in the case study reports transparently (study articles 1–IV). The strength of the case study approach is in-depth understanding the studied phenomena that occurs in its authentic context (Schreier, 2012: 26). The cases of the present study are conducted during the participants' vocational teacher studies in the real-life educational setting.

5.3.2 Design-based Implementation Research

Study I focused on improving the pedagogical approaches for online learning process and the study was designed according to Design-based Implementation Research (DBIR). Study I was cyclic and it was made with several teacher student groups for three years. The process for online learning activities was improved during the research and therefore a design-based perspective was applied by Design-based Implementation Research (DBIR) approach (Fishman et al., 2013: 137). DBIR approach is primarily used when seeking information how to make readjustments in learning activities (Cobb et al., 2003) and how to solve practical problems of learning processes (Fishman et al., 2013). DBIR is developed to foster organisational change and evaluation oriented quality improvement (LeMahieu et al., 2017) but it has the roots in several number of theoretical approaches (Fishman et al., 2011), such as evaluation research (Rossi & Freeman, 1989), community-based participatory research (Weinberg, 2003), design-based research (Cobb et. al, 2003), implementation research (Penuel & Means, 2004), and social design experiments (Gutierrez & Vossoughi, 2010). These theoretical approaches are concluded in DBIR

and thus it does not include specific steps to follow (LeMahieu et al., 2017). DBIR focuses on four principles to be followed: a) a concentration on practical problems from multiple stakeholder's perspectives, b) commitment to collaborative design, c) developing theory related to classroom learning and implementation systematically, and d) developing capacity for sustaining change in systems (Penuel et al., 2011; Fishman et al., 2013; LeMahieu et al., 2017). By following DBIR it is possible to pose wider research questions, such as 'what works when, for whom, and under what conditions' (Fishman et al., 2013). The goal is to change educational systems so that all students have an opportunity to learn and the potential of DBIR in collaborative design is providing innovative education programs for all (Penuel et al., 2011). LeMahieu et al. (2017) address also challenges for DBIR pointing out that it requires good infrastructure to collaborate between researchers and practitioners.

5.3.3 Data collection

The qualitative data is collected during years from 2014 to 2018. All studies were conducted in Finland and in Finnish. The collected data, the studies and years as well as methods are presented in Table 3.

In Study I Design-based Implementation Research (DBIR) was used as a research design. There are several considerations for strategies to ensure reliability of Study I. Theoretical triangulation of Study I is on many theoretical frameworks that were chosen (DIANA model, Five-stage model, PLE) to study the phenomena of scaffolding in order to explain it from different perspectives (Johnson & Christensen, 2008). In addition, following Johnson and Christensen (2008, p. 275) definition, the data triangulation was also ensured by collecting the data two times with different research questions in order to extend the fieldwork for deep understanding of the phenomena in question. In addition, it was possible to use two researchers to conduct Study I by planning the process, conducting the teaching and scaffolding activities, and planning the data collection, as well as collecting the data together. These activities between two researchers support investigator triangulation that is diminishing errors (Maxwell, 2005: 112). The data in the first phase were drawn from an online questionnaire I (n=63) that was designed according to the theories related to the research questions of Study I. The questionnaire included multiple-choice questions related to participants' use of web tools and, in addition, their experiences of the chosen web tools. Also open-ended questions were included concerning web tools and suggestions of further development. By the second phase of Study I it was to compare the activities of the DIANA model and the five-stage scaffolding model. All lecturer's activities as well as used digital tools related were listed and categorised by following the pedagogical DIANA model. The third phase of Study I was to collect answers to four questionnaires that were conducted right

after each cornerstone of the DIANA model. All questions were multiple-choice questions. There was a need to dive deeper into lecturer's scaffolding activities in each cornerstone (A-D) of the pedagogical DIANA model. An online questionnaire II (n=13) was designed and conducted after each cornerstone of the DIANA model (four times) and a process data was collected by four questions. The questions related to dialogical collaborative knowledge construction using the DIANA model as well as web tools by which scaffolding was required.

ePortfolios as the data of Study II was considered as an important component of the study. As Yin (2009, 113) have pointed out artefacts, such as ePortfolios are used extensively in research. The data for Study II was drawn from documentation (ePortfolio). Strengths of the data as a document, according to Yin (2009: 102) is that it is stable and can be reviewed several times, includes exact content, and is broad as coverage. In addition, weaknesses of the data were considered according to Yin (2009: 102) as he remarked that detailed information may be hard to find since the documentation (ePortfolios) are not made for research purposes. In addition, access to the data might be a problem but before the data collection and analysis it was ensured that the researcher was able to enter in digital ePortfolios. The data of Study II were only the material in ePortfolios. The researcher had access to the online ePortfolios that were created with digital tools, such as Mahara portfolio tool and social media blog platforms (WordPress and Blogger).

The group interview was chosen as a strategy in Study III because it used structured open-ended questions in order to discover experiences and construct contextual knowledge by focusing on relevant topics (Mason, 2002: 64). Group interview gives also an opportunity to ask further questions while interviewer follows the discussion (Manon, 2002: 65) and it gives more information than the researcher could have known before. Online group interview was conducted since participants of Study III were around Finland and it would have not been meaningful or cost effective to meet all the informants face-to-face as Sedgwick and Spiers (2009) have found. In addition, these researchers found that videoconferencing is a successful way to collect data when online connection works well and the topics and questions are not too personal to discuss online without seeing the interviewer. The online conferencing was considered meaningful to collect the data in Study III by guided group online interviews (Russel & Gregory, 2003; Sedgwick & Spiers, 2009) through Adobe Connect web conferencing. The interviewer's role was to facilitate dialogue by predefined questions about criteria and competence-based assessment, learning motivation and digital open badge-driven learning experiences.

The data of Study IV were collected during and by support of the Erasmus+ project Empowering ePortfolio process (EEP) in the spring 2018. The data was collected by focus group interview where small group of individuals (e.g. students) discuss by the lead of moderator how they think and feel about the topic (Johnson &

Christensen, 2008). Focus group interviews are usually based on open ended and structured questions that an interviewer asks. Focus groups are providing data that is even close to emic data (Steward & Shamdasani, 1990: 13) because individuals' answers with their own words is producing new information. In addition, by focus groups it is possible to examine several topics (Steward & Shamdasani, 1990: 13) that was a case in Study IV when it was explored answers to three different questions related to 1) ePortfolio practices, 2) recommendations for support with ePortfolio practices, and 3) motivation to work with ePortfolios. Multiple researchers participated to collecting, analysing, and interpreting the data (Johnson & Christensen, 2008, p. 276) providing in such way triangulation of investigators. The discussion was based on pre-defined questions that two researchers have structured (Steward & Shamdasani, 1990: 11). Four groups were formulated and each group answered to same pre-defined questions. The length of the discussions varied between 36 and 56 minutes. The group discussions were recorder by voice recorder. The questions related to topics such as enthusiasm to create an ePortfolio, understanding how to make competence visible in ePortfolio, recommendations of scaffolding ePortfolios, and motivation to work with ePortfolios. The questions related to scaffolding were composed by following the idea of distributed scaffolding (Tabak, 2004) and questions related motivation were based on Ryan and Deci's (2000) theory of intrinsic and extrinsic motivation.

5.3.4 Qualitative content analysis

The studies are conducted with qualitative research methods because the interest is in particular groups and people, as well as in socially constructed situations while the nature of the data is word, images, and categories (Johnson & Christensen, 2008). The reliability of the analysis is in a classification of the data (Schreier, 2012, 168) that includes the research context and clear categories related that are used with consistency. The categories are all agreed with all researchers participating in each study. In Study I a qualitative deductive content analysis was utilised to explore relationships between the data and existing theories (Johnson & Christensen, 2008; Bogdan & Biklen, 1992) by segmenting and coding the text, and deriving meanings. The first analysis of Study I related to PLE theory, knowledge construction, and scaffolding and the data were coded under these categories. The two authors of the study read the data independently several times and compared and discussed their coding. By the second phase of Study I it was to compare the activities of the DIANA model and the five-stage scaffolding model. The two authors analysed listed activities through the lenses of the five-stage model. The third phase of Study I was an analysis of four questionnaires administered immediately after each cornerstone

of the DIANA model. All questions were multiple choice and the data were analysed based on these questions.

In Study II abductive analysis was conducted in order to meet a reliable study by inquiring the data constantly during the data collection and not expecting any specific information (Yin, 2009: 69) since the ePortfolios were all different by their content as well as by their outlook. Abductive analysis is a qualitative data analysis approach by which the aim is to advance creative and new theoretical insights (Timmermans & Tavory, 2012). It is also to understand as a model of exploring something anomalous or surprising phenomena (Paavola, 2004). By abductive analysis new concepts may be developed by empirical materials (Timmermans & Tavory, 2012), and that was the case with Study II where the understanding of student teachers' ePortfolios was composed. The abductive analysis is a process of gathering observations, reading theories, working with data, and actively combining theory-informed and data-grounded approaches (Tavory & Timmerman, 2014). The following issues was explored through ePortfolios of student teachers: sections and artefacts of ePortfolios, learning designs, and project work reports. Study II included four phases of analyses and new evaluating criteria for studying the quality of ePortfolios were found: artefacts and sections indicating a general structure of ePortfolios, technical use of ePortfolio tools indicating digital competence, analysis of learning designs indicating pedagogical competence, and analysis of project work report indicating also pedagogical competence. All artefacts and sections of ePortfolios were gathered into an Excel file. Participants' digital competence was assessed in a way they have used ePortfolio tools by coding findings. The definition of digital competence by Ilomäki et al. (2016) was used to categorise these findings. Participants' learning designs were used as data to analyse their pedagogical competence by following Lakkala's et al. (2010) pedagogical infrastructure framework that includes four components: technical, social, epistemological, and cognitive. The criteria for evaluating learning designs were created. In addition, project work reports were analysed as a part of pedagogical competence by exploring participants' activities in practical educational development work in educational institutions. Criteria for evaluating the project work reports were created. Finally, all scores of each ePortfolio were calculated.

In Study III the analysis followed data-driven content analysis method (Schreier, 2012) and the analysis was made by using NVivo software. First, the found expressions were coded as cases representing opinions about the provided scaffolding. The data saturation within the coding process enabled the identification of what the items students considered important in the scaffolding activities conducted offered during the open badge-driven learning process. Second, a cause map (Hodgkinson & Clarkson, 2005) was constructed by organising the participants' expressions following Salmon's (2011) five-stage online scaffolding model and

comparing these in order to find similarities and differences of the two processes (open badge-driven learning and five-stage model). The Similarities and differences were compared in order to find causal patterns and homogeneity (Hodgkinson & Clarkson, 2005).

The recorded group discussions were the data in Study IV and they was transcribed and uploaded into NVivo software. The analysis was conducted in three phases: the first and second phases of the qualitative analysis were conducted using abductive analysis (Tavory & Timmerman, 2014). The theory was read, found to work with the data and actively combined theory-based and data-grounded approaches (Tavory & Timmermans, 2014). The data were first categorised by the types of practices and secondly by types of supportive methods. The third phase of qualitative analysis concerned the participants' motivation to learn and to make their vocational teacher's competence visible in their ePortfolio. Deductive analysis was used to study the third phase of the data by exploring the relationship between the data and theory (Schreier, 2012). The data were compared to Ryan and Deci's (2000) SDT in order to explore the intrinsic and extrinsic motivation in each regulation style and orientation.

In Studies II, III and IV the qualitative analyses were quantified in order to discover the quality level of ePortfolios (Study II), important means of scaffolding in the badge-driven learning process (Study III), and the most meaningful methods of scaffolding for ePortfolio processes (Study IV). Chi (1997) explained that it is relevant to integrate qualitative-based quantitative data in order to achieve less subjective results and this is often the question when the data is verbally complex but the overall structure must also be assessed, however, qualitative-based analysis methods remain relevant even when one's aim is a quantitative analysis.

5.4 Ethical considerations in data collection and analysis

The aim of ethical consideration is always to find a balance between the costs and benefits of conducting a study, particularly the harm or benefit of participants, expenses, the time required of participants and researchers, benefit to society and improvement of educational systems (Johnson & Christensen, 2008). The researcher's organisation follows the research ethics of the Finnish Advisory Board on Research Integrity (TENK, 2012) and requires that researchers apply a research consent from the organisation before collecting any data. Consent was granted for the present study and all four component studies were conducted without any financial funding except for Study IV, which was partly conducted during the Erasmus+ project (Empowering ePortfolios) funding period (specifically the data collection). The researcher was working as a lecturer during each of the component

studies and was very familiar with the curricula, teaching activities and student processes. The studies were integrated with the participants' curricula and proceeded as a part of their vocational teacher studies.

The participants' consent for study is required (Christians, 2000, 138). The participants were informed of the purpose and methods of the study. Those who took part in Study II were instructed that they could remove readers' rights from their ePortfolios whenever they wished. The only person to read the ePortfolios was the first author of Study II. The participants' ePortfolios were stored on the participants' own computers or created using social media (Web 2.0) tools and restricted to the participants' private accounts unless the participant chose to alter those settings.

During the present study the data collection was based on surveys and interviews (Studies I, III and IV) which required the participants to volunteer their time. In addition, the study collected data which would have existed regardless of whether the study had been completed. This is the case in Study I, where analysis concerned the activities included by the lecturers, and Study II, where ePortfolios were created for participants' teacher studies. The data of all studies were stored according to the instructions of the Finnish Advisory Board on Research Integrity (TENK, 2012) and according to the practices of the educational institutions the participants attended. Only the author of the present study and the second author of Studies I and IV had access to the secure server on which the data was stored, except for that gathered during Study III, which was stored in the data server of the employer of the first author. In addition, the data and results have been reported in a way that ensures the anonymity and privacy of every participant.

The study ensures four basic types of triangulation (Denzin, 1970): multiple data sources were used, multiple researchers participated to the study, multiple methods were used to conduct the study and multiple theoretical perspectives were used to interpret the results of the study.

The benefits of the studies are directly useful in the context of the studies and vocational teacher education programs and can be easily adjusted to other contexts of vocational education and training as well as in degree programs in universities of applied sciences.

6 Overview of empirical studies

6.1 Stydy I

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

Study I explored the tools used in, location of and time for scaffolding activities during the learning process in the study module that followed the learning design composed by the DIANA model (Aarnio & Enqvist, 2016) and adapted PLEs. The study followed design-based implementation research (DBIR) process. The first phase of the study concerned the implementation groups 1–4, which included 63 student teachers; the second phase of the implementation group (n = 13) was conducted with the fifth group. The activities of the study module, developed using the DIANA model, were compared to the activities of the five-stage scaffolding model for online learning (Salmon, 2003). Several activities followed both the DIANA model and the five-stage model. While the DIANA model concentrates on deep learning using specific dialogical activities, the five-stage model concentrates on teachers' online scaffolding activities in general. In Table 4 above a comparison of the activities of both models is presented.

Table 4. Comparing the activities of the DIANA (Aarnio & Enqvist, 2016) and the five-stage model (Salmon, 2003)

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

The comparison of the activities of the two models demonstrates a need for general and whole-group scaffolding as well as individual and peer-group scaffolding that aims for collaborative learning.

Following Bassani and Barbosa's (2014) and Wheeler's (2015) conception of PLEs, Web2.0 tools (e.g. Blogger, Google Drive, WhatsApp and Facebook) were utilised as personal digital tools in the learning process. Blogger was found a suitable tool for collaborative learning environment for study circles. WhatsApp was found a good tool for general discussion and instant messages as instructions. Student teachers became more able to use digital tools in their own teaching work after participated in the conducted learning process. A blog is said to be a collaborative tool for knowledge construction and sharing (Özkan & McKenzie, 2008; Wheeler, 2015; Bassani & Barbosa, 2018) and it is seen as a popular tool to support learning through PLEs (Quadir & Chen, 2015; Aramo-Immonen et al., 2016; Sahin & Uluyol, 2016; Yang et al., 2016). The findings of the study support the previous research as student teachers found blogs to be excellent PLEs during the study module. We noticed also that using blogs promoted a positive attitude toward ICT use in education that also Goktas and Demirel (2012) suggested.

The results indicate that teacher's scaffolding was needed in each cornerstones of the DIANA model to ensure dialogical and collaborative knowledge construction in the study circles' blogs that were chosen as their personal digital tools. However, the scaffolding activities varied between the cornerstones. The results indicate that

teacher's comments in study circles' blogs were the most useful way to advance learning and they were the most necessary way to scaffold from cornerstones B to D. Study indicates that following the DIANA model as a learning design the most important and productive way to scaffold is that teacher comment and assess directly in study circles' blogs. At the same time teacher's blog served a central hub for the learning process including material sharing, general instructions, and the teacher's reflection for the whole group.

6.2 Study II

Korhonen, A.-M., Lakkala, M. & Veermans, M. (2019). Identifying vocational student teachers' competence using an ePortfolio. *European Journal of Workplace Innovation*, 5(1).

Discussions of learning, making competences visible through ePortfolios and how to provide scaffolding for them raises the question of what should be shown and how to show it. Therefore the second study started by defining what is vocational teacher's competence and how to evaluate it. In addition, the study searched also answers to digital possibilities as making competence visible. Using ePortfolio during the vocational teacher studies highlights the need for scaffolding student's professional development in a way that they will continue maintaining ePortfolios during their entire career. This is based on the idea of continuous learning.

The data of the study were collected through student teachers' ePortfolios (n = 36). All other way produced and delivered artefacts and information was not observed. The data were analysed in four phases that concerned a general structure of ePortfolios, technical implementation indicating digital competence, learning design indicating pedagogical competence, and project work reports indicating pedagogical competence. The general structure was identified by counting multimodal and single-modal artefacts and sections of ePortfolios were explored. The participants' pedagogical competence was evaluated by examining how they created a learning design based on Lakkala's et al. (2010) framework. Finally, as a part of their pedagogical competence, participants' project work reports were analysed by exploring practical educational development work in educational institutions. The results indicated that at the time of the study single-modal artefacts in text format were mainly used in ePortfolios (208) and the participants were unfamiliar with multimodal artefacts (120). Almost all of the ePortfolios contained learning diaries (33) and project work reports (30). While learning designs were considered an important source for identifying pedagogical competences, they were featured in only 24 of the 38 ePortfolios. Sixteen personal development plans were shared through ePortfolios, while 24 students shared artefacts based on given learning assignments. Only a few shared their profile information.

Pedagogical competences were evaluated using learning designs and Lakkala et al.'s (2010) pedagogical infrastructure framework, and each was given a score between 1 and 15. All of the learning designs received scores between 6 and 14, the mean being 9. Most learning designs included components of 1) cognitive/level of scaffolding (level 3), 19 pieces; epistemological (level 2), 18 pieces; and 3) social (level 3), 12 pieces. The scores of project work report were given between 3 and 9 while the mean was 6.6. The total score of ePortfolios are presented in Figure 8.

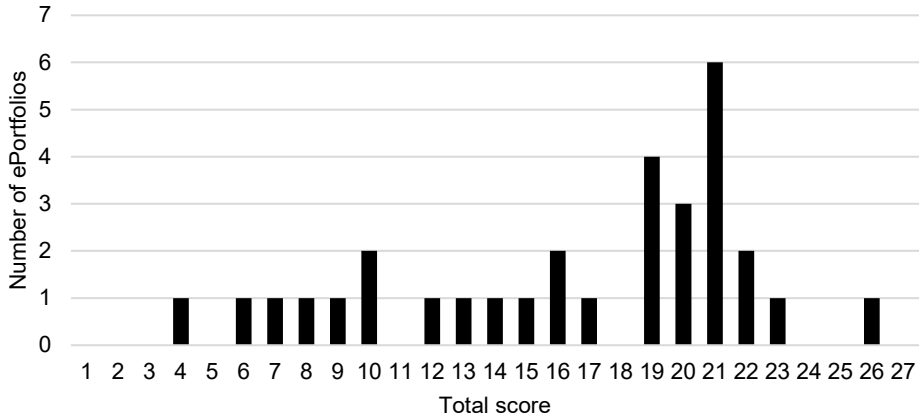


Figure 7. The total score of ePortfolios

The ePortfolios represented the low level of digital competence according to Ilomäki's et al. (2016) definition as mainly MS word was a used tool with written text. ePortfolios did not reflect motivation to participate in digital culture. The reasons may be in a lack of technical skills and a lack of motivation to use time to compose an ePortfolio. The sections of ePortfolios addressed well with the goals that were set for the participants by the curriculum of the vocational teacher education program. However, none of the examined ePortfolios included all the sections. Pedagogical competence is crucial and highlighted in vocational teachers' work activities and learning designs includes lot of information related. The learning designs that were evaluated by Lakkala's et al. (2010) pedagogical infrastructure framework revealed that half of the learning designs were given scores in the highest of the three categories. It can be said that half of the student teachers demonstrated advanced pedagogical competence by combining technical, social, epistemological and cognitive components in their learning designs. However, one-third of ePortfolios did not include a learning design and therefore a lot of information is missing about the pedagogical competence of the participants. Student teachers'

competence in understanding the importance and activities of constant scaffolding and assessment was particularly advanced.

There is a lot of variance of ePortfolios when investigating the total results of the scores. Some received very low scores, while some ePortfolios were high quality indicating high level of competence. The poor quality was caused mainly by a lack of a learning design and the weight of this was high. This result indicates that more scaffolding is needed when students are planning the structure of their ePortfolios and how they could show their pedagogical competence through ePortfolio. The ePortfolios were left unfinished, indicating that more scaffolding is needed to explain who the audience of ePortfolio as well as how to compose a workspace and later a showcase ePortfolio. In Figure 9 the two faces of ePortfolios are illustrated. The grey area appears as workspace in ePortfolio process and the light grey on the right side represents processes which were not followed for showcase ePortfolios.

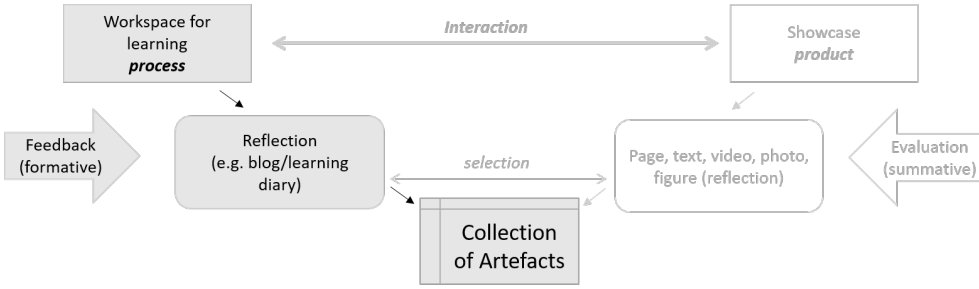


Figure 8. A workspace for the process and showcase for the product

Teaching competence cannot be learned only through formal education but rather it is an ongoing process through entire teacher career (Toom, 2017). Therefore it has arisen a question how to scaffold it in a way that learning happens after teacher studies. ePortfolios are a place to collect achievements in digital format that could help to see one's own competence and how to develop it further as well as to show it to the various audiences. ePortfolios are justified as a part of PLEs for ongoing learning, as Fiedler (2012), Vuojärvi (2013) and Wheeler (2015) suggested. In future the developed evaluating model can be used systematically as a tool to assess teachers' competence critical points that need scaffolding. For future studies we suggested to explore student teachers' motivation aspects to work with ePortfolios during their teacher studies.

6.3 Study III

Brauer, S., Korhonen, A-M & Siklander, P. (2019). Online Scaffolding in Digital Open Badge-Driven Learning in Vocational Teacher Education. *Educational research*.

Scaffolding PLEs was studied from a relatively new perspective when the open badges were utilised in creating a learning process for vocational teacher students. Open badges, which are in a digital format and available online, make it possible to recognise students' competences via demonstrations of their skills. The whole learning process may be scaffolded using the open badge management system and support from peers and teachers.

The context was a vocational teacher education program; the participants were vocational teaching students (n=12) and students enrolled in a professional development program called 'Learning Online' (n=17). The data were collected from online group interviews (n=6) based on the participants' achievements in the Learning Online course with open badges. Learning Online was a gamified Massive Open Online Course that was open to anyone. Participants chose one of the offered three paths and utilised openly licenced learning materials online, Learning Online badges and a badge management system. Participants were able to join a closed Facebook group in order to receive scaffolding from their teachers and peers.

The analysis was conducted by following content analysis (Schreier, 2012) using NVivo software. The participants' expressions were analysed and mapped following the five-stage model (Salmon, 2018). Hodgkinson and Clarkson's (2005) mapping tool was used, first to construct the causal map by describing elements of individual and group thinking following the five-stage model (Salmon, 2011) and second to compare the stages against the identified process of digital open badge-driven learning (Brauer et. al., 2017). The aim of causal mapping is to identify structural differences and similarities (Hodgkinson & Clarkson, 2005).

The findings were described according to mapping participants' experiences in each of the five stages of the online scaffolding model. Stage 1 (access and motivation) of Learning Online provided easy access to the online learning material. The material comprised the recordings of the online lectures, which were also provided synchronously as webinars. The results indicated that most students did not listen systematically to all webinars or recordings, but instead explored the material according to their needs. Stage 2 (online socialisation), the closed Facebook group, was the students' most important means of asking for and gaining support, instructions and scaffolding from teachers and peers. The further the students advanced with the digital and pedagogical studies via Learning Online, the less they needed scaffolding from their teachers—the open community in the Facebook group provided the support they required. Stage 3 (information exchange) was included to

personalise learning in order to create and utilise the students' criteria-based badge constellations. The students demonstrated their skills related to authentic work situations as vocational teachers and provided a documented demonstration of this in a digital format. The study revealed that carefully created badge criteria could in some cases ultimately replace learning materials and scaffolding. Knowledge construction with ongoing scaffolding using open badges occurs between students and teacher via an open badge management system. This was considered to comprise Stage 4 (knowledge construction). The teacher scaffolds the students with feedback and instructions regarding the demonstrations of their skills according to their badge application. It seems that the more quickly students receive feedback and further instructions from their teacher, the more inspired they are to continue learning and demonstrating their skills. In stage 5, development, students conducted self-assessments and reflected on how to continue earning badges, which learning path to choose and what competences they needed to improve of those represented in the open badge constellation. They were also asked to apply the skills and competences they learned in their practical teacher work.

The study suggests that an open badge-driven learning process follows Salmon's (2018) five-stage online scaffolding model and seeks to extend its stages. The first stage is required to offer easy access online material with advanced search options, as students may not follow the learning paths that they are given; students favour creating their individual learning paths. In the second stage it is essential to provide a peer-group discussion forum which will bring together novice and more advanced students because students prefer asking instructions from their peers rather than their teacher. In the third stage, students need clear badge criteria for independent progress and development (Wood et al., 1976). Forth, rejecting or asking more detailed information for the badge application is an effective way to provide scaffolding which focuses on supporting students in continuing their studies (Brauer & Siklander, 2017). In the fifth stage students are encouraged to share their achievements with their peers in order to discuss where to continue and what badge to apply next.

The findings indicate that earned badges encourage students to explore new topics in the learning materials and to ask peers how to continue and progress. In addition, students may independently explore the badge constellation more profoundly in order to decide how to continue professional development. To conclude, these results will be helpful in designing the structure and stages of online scaffolding implemented in the digital open badge-driven learning process. It is also recommended to extend the five-stage scaffolding model when open badge driven-learning is conducted by adding advanced search options to online materials, provide a peer-group discussion forum that will bring together novice and more advanced students, compose clear badge criteria, give an opportunity to share achievements to

peers, and finally add gamification elements. Nevertheless, the instructional badging is not the scaffolding process itself. There is still a need to explore how to compose a learning design in open badge-driven learning processes, which could be explored in future studies. More research is also needed to investigate the gaming models which support the collaborative learning processes rather than individual work (Deterding, 2012).

6.4 Study IV

Korhonen, A.-M., Ruhalahti, S., Lakkala, M. & Veermans, M. (in press). Vocational student teachers' self-reported experiences in creating ePortfolios. *International Journal for Research in Vocational Education and Training.*

ePortfolios have become one format in studying through PLEs. In order to still improve scaffolding activities that support vocational student teachers to create ePortfolios and make their competences visible, the fourth study was conducted. The main focus was to ask student teachers' opinions about the received scaffolding activities and what kind of scaffolding they would prefer. In addition, their motivation to create ePortfolios was asked.

The participants of the study were 20 vocational student teachers in year 2018, when they were in the end of their vocational teacher studies. The data was collected from four focus group discussions that were recorded by a voice recorder. The groups were given a predefined questions and discussions were led by one member as a chair of the group. The questions related to scaffolding activities that were defined according to the idea of distributed scaffolding (Tabak, 2004). In addition, the questions related to motivation of creating an ePortfolio were based on Ryan and Deci's (2000) definitions of extrinsic and intrinsic motivation. All participants took part in dialogue. The recordings were transcribed and transcriptions were uploaded to NVivo software. The analysis was conducted in three phases and in two first analysis were conducted using abductive analysis by Tavory & Timmerman (2014). The data were categorised according to the types of practices and the main categories was emerged: 1) practices involved in creating an ePortfolio; and 2) practices of demonstrating a vocational teacher's competence in an ePortfolio. Second phase of the analysis the participants were asked what kind of scaffolding activities they would prefer during their studies when making also an ePortfolio. The main categories were defined as recommendation of scaffolding as 1) supportive methods of creating an ePortfolio, and 2) supportive methods of illustrating a vocational student teacher's competence using an ePortfolio. The third phase of qualitative analysis related on the participants' motivation to learn and make competences visible through ePortfolio. Deductive analysis by Schreier (2012) was conducted and

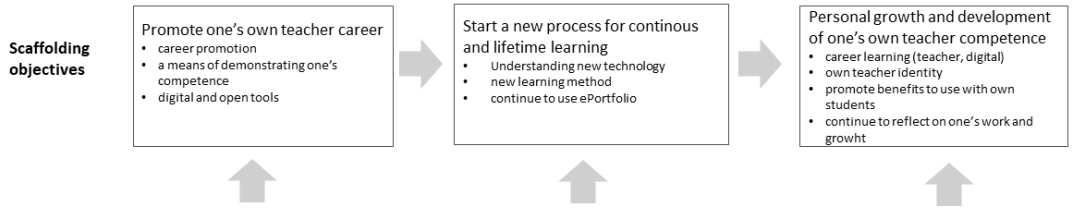
Ryan and Deci's (2000) SDT was used to study intrinsic and extrinsic motivation in each regulation style and orientation.

The common practice that student teachers mentioned to make ePortfolios was recording reflections in a learning diary. Testing and using digital tools independently and various ways were also frequently mentioned. There were mentioned many different ways to document vocational teacher's competence, such as documenting visual evidence of teaching activities, attaching received feedback, and mentions of pedagogical and other competencies. The participants gave many suggestions how to organise scaffolding when the aim is to create ePortfolios. Collaborative tasks related to creating one's own ePortfolio were found the most important way to proceed, e.g. by following and commenting each peers' ePortfolios and giving presentations of one's own ePortfolios more often. The feedback and assessment were expected from lecturers in order to improve the performance in ePortfolios. In addition, an orientation to ePortfolio work was mentioned and there were expectations like to have good examples of ePortfolios, to have learning objectives and criteria of ePortfolio work, and what is an audience of an ePortfolio. The findings were in line with the perspective of distributed scaffolding (Lajoie, 2005; Tabak, 2004) as various actors were mentioned as being important scaffolding providers. These were mentioned to be lecturers, peers, written instructions and other materials online. By this study it was also found that digital tools and freedom to choose them by students' themselves were not difficult tasks. This founding is not supporting earlier studies, while it has been found that ePortfolio tools are difficult to use and requires more technical scaffolding (Parker et al. 2012; Masters, 2013; Roberts, 2018; Douglas et al., 2019). Earlier studies also utilised specific applications given by lecturers as ePortfolio tools, so in this study we fully implemented the concept of the PLE and allowed students to choose their own digital tools.

This study revealed that the most frequently mentioned sources of motivation were to pass studies and achieve personal growth by mastering one's chosen teaching competence. The next was to use ePortfolio for career purposes and in job applications. The participants had a self-determined orientation to learning and making their competences visible in their ePortfolios; but in the same time they completed their ePortfolios because it was a compulsory element of the studies so their motivation was also control-oriented. In the field of vocational teacher education it is important to be motivated by job application purposes (Mobarhan et al., 2015) as ePortfolios are offering a modern way to promoting oneself in labour markets.

The results of Study IV are summarised in Figure 10. The practices and methods with motivational orientations are illustrated as activities to follow when designing

methods of scaffolding ePortfolios. All phases are important to conduct in order to support and activate student teachers to understand the idea of PLEs and ePortfolios.



Scaffolding provider	Methods of scaffolding		
lecturer	• instructions to complete learning assignments • instructions on teacher's competence (wider than pedagogical competence, learning design, themes of educational program) • choices of target groups of ePortfolio	• instructions on how to use digital tools (incl. use of open ePortfolio) • difference between workspace and showcase portfolio • start both portfolio processes at the beginning of the course • feedback to continue and prevent dropouts • giving examples of other people's ePortfolios	• Orientation: set learning objectives and assessment criteria for ePortfolios • giving feedback and assessment constantly • supporting a personal growth (development plan in the beginning and reflection after)
workplace mentor	• to make competence visible by providing feedback and assessment, including students' feecback • choises of target group	• digital tools in workplace institute • feedback to continue and prevent dropouts	• giving feedback and assessment constantly • development plan as a basis for training period
computer	• Instructions written by lecturer in digital (learnng) environment	• Self-directed MOOC: instructions and practices on how to use digital tools	• tools for continuous documenting
peers	• ask students to actively follow peers' ePortfolio for learning purposes • set up collaborative assignments by grouping students in various ways related to ePortfolios • giving examples of other people's ePortfolios		

Figure 9. Scaffolding objects and methods of scaffolding with motivational orientations of vocational student teachers to learn and document their competences in their ePortfolios

7 Main findings

7.1 Students' use of PWT and the need for scaffolding in digital PLEs

This digital era is allowing many kinds of learning environments and tools to be used in collaborative activities as well as individually in educational settings. The first research question (RQ1) of this dissertation was to examine how scaffolding should be provided alongside the use of digital PLEs and PWTs. This was studied from the perspective of teachers, whose activities are needed to support students. All of the studies were applied using PLE and the student teachers chose their learning environments themselves. In Study I PLEs were used to examine collaborative learning and the learning designs created using the DIANA pedagogical model. Student teachers created their artefacts and discussed them in blogs created using platforms which were freely available online. However, their own blogs were visible only to peer-students and the lecturer. Student teachers found the collaborative blog format suitable, as have many researchers before them (e.g. Özkan & McKenzie, 2008; Wheeler, 2015; Bassani & Barbosa, 2018). The student teachers also found that after the course they were able to use blogs with their own students and in their teaching practices. Referring to the earlier studies of Goktas and Demirel (2012), this result follows the understanding that when using digital tools in teacher education, student teachers are more likely to apply digital tools in their own teaching practices because they understand how the tools can be used based on their own experience as a student. Student teachers reported the same results for the other tools that were used, such as WhatsApp. Study I revealed that social media tools are easy to apply in study processes, following the PLE concept which integrates formal and informal learning, as Dabbagh and Kitsantas (2012; 2013) stated earlier. When the student teachers looked closely at the DIANA pedagogical model (Aarnio & Enqvist, 2016) and the digital tools used during the learning activities, they found different tools significant when used with various cornerstones (A–D) of the pedagogical DIANA model. Cornerstones A–D were defined as follows: A: the creation of common ground for collaborative learning; B: the enabling of authentic learning; C: the provision of an opportunity for deeper-orientated learning through dialogical actions; and D: the integration of theory and practice (Aarnio & Enqvist, 2016).

Along with these cornerstones, the digital scaffolding tools which were the most important for student teachers were: A) teacher's blog; B) teacher's blog, study circles' blogs and online meetings; C) study circles' blogs; and D) study circles' blogs. The most significant finding was that students needed scaffolding in their own digital environments (personally/peer-group wise) during the course when PLEs were used. This means it is a teacher's responsibility to visit, study, comment on and/or give advice on students' PLEs. Study I also revealed that blogs can also be useful as teaching tools for sharing general instructions, providing learning materials and posting assignments to the whole group.

Working with ePortfolios can be understood as a competence itself (Korhonen et al., 2007). This technique was examined in Study II, which was conducted at the beginning of the present study. Most of the student teachers used digital text-based formats to create their artefacts for learning assignments; very few used photos, videos, figures or other visual elements. The digital quality of the ePortfolios was studied with reference to Ilomäki's et al. (2016) definition of teachers' digital competence. The results were not good, as most of the participants were at the lowest level of digital competence. It is becoming more necessary to possess digital competence in modern society, which was reflected during the study in question. Specifically, Study IV found that student teachers were very capable of using digital tools in ePortfolio processes when the PLE concept is implemented. This result does not support the earlier studies of Robert (2018), Master (2013), Douglas et al. (2019) or Parker et al. (2012), who also studied ePortfolios in a teacher education context and found that students have many difficulties with technology. These researchers did not include the concept of PLE but instead offered one option, a technical program that all students used. When the student teachers are given technical support and training they become adept at using digital tools smoothly and in various ways. They can be said to be motivated to use digital tools and modern approaches to join the digital culture when they are in charge of the tools by themselves from the beginning, when the tools are first selected and later used in various ways.

The open badge concept is a modern tool for digital learning, making competences visible and supporting competence-based evaluations. Open badges are always in a digital format and include the owner's personal information related to the competence in question. In this dissertation, open badges were used in one PLE format: In Study III, open badge-driven learning (Brauer & al., 2017) was facilitated by providing learning materials, webinars, a discussion forum and open badges online. It can be said that open badge-driven learning is the process of scaffolding students in digital environments and students' personal web tools are used to make their competences visible. According to open badge-driven learning, scaffolding is implemented by answering to open badge applications and issuing badges online.

7.2 Vocational student teachers' PLE and ePortfolio content

When the vocational student teachers' PLE and ePortfolio content was explored, research question (RQ2) was posed: What is the content of PLEs and more specific ePortfolios of vocational student teachers? Study II was conducted to investigate how the student teachers organised their ePortfolios and what content they included. The expectations and requirements of ePortfolio were defined during this study. It was found that most ePortfolios included a learning diary and a project work report. Many ePortfolios included artefacts which were created according to learning assignments included in the teacher education program curriculum. Designs for learning activities were found in several ePortfolios, but few contained a personal development plan, a profile and information about student teachers' own teaching and learning material for their students. Because pedagogical competence is an especially important aspect of every teacher's work activities, it was highlighted in Study II by analysing the learning designs in order to discover what kind of pedagogical decisions the student teachers had made. The learning designs were supposed to include information on learning activities, learners' background and individual needs and materials related to the subject (Schulman, 1987). Study IV also provided some answers to the question of the content of ePortfolios. Student teachers explained that scaffolded ePortfolio practices made them create content, such as a learning diary, completed learning assignments (artefacts related), documentation of their own teaching activities in the classroom and online (videos, photos, and reports), documentation of feedback received from their students and the lecturer and documentation of pedagogical and other competencies. These were also more or less what the student teachers recommended that guidance be offered for.

The pedagogical competence demonstrated by the learning designs followed Lakkala et al.'s (2010) study of the pedagogical infrastructure framework. As Lakkala et al. (2010) concluded that their framework is a general one, more specific criteria were created and used to evaluate the learning designs. These criteria are useful and practical tools to use in designing learning activities for students in vocational education sector, but they are even more valuable as self-assessment tools for vocational teachers seeking to improve their teaching practices. These evaluation criteria are presented in the discussion of Study II. The evaluation criteria were divided into three levels. The student teachers were able to achieve authentic learning by applying theory in creating learning assignments for their own students. The student teachers' competence in applying constant scaffolding and assessment in their learning designs was particularly advanced.

The total scores of ePortfolios indicated that there was considerable variance among student teachers ePortfolios (Figure 8). Some received very low scores, indicating that these individuals may lack the motivation or skills to make their

competences visible through ePortfolio. The lowest-scoring ePortfolios were missing a learning design, a factor which produced the highest scores following evaluation because it is the most important competence for teachers. The contrasts between some ePortfolios were also significant because some documented high levels of competence on the part of certain participants. It is useful to keep in mind that teachers' competences develop not only during teacher studies but continue to grow throughout a teacher's entire career (Toom, 2017). This was another reason for the low scores. Altogether the results of Study II revealed that the ePortfolio is a potential tool for the developing and assessing teaching competences, as Struyven, Blieck and De Roeck (2014) suggested.

The ePortfolio activities in Study II followed Barret's (2010) vision of working within a confined workspace and showcase portfolios. However, the results revealed that only workspace portfolios were created; the ePortfolios were left unfinished without a clear idea of whom to show the ePortfolio to. Figure 9 illustrates the two faces of ePortfolios. Study IV involved representing a vocational teacher's competence in an ePortfolio: although the participants reported that they understood the difference between workspace and showcase ePortfolios and how to document their teacher's competences in an ePortfolio, but the data revealed that they confused workspace and showcase ePortfolios during their discussions, highlighting that more and clearer instructions are needed (Barret, 2010). The results of Study IV also indicated that the failure to consider the audience reduced interest in creating ePortfolios. It is recommended that more effort be put into scaffolding student teachers as they create showcase ePortfolios for career purposes and make their competences visible, as Cambridge (2008) suggested. ePortfolios serve not only as learning diaries, as Kankaanranta (2007), Viksted (2007), and Awouters et al. (2007) found to be a key element of their ePortfolio studies: ePortfolios make it possible to create different kinds of artefacts which describe competences in a very organised way using various digital formats, many of which also make it possible to publish ePortfolios to wider audiences for different purposes.

7.3 Methods of scaffolding with PLEs

In order to study scaffolding methods, the following research question (RQ3) was posed: How should scaffolding methods be implemented with PLEs? Studies I–IV were designed to identify useful pedagogical practices to implement with PLEs. These practices were derived from pedagogical models, scaffolding models, ePortfolio practices, the open badge-driven learning process and motivational aspects. Study I revealed that the pedagogical DIANA model (Aarnio & Enqvist, 2016) included methods for scaffolding activities. This result was found by comparing the activities of the DIANA model to the activities of the five-stage model

of online scaffolding (Salmon, 2003, 2011). Both of these models support strict activities where the teacher acts as a manager, moderator and facilitator. The models allow space for learners to become self-directed and autonomous. Comparing the activities revealed which stages of the five-stage model are implemented as the cornerstones of the DIANA model (see Table 4). Each stage of the five-stage model is revisited several times during the pedagogical process designed for learning. The DIANA model was found to be suitable for implementing with PLE settings (Ruhalahti, 2018) and can be considered a method of scaffolding PLEs.

Study III revealed an approach to pedagogical practices where open badges are integrated into an online learning process using the method called open badge-driven learning (Brauer et al., 2017). Study III demonstrated that open badge-driven learning is a method of scaffolding students online: The scaffolding elements were the open badge criteria, teachers' or other badge issuers' instructions, comments made during the open badge application procedure and peer support. Gamification elements further supported learning during open badge-driven learning. Brauer and Siklander (2017) and Brauer et al. (2017) found that open badge-driven learning also offers support for personal development.

In the last study, Study IV, student teachers gave several recommendations for how to improve support for making ePortfolios based on their own experiences. Specifically, they explained they needed more collaboration with peer-student teachers the most. To a lesser extent, they mentioned needing lecturers' feedback, comments and assessments, as well as support for personal growth. These findings confirmed those of Tabak (2004) and Lajoie (2005), both of whom suggested sharing scaffolding activities among several providers, such as lecturers, peers and technological environments. During the present study I noticed that in vocational teacher education even more actors share scaffolding responsibility, such as mentor teachers in the teacher training period, a student teacher's own students (who may, for example, be asked to provide feedback to the student teacher) and lecturer's colleagues who participate in their learning activities. However, a single lecturer always manages the scaffolding process and assigns activities to the others. As supportive methods of illustrating a vocational teacher's competence through an ePortfolio, the student teachers explained that learning objectives and assessment criteria for the ePortfolio itself are needed at the first place, as well as instructions on how to create a workspace and showcase portfolio. In addition, Study IV indicated that the target audience of ePortfolios should be considered in order to focus on the most important documentation of competences (Parker et al., 2012), which requires more scaffolding, as Roberts (2018) pointed out. Scaffolding is not intended as a means of giving general instructions for online activities (Lakkala et al., 2005): In the context of vocational teacher education, it is more to provide detailed instructions related to studies, to make competences visible and to offer suggestions for continuous learning, as mentioned in

Study IV. Korhonen et al. (2007), Struyven et al. (2014) and Berrill and Addison (2019) made similar observations when they discovered that ePortfolios help students better understand their own competences and personal development and narrow the boundaries between school and working life.

Finally, in Study IV the scaffolding objects and methods of scaffolding ePortfolios with motivational orientations are collected and presented together in Figure 10. This image is useful when designing scaffolding methods to be used with PLEs, particularly ePortfolios. These methods motivate continuing learning throughout a teacher's career (Toom, 2017), as student teachers found it interesting to study their own ePortfolios later and review their skills.

7.4 Designing scaffolding for PLEs

The study revealed several educational implications which may be utilised in scaffolding students in their PLEs. The results provided a final answer to the main research question of the dissertation: How to design scaffolding when students use their PLEs in the learning process to make their competences visible? In Study I instructions were provided to create a design for online learning which follows the DIANA pedagogical model, which includes plenty of scaffolding activities. The instructions give several examples of Web 2.0 tools for creating knowledge collaboratively. It was also pointed out that scaffolding is most effective when conducted with students' PLEs and personal web tools. Study II explored how ePortfolios as a part of PLE provide information on their owners' competences. During the study an evaluation framework for vocational teachers' competence was created which, at a very practical level, can be used to create a learning design or to self-assess a created design. The study also analysed how to organise workspace portfolio and showcase portfolio in such a way that they support learning and are based on the creator's competence. Study III suggested that open badge-driven learning can be used as a method of scaffolding based on awarding instructional badges (badge criteria). Open badge-driven learning includes a digital management system for open badges and students demonstrate their skills using their personal web tools. The badge management system ensures that the scaffolding is given in digital format by the badge issuer, who is usually a teacher. It is recommended that the issuing process be shared among several actors, such as workplace mentors, teaching colleagues and peers. Anyone can be given access to a badge management system, so it is recommended that an even wider range of scaffolding providers be considered. Scaffolding based on an open badge management system is very personal and is usually conducted via a student's email. It is recommended that scaffolding or instructions for students focus on and point out to students the required skills or competences and instruct the students in how to demonstrate their skills in a digital format, implementing authentic work

situations. The final study (Study IV) introduced the practices and methods of scaffolding vocational student teachers in learning and documenting their competences in their ePortfolios in a way which would motivate them to continue the practice during their professional career (Figure 10).

The present dissertation reveals the three elements designing scaffolding PLEs may be based on: personal web tools, content and methods. These three approaches combine all the studies, introduce methods related to each element and explain features (Table 5). The methods, any of which may be chosen by an instructor responsible for creating a learning design for a PLE, feature examples of successful means of supporting learning in PLEs. However, it is recommended that all organising elements considered carefully before being included. Scaffolding models are often seen as very general instructions, so the present study produced detailed and specific instructions and continues the discussion of continuous learning via concrete activities and practical methods. These issues must be discussed with teacher students in order to promote their own continuing learning after completing their studies, and must also be presented them as a practice through which they can support and teach their own students in continuous learning.

The conclusions derived from all the findings—i.e. the approaches for organising scaffolding for PLEs in vocational teacher education—are presented in Table 5.

Table 5. Designing scaffolding for PLEs in vocational teacher education context

Organising elements	Methods	Features of methods
personal web tools	Learning outcomes goes into students' environments only (driven by pedagogical model/ other educational structuring)	• students choose and use tools they prefere
	Utilising ePortfolios	• Both workspace and showcase ePortfolios
	Ensuring students' digital competence	• To create digital artefacts • To create ePortfolio • To explore digital possibilities also independently
	Teacher goes to student's environments	• Feedback and comments directly to students' PLEs • User rights for teacher for reading and commenting
Content of PLEs	Pedagogical competence and other professional competences	• Design for learning activities as an evidence of pedagogical competence • Self-assessment by evaluation table (Study II) • Other relevant competencies (e.g. substance related)

Organising elements	Methods	Features of methods
	Documentation of conducted teacher's activities	• Videos, photos, reports from classroom or online teaching • Feedback from workplace mentor and students
	Personal development for teacher's profession	• Reflection, development plan
Practices	Activities always aiming to future development (continuing learning)	• Interest to promote own teacher career • Starting point for a kind of a new process for ongoing learning • Personal growth and development of one's own teacher competence
	Following pedagogical model as a structure for learning activities or structures where PLEs are integrated	• Ensure that used pedagogical model includes enough scaffolding activities (e.g. DIANA or open badge-driven learning)
	Sharing scaffolding responsibility to different providers	• Share scaffolding to teachers, peer-students, as digital instructions, practical training period in workplace - school (mentor, students)
	Implementing always peer-learning activities	• Also in individual development tasks
	Orientating to PLE work	• Learning objectives and assessment criteria concerning the documentation in PLEs and ePortfolios • Examples of earlier conducted studies by PLE

In educational settings the complexity of learning is usually tackled by formulating designs or frameworks which can then be used to create and implement learning activities. Although the solutions of the present study are in the context of vocational teacher education focusing on vocational teachers, I believe that this framework can be applied and utilised in any vocational learning and teaching context by replacing the substance field.

The results of the present study indicate that the five-stage model for scaffolding represents a general model for online scaffolding without giving practical instructions for specific scaffolding activities. As revealed by the present study, the DIANA pedagogical model includes scaffolding activities derived from the five-stage model, and the former actually offers more detailed activities for supporting and scaffolding students than the latter. Open badge-driven learning also includes activities arranged according to the five-stage scaffolding model and actually provides students with more concrete and detailed instructions for support and scaffolding. The distributed scaffolding framework makes it clear that there are

several relevant providers suitable for scaffolding students, from teachers and peers to digital online materials and instructions. The present study also outlines an arena for providing scaffolding to workplace mentors as well during practical teacher training periods and suggests that asking for feedback from student teachers' own students may help them develop professionally and thus can be seen as an aspect of scaffolding. Instructional badging (badge criteria) is another means of providing scaffolding. While PLEs are in use and support is offered by several providers, students' professional development is ensured during their studies and may be sustained by their continuous learning. It is suggested that learning objectives and assessment criteria for using ePortfolios be formulated when planning curriculum integration with PLEs—scaffolding is context-related, but the given suggestions for scaffolding are discussed from the perspective of PLEs and should be utilised widely across all educational sectors.

The Teacher Education Forum (Ministry of Education and Culture, 2018) suggested increasing teachers' competences in implementing digital tools and environments with pedagogical approaches in teaching and learning activities. The present study offers insights into how to implement teachers' development and encourage their interest in developing throughout their teaching careers by scaffolding them in their PLEs.

8 Discussion

8.1 Theoretical implications

The theoretical implications of the present dissertation relate to conceptualising scaffolding when learning and making competences visible by documenting them in PLEs. This chapter discusses this issue from the perspectives of scaffolding and PLEs.

The distributed scaffolding theory, in which multiple providers are scaffolding students, such as teachers and peer-students and the instructions given in digital learning environments (Lajoie, 2005; Tabak, 2004), is a relevant framework. This theory is extended by the present dissertation in its use of the context of vocational teacher education (or vocational education in general). Namely, as explained in Study IV, a lecturer's colleagues and workplace mentors are important scaffolding providers during the practical teacher training period. Even a student teacher's own students participate in scaffolding when they give feedback on their lessons and teaching activities. Such feedback enables the student teachers to improve their teaching methods.

Open badge-driven learning (Brauer et al., 2017) offers scaffolding in the form of instructional badging: the badge criteria (including competence or learning objectives, assessment criteria and instructions for skills demonstration) is an independent means of scaffolding students without human contact. Issuing badges is a procedure usually conducted by a teacher but may also be done by peers, workplace mentors or other network members. The technology used in instructional open badge management systems allows teachers, peers, workplace mentors or whoever is given permission to work with badges to provide scaffolding. From the perspectives of formal, informal and continuous learning, is a relevant advance and presents the possibility of sharing scaffolding activities. Instructional badges are an extension of distributed scaffolding. In Study III, open badge-driven learning was found to have scaffolding activities which followed Salmon's (2018) five-stage model in that they offered easy access to online materials, peer-learning and communication, facilitated knowledge construction, and provided links outside the learning society. Scaffolding is also extended by implementing the gamification elements found to empower students' learning.

Student teachers' motivations (Ryan & Deci, 2000) to learn and demonstrate their competences through ePortfolios include job application purposes, interest in starting a modern learning process using them and their personal growth as a teacher. It may be concluded that external motivations are also highly relevant and an important reason for promoting one's career in a modern way with ePortfolios, as confirmed by Mobarhan et al. (2015). As found in Study IV, teachers may be prompted by multiple motivations when planning how to scaffold students. In vocational teacher education it is important to promote one's own teaching career in order to be recruited in teachers' positions. The ability to use modern digital technology in teaching is also relevant. These two practices relate to external motivations but are nonetheless essential to a career as a vocational teacher.

When comparing the activities of the five-stage online scaffolding model (Salmon, 2003) and a pedagogical model—in this case Aarnio and Enqvist's (2016) DIANA model—it is evident that the five-stage model is a better general model for scaffolding without having to rely on specific instructions (Lakkala, 2010; Lakkala et al., 2010). With regard to the reverse, however, Study I revealed that the DIANA pedagogical model is also a model for scaffolding, and it includes instructions for how teachers should support students' learning at each cornerstone and stage. The instructions are very detailed, but they enable the model to be implemented in various learning processes.

The present dissertation defined vocational teachers' pedagogical competences according to the pedagogical infrastructure framework (Lakkala et al. 2010) used for exploring student teachers' created learning designs placed in ePortfolios. As Lakkala et al. (2010) explained, the pedagogical infrastructure framework is a general guideline for creating learning designs, and therefore the criteria for evaluating learning designs were very detailed (see Study II). These criteria were based on the learning designs created by the student teachers during their studies. In Study II the formulated evaluation criteria for learning designs are mostly seen in the types of learning assignments the teachers created for their students. A perspective on scaffolding and feedback as teaching activities was also integrated in the student teachers' learning designs.

Scaffolding PLEs using various digital tools was studied from several approaches. Studies II and IV focused on ePortfolios. The two faces of ePortfolios (Barret, 2010) suggested that showcase artefacts are created at the beginning of the showcase portfolio process, independently but at the same time, based on discussions of workspace portfolios. Barret's (2010) theory was extended: The artefacts created during a workspace ePortfolio process can be incorporated in a showcase directly or in an edited version.

The present study suggests that ePortfolios are more than learning diaries; however, it is essential that they should include ePortfolio owners' reflections related

to studies, learned topics and their competences. It is highlighted the difference between workspace and showcase ePortfolios from a perspective how to make reflections visible. Creating an ePortfolio is also understood as a skill itself (Korhonen et al., 2007), so the present study also follows Lumsden et al. (2007) in suggesting focussing on the learning objectives and assessment criteria relating specifically to the ePortfolio process and the personal development which ePortfolios document. The present study extends this idea by identifying student teachers' motivations as a background for creating learning objectives and assessment criteria for ePortfolios. In Study IV it is suggested that ePortfolios provide student teachers with an understanding of continuous learning, a way to utilise digital tools in teachers' work and guidelines for implementing digital tools and environments in student learning. The present study indicates that the concept of PLE supports digital competences.

8.2 Methodological implications

The data of the present study is qualitative and various empirical approaches and analytical methods were used to assess and better understand the subject matter (Denzin & Lincoln, 2000), including deductive content analysis (Johnson & Christiansen, 2008), abductive analysis (Timmermans & Tavory, 2012) and data-driven content analysis (Schreier, 2012). The qualitative results were then quantified to reduce subjectivity (Chi, 1997). The main reason for conducting qualitative research is often that there is a need to collect in-depth data from a specific group of participants or events (Maxwell, 2005, p. 22). However, this might impose certain limitations, particularly the issue of a small sample size limiting the perspective of a study. Study I covered a small number of courses and iterations, which may be seen as a limitation of the study. Study I followed the DBIR (Fishman et al., 2013), so its reliability would have been stronger if someone outside of the study had analysed the data. Student teachers were valuable informants, but they could have been more involved in planning the course design. Furthermore, more detailed questions concerning the concept of PLE could have elicited more information about the participants' understanding of the PLE. Study II was perhaps limited with regard to the disciplines represented by the participants, most of whom worked in technology, communication and transport. When discussing ePortfolios, the practices of each discipline are highly relevant and there is a divergent between disciplines.

A limitation affecting all four studies was that some of the authors had many years' experience with the courses used as the context of the study and were thus very familiar with them. If an external designer had been involved in planning the course design it might have influenced the practices and results. The researcher's position thus constitutes a limitation which may impact the study; however, readers

of the study expect a researcher to know his or her subject (Yin, 2009, p. 189). Teachers who are also researchers are better able to accelerate their professional development and improve their teaching and learning practices (Xerri, 2018). The trustworthiness of the study is founded in the activities the researcher conducted in close communication with the participants while teaching and guiding them through the topics and processes covered by the present study. The validity (or trustworthiness) of all studies is based on a context familiar to the researcher, who was aware of the questions and approaches required to study the relevant practices. A strong understanding of how the participants think is also important in order to interpret the data and to ensure interpretive validity (Johnson & Christensen, 2008). As the researcher acted as the participants' teacher trainer during their studies, which lasted for approximately one year, it could be said that the participants are familiar to the researcher; bias was therefore limited by continuous self-reflection and collaboration with co-authors and supervisors, and objectivity was considered carefully in each phase of the present study. The validity was maintained by the facts that the relevant data were collected in the natural settings of the studied processes and the phenomena increased in internal validity (Schreier, 2012, 27). The internal validity was further supported by the triangulation of both the method and the data, as reported in Chapter 5 (Research design), where the strategies of the study methods are described and the data collection, participants, methods, and data analysis techniques are introduced; this chapter also deals with the external validity of the study. The studies followed the key features of qualitative studies in being interpretive, situational, reflective, flexible and case-oriented (Schreier, 2012). Studies I–IV were conducted, reported and documented carefully, as description is a major objective in qualitative research (Johnson & Christensen, 2008), and were mostly data driven, which further supports their validity (Schreier, 2012, 35).

DBIR was chosen as the methodological approach in Study I, as the study process was cyclic and included several questions to be explored in the process. While applying DBIR, the empirical material and analysis methods may vary in all phases by producing information which provides directions for continuing to the following phases (Cobb et al., 2013). The DBIR was found to be a relevant method for improving learning designs which can be used in teachers' daily work. Students' valuable feedback is highlighted by DBIR and engaging students even more in planning and designing learning activities is encouraged.

Studying the content and structures of ePortfolios was found to be a challenging task; it was even more challenging to determine how to assess teachers' competences by studying ePortfolios. The data of Study II was multidimensional and therefore complex; all ePortfolios were constructed in different ways, and there was no set pattern for them. Methodologically, the solution—analysing the ePortfolios—was arrived at by first systematically reading ePortfolios according to their most

significant content areas (sections), second by selecting a theoretical framework for evaluating digital competence (Ilomäki et al., 2016) and third by setting the criteria for evaluating the learning designs used by the participants in their pedagogical approaches. The evaluation criteria for the learning designs followed the pedagogical infrastructure created by Lakkala et al. (2010). The pedagogical approaches were also evaluated by analysing pedagogical development work reports. All data were analysed solely through the ePortfolios. This multidimensional method created a solution for analysing the multidimensional digital material relating to teachers' competences. It is recommended that the created evaluation frame also be utilised when creating or selecting learning or competence objectives, assessment criteria and instructions for skills or competence demonstrations of ePortfolio practices in vocational teacher education.

In Study IV participants were asked about the practices they used to create their ePortfolios, their recommendations for scaffolding them and their motivation to create, learn and make their competences visible using them. Several scaffolding providers were identified, as Tabak (2004) suggested, and more were described in earlier chapters. Furthermore, participants' motivations (Ryan & Deci, 2000) for creating ePortfolios were identified during this same data collection. When the data were collected in one discussion session which addressed the same phenomena from various aspects, it was also possible to combine all three aspects of ePortfolios (practices for creating them, recommendations for scaffolding them and motivations to create, learn and make competence visible using them) to establish a process for scaffolding ePortfolios which motivates students extrinsically and intrinsically.

8.3 Future directions

The study explored scaffolding PLEs in personal web tools, content, practices and points of view. Detailed and concrete methods were identified in order to participate in the ongoing discussion of continuous learning and PLEs as an arena for formal, informal and nonformal education. It is recommended that digital tools for PLEs be organised in such a way that the tools and content of ePortfolio can follow students after their studies are completed, thereby supporting continuous learning. In addition to the vocational teacher education program, it would be interesting to apply the studied elements and methods to organising PLEs in other professional fields. This might be a relevant topic to study in a vocational education and training context in order to consider what the key competences of each profession are. The methods of organising scaffolding when PLEs are utilised should be tested in teacher education programs as a part of a curriculum and teacher students' experiences studied in order to improve these methods. In order to improve learning in PLEs by utilising ePortfolios, it is necessary to create learning and competence criteria for studying

and working with ePortfolios in vocational teacher education programs. It would be beneficial to study how ePortfolios could be implemented in vocational teacher education curricula, as well as to understand how student teachers have utilised PLEs, ePortfolios and other digital tools for their career learning purposes after their graduation and with their own students. Further research on the content of ePortfolios is recommended, particularly investigations into how to create learning assignments which enable student teachers to make competences visible in teacher education contexts. It might also be relevant to study this in vocational education and training degree programs.

In future studies there is room to discuss more approaches which would combine the discussion of General Data Protection Regulation (European Union, 2019)—specifically, how it governs education providers' digital tools and environments but does not support students' ownership of said digital environments. There are applications available to fulfil this gap, but it is not yet clear how to convince educational providers invest in them. Future studies may also address how Web 2.0 tools can be used to protect students' data.

The present study offers some insights to the discussion of continuous learning identified as a development target by Ministry of Education and Culture (2019). The findings, implications and recommendations of this dissertation may offer practical guidelines for future studies in greater detail.

Abbreviations

API	Application Programming Interface
DIANA[1]	Dialogical Authentic Networking Activity 1
$ECTS_2$	European Credit Transfer System
ICT	Information Communication Technology
LMS	Learning Management System
MOOC	Massive Open Online Course
PLE	Personal Learning Environment
PLN	Personal Learning Network
PWT	Personal Web Tools
SDT	Self-Determination Theory
SoMe	Social Media
ZDP	Zone of Proximal Development

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