Designing for added pedagogical value

A design-based research study of teachers' educational design with ICT

Jörgen Holmberg

Abstract

In an increasingly digitized world teachers are expected to take on the role of educational designers and use ICT to design in ways that add pedagogical value to teaching and learning. This thesis adopts a design-based research (DBR) approach to: (a) explore and contribute to the educational design processes of teachers of English as a foreign language in their efforts to use ICT for added pedagogical value, (b) examine how ICT is used in educational designs to create/contribute to what the teachers and students describe as added value and (c) explore, problematize and refine DBR as a research approach.

Literature studies and a collaborative self-study preceded the DBR to guide its focus and implementation. The DBR was carried out over a period of two years in four upper secondary schools in Sweden in which every student had access to their own computer. The research data consists of: (a) audio recorded design conversations, (b) enacted educational designs and design elements as parts of these, (c) reflective log entries written by the participating teachers, (d) focus group interviews with students and (e) the researcher's field notes.

Six different theoretical frameworks and models are used in combination in the accompanying articles to analyze the data and achieve the three research aims. The findings show how teachers' pedagogical reasoning and TPACK development are interconnected and reciprocal aspects of the educational design process and how the externalization of, and reflection on, these aspects is necessary to develop the specific and practical TPACK needed to realize design intentions in situated contexts. A number of challenges and opportunities in the educational process have been identified.

Moreover, the findings show how ICT was used to contribute added value in educational designs by facilitating: (a) more authentic and seamless learning experiences in external online contexts with both in-class and out-of-class actors irrespective of time and place, (b) an exchange of digital knowledge representations of understanding and practice between different actors, e.g. for the purposes of modelling, supporting cognitive apprenticeship, meta-cognitive self-regulation and formative assessment and (c) new and extended forms of, and opportunities for, collaborative creation and meaning-making.

The current common focus in DBR on the development of prescriptive design principles is problematized in relation to the findings of the thesis, which illustrate the complex and situated nature of the educational design process. A theoretically and empirically informed design framework (DF) is developed and used as a conceptual tool to guide and analyze educational design processes and enactments. The findings illustrate how the use of the DF and the process of collaborative design reflection contributed to the analysis of the teachers' design intentions and de facto design practices and to a DBR format that allowed the participants to use their respective competencies in the development of educational designs for added value. The thesis thereby serves as an example of how DBR can be methodically implemented to study and generate increased knowledge about teachers' design intentions and design practices, develop research-based educational designs in line with teachers' pedagogical intentions and support their development as educational designers.

Keywords: *added pedagogical value, design-based research, design framework, educational design, educational design research, EFL, ICT, teacher practice, TPACK.*

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List of abbreviations

DBR   Design-based research

EFL   English as a foreign language

ICT   Informations- and communications technologies

ILOs   Intended learning outcomes

PCK   Pedagogical content knowledge

The CF   The Conversationsl Framework (Laurillard 2012)

The DF   The design framework (constructed and used in the thesis)

TPACK   Technological Pedagogial and Content Knowledge (Mishra & Koehler 2006)

List of figures

List of articles

The thesis is based on the following articles, which will be be referred to as article 1, article 2, article 3, article 4 and article 5 in the thesis.

Article 1
Fransson, G., & Holmberg, J. (2012). Understanding the theoretical framework of technological pedagogical content knowledge: A collaborative self-study to understand teaching practice and aspects of knowledge. *Studying Teacher Education*, 8, 193–204. Reprinted by permission Taylor & Francis LLC, (http://www.tandfonline.com).

Article 2
Holmberg, J. (2014). Studying the process of educational design - revisiting Schön and making a case for reflective design-based research on teachers' 'conversations with situations'. *Technology, Pedagogy and Education*, 23(3), 293–310. Reprinted by permission Taylor & Francis LLC, (http://www.tandfonline.com).

Article 3
Holmberg, J. (2017). Applying a conceptual design framework to study teachers' intentions with and use of educational technology to support meaning making. *Education and Information Technologies, 22*(5), 23333-2349. Open access, distributed under the terms of the Creative Commons CC BY license.

Article 4
Holmberg, J., Fransson, G. & Fors, U. (2018). Teachers' pedagogical reasoning and reframing of practice in digital contexts. *The international journal of information and learning technology*, 35(2), 130-142. Reprinted by permission Emerald Publishing Limited.

Article 5
Holmberg, J. (Submitted to international peer-reviewed journal). Identifying the added pedagogical value in teachers' educational designs with digital technologies. Author's copyright.

Summary in Swedish

I takt med en tilltagande digitalisering av samhälle och skola finns idag förväntningar på lärare att använda informations- och kommunikationsteknologi (IKT) för att skapa nya och 'förstärkta' förutsättningar för undervisning och lärande. Ett annat sätt att uttrycka detta är att lärare förväntas utveckla sin förmåga att designa för lärande med hjälp av olika digitala verktyg så att didaktiska mervärden skapas. Denna omställningsprocess är emellertid både tidskrävande och mångfacetterad. Det finns därför behov av forskning som bidrar både till ökad förståelse om undervisningsdesign som process och som praktiskt kan stödja lärare i deras arbete med att skapa undervisningsdesigner där IKT tillför didaktiska mervärden. I denna avhandling används en designbaserad forskningsansats (design-based research, DBR) för att generera bidrag i båda dessa avseenden.

Avhandling har tre syften:
- att bidra i det praktiska utvecklingsarbetet i de berörda undervisningskontexterna
- att generera teoretisk kunskap om undervisningsdesign som process och om hur IKT kan användas för att skapa didaktiska mervärden för undervisning och lärande,
- att bidra till en problematisering och utveckling av DBR som forskningsansats.

Avhandlingsarbetet inleddes med en kollaborativ självstudie vilken bidrog med erfarenheter kring och förståelse av ett kollaborativt designsamarbete. Det gav också möjlighet att använda det teoretiska ramverket TPACK, som är en akronym för Technological Pedagogical and Content Knowledge, och att pröva det som ett verktyg för att analysera de kunskaper lärare behöver i digitala undervisningskontexter. Den designbaserade delen av avhandlingsarbetet föregicks också av litteraturstudier och teoretiska och metodiska reflektioner kring DBR, allt i avsikt att formulera en vetenskaplig bas som grund för genomförandet av DBR-delen av avhandlingsarbetet. Resultaten från dessa två studier redovisas i artikel 1 och 2 i avhandlingen.

Den huvudsakliga designbaserade delen av avhandlingsarbetet genomfördes under en period av två år i samarbete med åtta engelsklärare på fyra svenska kommunala gymnasieskolor där varje elev

hade tillgång till en egen dator. Resultaten från denna del av avhandlingsarbetet redovisas i artiklarna 3, 4 och 5 i avhandlingen.

Sex olika teoretiska ramverk används i kombination för att uppnå avhandlingens syften. Med utgångspunkt i tre av de nämnda ramverken utvecklas och prövas även empiriskt en alternativ konceptuell konstruktion i form av ett designramverk. Detta används som stöd för planering och praktiskt genomförande av undervisningsdesign, samt analys av undervisningsdesigner och designelement.

Forskningsdata består av: (a) ljudinspelade designkonversationer mellan forskaren och enskilda lärare, (b) digitala representationer av undervisningsdesigner och designelement i dessa, (c) lärarnas skriftliga självreflektioner, (d) fokusgruppintervjuer med elever, och (e) forskarens fältanteckningar. Data analyseras med hjälp av riktad- respektive tematisk innehållsanalys.

Avhandlingens resultat visar hur lärares didaktiska överväganden och deras utveckling av TPACK-relaterad kompetens är sammanlänkade och ömsesidiga aspekter i undervisningsdesignprocessen. Resultaten visar också hur en externalisering och reflektion kring dessa aspekter är nödvändig för att utveckla den specifika och praktiska TPACK som behövs för att realisera designintentioner i situerade kontexter. Ett antal utmaningar och möjligheter i lärarnas undervisningsdesignsprocesser identifieras och problematiseras i avhandlingen. Bland annat illustreras hur lärares undervisningsdesignsprocess måste inkludera överväganden relaterade till rådande skolkulturer, inklusive elevers digitala kompetens och acceptans av nya arbetssätt. Detta innebär i sin tur att IKT-relaterade utvecklingsprocesser ofta får implementeras gradvis och över tid.

Resultaten visar också hur IKT användes i undervisningsdesigner för att bidra till didaktiska mervärden i form av: (a) nya och förstärkta upplevelser i lärandet, ofta i skolexterna online-kontexter med olika aktörer oberoende av tid och plats, (b) utbyte av digitala kunskapsrepresentationer som uttryck för förståelse och praktisk färdighet mellan olika aktörer för understödjande av exempelvis modellering, kognitivt lärlingsskap, metakognition och formativ bedömning, samt (c) nya och utökade former och möjligheter till interaktion, samarbete och kollaborativt meningsskapande.

I relation till avhandlingens tredje syfte visar resultaten hur det designramverk som utvecklats i avhandlingen fungerade som ett

konceptuellt verktyg i den kollaborativa designprocessen för att synliggöra och underlätta diskussion kring olika aspekter av denna. Vidare visas hur denna kollaborativa designprocess, med designkonversationer som ett centralt inslag, möjliggjorde fördjupade analyser av lärarnas designintentioner och undervisningsdesigner, samt bidrog till ett DBR-format där deltagarnas respektive kompetenser tilläts komma till uttryck. Detta möjliggjorde i sin tur på sikt en utveckling av undervisningsdesigner där IKT enligt lärare och elever bidrog med didaktiska mervärden.

Avhandlingen tjänar därmed som ett exempel på hur DBR kan implementeras metodiskt för att: (a) studera och generera ökad kunskap om lärares designintentioner och designpraktik, (b) utveckla forskningsbaserade undervisningsdesigner i linje med lärares didaktiska intentioner, samt (c) bidra till deras förmåga att designa för lärande med olika digitala verktyg.

Abstract

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Six different theoretical frameworks and models are used in combination in the accompanying articles to analyze the data and achieve the three research aims. The findings show how teachers' pedagogical reasoning and TPACK development are interconnected and reciprocal aspects of the educational design process and how the externalization of, and reflection on, these aspects is necessary to develop the specific and practical TPACK needed to realize design intentions in situated contexts. A number of challenges and opportunities in the educational process have been identified.

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Acknowledgements

Introduction

The considerable economic and prestigious investments in information and communication technologies (ICT) in schools and the recent inclusion of teachers' and students' expected digital competence in the national curricula are two strong indicators of the effects of digitization on schools in Sweden. Large scale investments in ICT, for example in the form of 1:1 initiatives, where every student has access to a computer or tablet, are not only common in Sweden, but also in Europe and the western world as a whole (OECD 2016; Tallvid 2016). These initiatives, which are designed to help make *all* students digitally competent, are seen as very important (Council of the European Union 2018). Teachers are thus expected to help students to develop a digital competence by using ICT as part of their teaching.

Another argument for introducing ICT and 1:1-initiatives in schools is the hope that ICT will serve as a *change-agent* and help to transform teaching, for example by leading to more student-centred approaches (Tallvid 2016). In addition to teachers being expected to help students develop digital competence, they are also expected to exploit the potential of ICT in their own teaching in ways that help students' learning in new or enhanced ways (Wastiau et al. 2013). This is reflected by the increasing reference to teachers as *educational designers* and their work as *educational design*, which stresses the (theoretical) possibilities that teachers have to use different ICTs as digital tools to design teaching and learning, not only in new ways, but in ways that add pedagogical value (Ertmer, Parisio & Wardak, 2013). The concept of *added pedagogical value* is central in this thesis and is used to describe the goal of using ICT in ways that bring about unique qualitative enhancements in teaching and learning. This might mean:
- enabling teachers to use their existing pedagogical strategies in enhanced ways, e.g. by making multimodal formative assessments available, irrespective of time and place
- enabling teachers to realize pedagogical intentions that were practically impossible without ICT, e.g. by allowing students to experience an historical setting in Virtual Reality (VR)
- enabling teachers to formulate new pedagogical intentions brought about by new understandings of the teaching content and possible ways of working in an increasingly digitalized society.

Exploring how to use ICT for pedagogical purposes in ways that add pedagogical value thus becomes an important part of teachers' work. However, there is research to indicate that this process is limited and slow and that teachers in their roles as educational designers use new digital tools in ways that mirror their existing analogue practices and do not therefore transform their teaching (Sanders & George 2017; Vrasidas 2015). As is elaborated on below, it can be argued that the goals for teachers' educational ICT use have often been unrealistic and that there are many possible reasons why teachers have not adopted ICT in their teaching as some have hoped (Sanders & George 2017). Nevertheless, there are indications that the expectation that teachers will use ICT to add pedagogical value has not been met and that further research is needed on teachers' educational design (Livingstone 2012; Olofsson, Lindberg & Fransson 2017; Pate 2016).

In view of the above discussion, the research interest in this thesis is to explore how ICT can be used to add pedagogical value and to study teachers' educational design processes and the challenges and opportunities they face as educational designers. However, before specifying the thesis' aims and research question, I contextualize my research by providing a short background description of the opaque affordances of ICT, the historical recentness of ICT in schools, the limited availability of guidance for teachers in the educational design process and the need for educational research that can support teachers' as educational designers and increase our understanding of the educational design process.

The opaque affordances of ICT

An important part of studying teachers' educational design processes involves studying how they test different ICTs as 'digital tools' in their practices. Exploring how to use ICTs as digital tools for pedagogical purposes involves working out how these tools facilitate, or afford and/or constrain different pedagogical intentions, choices and actions. The *affordances* of digital tools, i.e. the perceived and actual properties of digital tools that indicate the possible actions that are available to a user, are often multifaceted and *opaque* in the sense that they are not immediately apparent (Bannan, Cook & Pachler 2016; Kaptelinin 2014). The difference between analogue technologies such as chalk and multi-coloured whiteboard markers are obvious. The difference between an

abacus and a digital calculator is also apparent, even though the affordances of the calculator are more opaque in the sense that it will take some time to work them out. Generally speaking, the calculator can still be described as affording different kinds of mathematical calculations (if we disregard more advanced calculators that can produce graphs etc.). However, the affordances of digital tools such as the internet, wikis and smartphones are much more multifaceted and opaque. For example, a smartphone can be used as a tool for accessing multimodal teaching materials irrespective of time and place (e.g. text, audio, video, or an interactive website). A smartphone can also be a creative advice that enables students to document, reflect on and illustrate their learning process, and/or their knowledge and skills, through different modalities in and relation to the expected learning outcomes. It can also be a calculator.

Working out how to take advantage of the affordances of ICT is thus no mean feat. In addition, digital tools and their affordances also have a tendency to become what Latour describes as black-boxed, i.e. their use and function is taken for granted and their inner complexity and alternative uses might be overlooked (Latour 1999). Moreover, for teachers the use of technology does not only include their own knowledge and possible uses of technology, but also that of their students. Teachers need to consider whether students will grasp their pedagogical intentions and be able and willing to take advantage of the affordances of a tool in the way that is intended. The affordances and constraints of digital tools can be seen as *relational* properties, i.e. a tool does not simply *have* affordances, but affordances are *perceived in use* when teachers and students use the tools and evaluate the outcomes (Jones 2015; Norman 1988). This means that different teachers (and students) might perceive different affordances in the same tool. It also means that as teachers develop their practices (e.g. learn more about digital technologies, the teaching content or ways of working pedagogically) they might discover or develop ways of using existing digital tools that afford their pedagogical intentions, choices and actions in new ways. If, how and why technology is used in teachers' educational designs is thus related to their technological, pedagogical and content knowledge and the dynamic and reciprocal relationship between these knowledge domains in situated practice. The understanding of the complex relationship between these different knowledge domains and the ability to coordinate and integrate them successfully in teaching is referred to as technological, pedagogical content knowledge, or TPACK

for short (Mishra & Koehler 2006, 2008). The TPACK framework has proved to be a valuable tool for describing, discussing and analyzing teachers' knowledge, both in research and in collaborations between researchers and teachers (Voogt et al. 2013*)*.

The historical recentness of ICT in schools

Considering the often rich and opaque affordances of digital technologies, and how the integration of a new knowledge domain alongside already existing ones requires teachers to develop, reflect on and reframe their teaching practices, the complexity of developing TPACK and designing for added pedagogical value should not be underestimated (Mishra & Koehler 2008; Tondeur et al. 2017). It should also be remembered that from an historical perspective it is only very recently that teachers and students have been given access to the type of ICT technology that is often mentioned as the potentially most powerful for teaching and learning, e.g. social and interactive web 2.0 technologies (Hsu, Ching & Grabowski 2014). The term web 2.0 was introduced in 2005 to describe the new kind of free or cheap web-based software and services that were being introduced to enable people to create, collaborate, share and communicate across the boundaries of time and place (O'Reilly 2005). Popular and free wiki or blogging solutions like Wordpress and Tumblr were introduced around the same time. However, the introduction of web-based collaborative tools intended for schools is more recent than this. For example, Google apps for education were not widely introduced until 2010 and the cloud-based storage solution Google Drive was only introduced in 2012. Hardware with wireless internet connections and sufficient battery capacity to take advantage of the potential of web-based tools have also only been available for a limited time. For example, high speed wifi, 3G/4G mobile internet, smartphones and ultrabooks were available on the market less than a decade ago and often introduced into schools later than that.

Apart from the recent introduction of ICTs with promising pedagogical potential, teachers also often have limited access to existing ICT. From an international perspective (OECD 2018), Sweden is a country with a well-developed digital infrastructure. Nevertheless, a statistical report by the Swedish National Agency for Education showed that in 2015 seven per cent of the upper secondary teachers included in the survey (n=1624) stated that they had limited or very limited access to a computer or tablet

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that they could use in their classroom education and that five per cent of the teachers expressed that they did not have sufficient access to a computer outside the classroom (Swedish National Agency for Education 2016, p. 44.). The same report shows that the computer/tablet to student ratio in Swedish upper secondary schools is 1 to 1.3. However, when students who bring their own computers or tablets to school are included in the statistics the ratio is 1 to 1 (ibid., pp. 43-44). This means that in 2015, and for the first time since statistics of this kind were collected, all upper secondary students now (in theory) have access to their own computer.

The limited availability of guidance in teachers' educational design process

Teachers in Sweden have also received limited support in their efforts to explore how to design with ICT for added value (Salavati 2016; Tallvid 2015). According to the Swedish National Agency for Education (2016), one third of the teachers who responded to the survey in 2015 stated that they had limited or very limited pedagogical support to help them explore the potential of ICT in relation to their teaching practice (p. 57). When questioned about the functionality and quality of the available ICT equipment and the availability of technical support, approximately one third of the teachers stated that they were often or very often limited by malfunctioning ICT and that they only had limited or very limited technical ICT support to help them overcome these issues (ibid., p 56-57). Generally speaking it can thus be said that Swedish upper secondary teachers have received little guidance about *what kind of* added value to design for, or *how* to design for it (Willermark 2018, p. 21). A similar lack of technical support and also of professional development programmes for teachers is reported in other countries (Albion et al 2015). This lack of guidance can contribute to a lower teacher self-efficacy in relation to their digital competence; something that in turn can affect their de facto inclusion of ICT as part of their practice negatively (Hatlevik 2017).

Another reason for the sometimes limited uptake and use of ICT that has been mentioned is related to the existing educational research to support teachers' integration of ICT as part of their practice. Educational research on teachers' use of ICT has been criticized due to a limited theoretical

grounding or insufficient use of theoretical models (Kirkwood & Price, 2014). In relation to teachers' efforts to explore the potentials of ICT, the often limited ability of educational research to provide guidance and support in those efforts have been commented on (Anderson & Shattuck 2012; Reeves, McKenney & Herrington 2011). To what extent this criticism is valid or not is debatable, but there is arguably a consensus that further research on teachers' pedagogical use of ICT and the outcomes of this use is needed, and that new or 'rearranged' ways of doing educational research needs to be considered in order to make it more useful to teachers and contribute to closing the gap between research and practice in education (Bereiter 2014; Olofsson & Lindberg 2014).

It is also increasingly suggested that a closer collaboration between teachers and researchers can help to close this gap and generate a knowledge that is characterised by (practical) know-how and scientific (theoretical) know-why (Bereiter 2014). The Swedish Ministry of Education and Research recently published a report with recommendations for increased funding and collaboration opportunities between teachers and researchers in schools (SOU 2018:19). Some researchers have even suggested that practice could be used as a criterion to determine the rigour of educational research (Gutiérrez & Penuel 2014). Educational design-based research approaches in which teachers and researchers collaborate closely and contribute their respective expertise in the design process are increasingly mentioned as ways of sustaining scientific rigour and relevance (Albion et al. 2015).

The need for research to support and increase understanding of teachers' educational design processes

Considering the recent introduction of ICT, the rich and often opaque affordances of constantly emerging new digital tools, the complexity of developing TPACK and the limited guidance that teachers have received in their exploration of these affordances and the interconnected process of TPACK development, it is understandable that teachers' adoption of ICT in their teaching has been slower and more limited than some have expected.

In line with the argumentation presented above, it can be claimed that research is needed to; (a) support teachers in their development of added pedagogical value and provide research-based theoretical outcomes as guidance for educational design in different contexts, and (b) better understand the challenges of and possibilities for teachers to explore how to design for added pedagogical value. Moreover, given that the processes and outcomes of teachers' educational practices are reciprocally connected and still under development, there is a need for research approaches that can both contribute to and analyze them. Developing and refining research approaches that can address these dual functions thus becomes an additional priority in educational research.

In this thesis, a design-based research (DBR) approach is adopted to develop ways of using ICT for added pedagogical value in educational designs and to generate theoretical insights into the educational design process and the characteristics of designs that teachers and students consider bring added value. I have thus adopted the dual roles of educational design partner and researcher. To increase my understanding of the TPACK framework as an analytical tool for analyzing the knowledge that teachers need and develop as educational designers, and of collaborative educational design work and research, the DBR part of this thesis is preceded by a collaborative self-study (article 1). The foci and envisioned outcomes of the ensuing DBR are informed by the findings in article 1 and by previous research on educational design, in particular Schön's (1986, 1987) view of educational design as reflective conversations with design situations (article 2).

The DBR was carried out together with eight teachers of English as a foreign language (EFL) in their respective design contexts over a period of two years. By focusing on EFL as the formal subject in designs, the inherent complexity of educational design was reduced and I was able draw on my own background as an EFL teacher in the collaborative design processes. Article 3, 4 and 5 present the results of this main part of the thesis work.

Today, digital tools are used in numerous ways in our daily lives and have become intricately linked to what we can do, what we know, what we define as knowing something and how we go about learning something. This means that the premises for understanding knowledge and learning change. The ontological and epistemological vantage point in this thesis is that knowledge is not a clearly defined entity that is

transferable between minds. Learning is understood as a process of meaning-making that is dependent on factors such as a person's level of engagement, preconceptions and personality, the social contexts in which it takes place and the mediating tools that are used. The process of meaning-making is seen as a dialectic process in which individuals, through communication and interaction with others, contribute to defining and refining what is accepted as signs of learning. A view of learning as (individual *and* collaborative) meaning-making expands the focus from individual minds to connections and interactions among minds and stresses the communicative and situated nature of learning (Brown, Collins & Duguid 1989; Lave & Wenger 1991; Wertsch 1998; Vygotsky 1978, 1986). It also affects how one envisions the nature and foci of practical educational designing and the potential outcomes of DBR. The focus of this thesis is not, as is some DBR, to generate specific design principles as 'blueprints' for design (cf. Plomp & Nieveen 2013a). The focus is rather to identify fruitful ways of thinking about how to design with ICT and to provide empirical examples of how this thinking is elaborated, supported and applied in the different studied contexts to create designs that teachers and students describe as having added value. By providing theoretical insights at a higher level of abstraction, and in relation to design thinking rather than detailed design descriptions, the applicability of the findings in other situated design contexts is arguably increased.

Aims and research questions

This thesis has three overarching aims. One aim is to develop educational designs in which ICT is used to add pedagogical value in EFL teaching and learning. Another and closely interrelated aim is to generate theoretical knowledge about the teachers' educational design processes and their outcomes. This is thus a twofold aim that includes generating theoretical knowledge about the educational design process and the challenges and opportunities that teachers face in this process as well as the identification and description of common characteristics of ICT-supported educational designs that the teachers and students studied in the thesis describe as having added value in teaching and learning. A DBR approach is adopted to achieve the two aims described above. However, the literature studies and empirical experiences in relation to DBR as an evolving research approach prompted the formulation of a

third aim of the thesis, namely to explore, problematize and refine DBR as a research approach that contributes to situated educational practice and an analysis of educational practice.

The following three research questions have guided the work:

- How can educational design as a process be conceptualized and what challenges and opportunities for teachers are identifiable in this process?

- What are the characteristics of educational designs that are considered as successful in supporting teaching and learning by the teachers and students, and how is ICT used to create added pedagogical value in these designs?

- How can educational design as a process be studied and supported through DBR?

Structure of the thesis

Following this introduction a clarification of some of the central concepts and their use in this article is provided. I then account for the historical roots of the field of educational design and make a distinction between two current perspectives on educational design. I also present previous research in order to put this thesis and the research questions into context. After this I account for and discuss my use of the theoretical frameworks that are applied in the thesis. The following methodology chapter includes a description of the overall research design, the empirical context and how the data was generated and analyzed. This chapter also includes a discussion about the measures taken to establish qualitative educational designs and trustworthy research, and the ethical considerations made during the thesis work. A summary of the five articles included in the thesis is provided and is followed by a chapter illustrating their contribution to answering the research questions. The final chapter discusses the theoretical and practical contribution of the thesis as a whole, draws conclusions and makes suggestions for future research.

Clarification of central concepts in the thesis

This thesis contributes to conceptual development in the field of educational design. Some concepts are particularly central to the thesis. These concepts and my interpretation and use of them is accounted for below and is further developed and problematized in the thesis.

Added pedagogical value
In this thesis the use of ICT as a tool for teaching and learning is focused. The term 'added pedagogical value' is used to describe the potential qualitative enhancement that ICT could contribute by supporting teaching and learning in new, extended and more varied and powerful ways in relation to specific educational goals. Designing for added pedagogical value thus means searching for ways to exploit the potential of ICT in teaching practice and help students to learn.

(ICT-supported) educational design
A central part of this DBR is the construction of educational designs. In a digital context, a teacher creates a pedagogical planning, i.e. a conceptual educational design, in which ICT is used with the intention of adding pedagogical value. The focus in an educational design is how ICT can be used to realize one or more pedagogical intentions to support teaching and learning. In an educational design there is thus an openness and 'flexibility' in relation to digital (or analogue) tools, which means that the 'same' educational designs can be enacted in different contexts by the use of different digital tools. For example: a teacher might want to create an educational design in which different shortcomings and qualities in oral communication are visualized and where the students' own abilities are visualized in relation to other examples of oral presentations. The digital tools envisioned here must thus afford the recording, sharing and commenting of students' knowledge representations.

Thus, the concept of *educational design* differs from the term *intervention*, which is often used in DBR. *Intervention* as a concept tends to focus more on the design product and is used differently by different authors (cf. Plomp & Nieveen 2013a). Authors describing an *intervention* can (or sometimes not) include a description of the overarching pedagogical intentions that are in focus, but tend to emphasize the digital tools used, the working methods, the use of time, the application of the digital tools in local practice, pitfalls and possibilities with the use etc.

By distinguishing between educational designs and interventions the aim is to contribute to a greater semantic and analytical precision.

The educational design process
In this thesis, educational design is also used to refer to the iterative and reflective process in which teachers engage as they plan, enact (i.e. put into practice, see below), evaluate and re-design *educational designs*. An important part of teachers' educational design processes is to interpret, test and evaluate the affordances of ICT in relation to their pedagogical design intentions.

(Pedagogical) design intentions and de facto design practice
Design ideas can be described as a teacher's notions about possible ways of using ICT. The term *design intention* is used to signal a conscious will, i.e. an intention to use ICT in a certain way in order to add pedagogical value. Design intentions can be general, e.g. the use of ICT to increase motivation, or more specific, e.g. using ICT to practise vocabulary with automated feedback. There are many possible contributing factors for teachers' design intentions and to how they are realized in teachers' *de facto design practice*.

Enacted educational design
With regard to the de facto representation in practice of a conceptual educational design, when a conceptual design is enacted it becomes interpreted and 'used' by students and the teacher in the situated contexts. If an identical conceptual educational design is enacted in two design contexts we will get two unique enacted educational designs, albeit with similar characteristics.

Design elements
Design elements are 'parts' of a conceptual or enacted educational design. They are intended to perform one or more 'functions' in relation to one or more pedagogical intentions. An educational design can thus be described as including a number of design elements. For example: the teacher's design allows students' essays to be read and commented on by peers (design element 1, a space for sharing and commenting of written texts to support feedback and modelling). The teacher also provides screencasts in which s/he uses extracts from the students' texts to

illustrate important aspects to consider (design element 2).

Digital tools
A central interest in this thesis is whether and how digital tools can be used to add pedagogical value in design elements and educational designs. Digital tools can be both physical artefacts and application software. In the example above, a wiki could be used in design element 1 as a digital tool to facilitate the sharing and commenting of texts between peers regardless of time and place. In design element 2, the screencasting application enables the use of multiple modalities when commenting on students' texts. If teachers wants to include their own faces as part of the screencast they would need a web camera as another digital tool.

Affordances
In order to understand which digital tools could be used to realize the teachers' intentions it is important to understand the affordances of a digital tool. Affordance is a complex term that is used differently by different authors. In this thesis, Norman's (1988, 2013) idea of perceived affordances is important, in that it indicates that whether and how a tool can be used for pedagogical purposes is often dependent on the teachers' and students' abilities to perceive ways of doing so.

Design conversations
In this thesis, data is largely generated through so-called design conversations. These can be described as open-ended 'interviews' about design intentions, previously enacted designs, design elements and digital tools. However, in design conversations teachers are free to ask questions and move the conversation in different directions. Design conversations thus have a holistic perspective, where theoretical and practical insights are discussed, compared and contrasted in a dialectical process.

(Educational) design framework
A design framework is a conceptual model that can be used to support the planning, enacting, evaluation and modification of educational designs. A design framework can also be used as a research tool to analyze educational designs (see article 3 in this thesis). There are a number of research-based educational design frameworks, all of which vary in focus, complexity and level of abstraction, depending on factors such as ontological and epistemological underpinnings and intended use

in the design process (Bower & Vlachopoulos 2018). This variation can be interpreted as yet another sign of the complexity and situatedness of educational design. The design framework developed in this thesis has been developed in line with the teachers' expressed design intentions and existing research on the educational use of ICT. To distinguish it from 'design framework' as a generic term, the design framework that is developed in this thesis is referred to as the DF.

Knowledge representations
Knowledge representations as used in this thesis refer to expressions of knowledge and skills that others can use to support their own development of similar knowledge and skills. A theoretical distinction is made between: a) externalized conceptualizations relating to understandings of the intended learning outcomes (ILOs) (e.g. questions, expressed interpretations and explanations), or b) manifestations of practice that can be used as signs of learning in relation to the ILOs (e.g. displayed skills and abilities, or produced artefacts). Through the use of ICT, knowledge representations from different actors, such as an explanation of a grammatical rule, or an argumentative speech, can be documented, annotated, shared and used to support teaching and learning. A knowledge representation can be illustrative of an incomplete or erroneous understanding or action, and then be used as an example of what is not a desired understanding or action.

Perspectives and previous research on ICT-supported educational design

Teaching and learning are highly dynamic and multi-dimensional activities. In the classroom context, students' preconceptions, pre-existing knowledge, expectations, needs and actions all affect teachers' decisions and the outcomes of teachers' efforts to support learning (Biesta 2010). The introduction of digital technologies with rich and opaque affordances in the teaching and learning contexts adds to this complexity (Koehler et al. 2014, Säljö 2010). The multifaceted nature of teaching, learning, digital technologies and educational design is evident in handbooks on educational design (cf. Luckin et al. 2013), in Technology Enhanced Learning (TEL) research (cf. Sawyer 2014) and in English as a Foreign Language (EFL) research (cf. Chapelle & Souro, 2017). The research foci and findings vary greatly depending on aspects like ontological and epistemological assumptions, the subject matter in question, the intended user of ICT, the ICT used etc. Giving a comprehensive overview of TEL research in general, or research on educational design, is therefore very difficult and beyond the scope of this thesis. The use of alternative terms to refer to is here labelled DBR, or research approaches with DBR similarities, also complicates a literature review of this type of research (McKenney & Reeves 2013).

As a consequence, this chapter provides an introduction to, and current examples of, perspectives and previous research related to the research aims of the thesis. First, a general historical overview is provided of research on the use of ICT for teaching and learning. Different collaborative approaches to the study of educational design are then discussed and compared. Finally, I present examples of studies and findings relating to the challenges and opportunities for teachers as educational designers, the potential and identified added values of ICT in language and EFL learning, previous DBR studies and their design and outcomes.

The history, conceptualization and study of educational design

The historical roots of what is referred to as (ICT-supported) educational design in this thesis can be found in the field of instructional design. In

research, the labels instructional design and educational design are sometimes used synonymously. However, the complexity of teaching, learning and educational design as described above is not recognized and/or interpreted in the same ways in the two fields. In this section, the historical roots of ICT-supported educational design are described and a distinction is made between instructional design and educational design as interpreted and described in the thesis.

The field of instructional design can be traced back to the United States and the Second World War, when educational psychologists were called on to conduct research and develop instructional materials for the military (Resier 2001). At the core of the field of instructional design is the *use of technology and media for instructional purposes* and *the use* of systematic design procedures (Reiser 2001, p. 57). Instructional design theory was originally heavily influenced by behaviourism and the trend of the 1950s to apply ideas and methods from natural science to social science (Tennysson 2010). One example is Skinner's ideas about the use of technology to construct 'effective' instructional materials that could deliver instructions in small steps and clearly defined tasks to support the learning of clearly defined sub-skills. The behaviourist influence continued to be evident throughout the 1960s, but was gradually replaced by cognitive learning theory as the main influence on instructional design during the 1970s and 1980s (Tennyson 2010).

Since the 1990s, constructivist learning theory has also influenced instructional design theory (e.g. Jonassen 1999; Willis 2009). However, even though instructional design and educational design are today used interchangeably by some authors (e.g. Ertmer, Parisio & Wardak 2013; Seel et al. 2017), instructional design has historically focused on what the instructor/teacher should do while paying limited attention to the learners in question and on problematizing the learning objectives and the social context of learning (Laurillard 2008; Willis 2009). To a large extent, instructional design considers design in terms of rational problem-solving and optimization. For example, Simon, whose influence on instructional theory has been substantial, writes in relation to design:

> *...the activity called human problem solving is basically a form of means-ends analysis that aims at discovering a process description that leads to a desired goal. (Simon 1996, p. 211)*

This *technological approach* (Willis 2009) to teaching emphasizes the actions of teachers and their design of instructional materials, their formulations of sub-goals, the paths to follow and the tools to use in order to learn well-defined cognitive skills (Tennyson 2010). As early as the 1980s, Schön criticized Simon and the idea of design as rational problem-solving through means and analysis as building on a positivist epistemology and ignoring the fact that in real world (educational) practices 'problems' constantly change shape and are therefore not easily identifiable (Schön 1983). Nevertheless, Willis (2009) argues that the view of design as rational problem-solving is still evident in instructional design and that the fact that Mager's *Preparing Instructional Objectives for Programmed Instruction* (Mager 1962) is still used in teacher training in the United States is an example of this. Willis uses a quote that illustrates how educational design and the role of the teacher is conceptualized in Mager's book (Willis 2009, p.52):

> *...I will try to show how to state objectives that best succeed in communicating your intent to others. The book is NOT about the philosophy of education, nor is it about who should select objectives, nor about which objectives should be selected. (Mager 1962, p. viii)*

The above quote is one example of how the field of instructional design reflects a transmission view of learning, where the designed materials and tasks are foregrounded. The conditions and complexities of the learning context are not considered in full and the users (e.g. students) are seen as passive recipients (Laurilllard 2008). Another example of this 'narrow' view of design is the ongoing efforts of design experts to construct a theory of instruction that is applicable in all learning situations (Tennyson 2010). As has been problematized in article 2 and article 3, instructional design and a view of design as rational problem-solving still influence some DBR research on educational technology.

Another view of ICT-supported educational design is that advocated by, for example, Laurillard (2008). This view recognizes the complexity of educational design and that it is not possible to create a design that is applicable in all learning situations. Instead, an important part of being an educational designer is to consider and interpret the complex learning situation and the affordances of the available technologies to make informed design choices (Olofsson & Lindberg, 2014). This view of design also recognizes that the choices and actions of the teacher and students 'within' a design constantly necessitate modifications of designs, which means that a design is never 'finished'. Hence, according

to this view, the principal focus of design is to create a learning environment that stimulates the 'learner's engagement with knowledge' (Laurillard 2008, p. 527) and encourages the learners' active participation and interaction with different actors and meta-cognitive reflection (Willis 2009). Alternative labels to describe the use of ICT to support learning have been introduced to signal the shift in focus to a more learner centred approach in educational design, for example *Learning Design* (cf. Maina, Craft & Mor 2015) and *Design for Learning* (Beetham & Sharpe 2013; Goodyear 2015; Laurillard 2012). According to this view of educational design, a design model cannot simply be followed irrespective of the context, but that a design is always tentative and the educational designer must always pay attention to the 'back talk' from the design situation and reflect on whether, and to what extent, a design supports learning in the intended ways (Schön 1983). Research influenced by the German and Scandinavian didaktik tradition stresses how teachers as educational designers should not only consider their own understanding of and relation to the teaching content, but also their relation to their students and the students' relations to the content (Kansanen 2009; Lund et al. 2014). Here educational design is about trying to understand and manoeuvre the complex relationships between the teacher, the content and the students. The quote below illustrates that this view of design does not assume that knowledge can be 'transmitted' to others, but that both the content and the students need to be considered in educational design:

> *The student's relation to the subjects, or more generally to the content, is the key to understanding the instructional process. (Kansanen 2009)*

Educational design viewed as a reflective practice acknowledges that teachers are not only content experts, but also need to consider the students' needs and capacities and how to make informed decisions about teaching content and how best to create opportunities for a specific group of students to study and hopefully learn it (Westbury, Hopmann & Riquarts 2012; Schön 1983). This view recognizes students as active participants in the design, and that educational designs should allow students to, in a sense, design their own learning (Kress & Selander 2012). Educational design in this context is thus not a matter of exposing students to knowledge, but creating opportunities for them to explore and interact with different potential knowledge resources, such as texts, videos and peers (Lund & Hauge 2011). It also means that in contrast to instructional design, the focus is widened from the design of digital artefacts for (individual) students to interact with, to the 'orchestration'

(Dillenbourgh 2013) of the students' engagement with learning materials and different actors.

If educational design is viewed as a reflective practice that aims to design for students' active interaction with representations and examples of what is to be learned together with others, this also has implications for how the educational design process to be studied is envisaged. As the complexity of educational design as a process has been increasingly recognized, educational design researchers therefore recognize the need to study educational design in the dynamic, complex and situated contexts in which it takes place. Based on their review of international research on the uptake and use of digital technologies in K-12 education, Olofsson et al. (2015) argue that educational design needs to be studied and understood both in theory and in practice and from different perspectives. Therefore, the authors call for longitudinal educational research that is carried out in close proximity to different multifaceted K-12 educational environments (Olofsson et al. 2015). In relation to the question of what to focus on in the study of educational design, Cross (2006) highlights three important sources of design knowledge for study. He labels these sources *people*, *processes* and *products*. *People* refers to educational designers and their design 'behaviour', what constitutes their design ability and how they learn how to design. *Processes* refers to the strategies and tactics used by the designer, but also the development and application of techniques that aid him/her in the educational design process. *Products* refers to the enacted educational designs and design elements as parts of these (Cross 2006).

Collaborative approaches to the development and study of educational design

The above discussion presents arguments for why research on educational design could benefit from studying educational designers and their design processes and design 'products' in situated contexts, as is done in this thesis. However, the rapid nature of ICT developments means that educational designers constantly need to develop and elaborate their design abilities, the strategies and tactics they use and their enacted designs. There is thus an incentive for researchers and teachers to collaborate in both the study *and* development of educational

design. Brown (1992) and Collins (1992) have written seminal articles in which they illustrate the importance of studying and contributing to educational design from the inside in what they refer to as design experiments. Building on Brown's (1992) and Collins' (1992) research, a number of labels have been assigned to research approaches where researchers and teachers collaborate to contribute to educational design practice and research. The nature and foci of this collaboration varies between the different approaches. In approaches such as *self-study*, *lesson study*, *teacher inquiry* and *teacher design research*, the role of the teachers and their studies of their own practices and outcomes is in focus (Bannan-Ritland 2008; Luckin et al. 2017). In *participatory design research*, which has its roots in systems design and human computer interaction (HCI), the research incentive is often taken by the researchers and the focus is often on the construction of a design. However, it is stressed that the users of educational designs should be involved in the construction of these designs (Halskov & Hansen 2015).

In DBR (e.g. McKenney & Reeves 2012), or *educational design research* (e.g. Plomp & Nieveen 2013a), which are terms that are often used synonymously, the collaboration between teachers and researchers and their use of their respective knowledge and skills in the design and research process are often stressed. A distinguishing characteristic of these research approaches is the dual goal of producing educational designs for use in practice and the development of design theory for use outside the immediate design context in which these theories were generated. The aim of contributing to local practice and theory *and* also to a theoretical understanding of educational design of a more general nature sets DBR apart from related research approaches, such as case study, lesson study, learning study and participatory action research (Bannan, Cook & Pachler 2016). DBR *uses* theory, empirical data and experience as input to create educational designs that are meant to created added value and support learning. DBR also *produces* theoretical understanding to guide educational design in other contexts (Barab 2014; McKenney & Reeves 2012; Plomp & Nieveen 2013a).

However, as is commented on in article 2 and article 3, the kind of design theory that is sought after in a lot of DBR is often influenced by instructional design theory and a search for design principles to be applied and followed. Design principles are often described as prescriptive guidelines 'to address a specific class of issues…'

(McKenney & Reeves 2012, p.19), as a form of blueprint to follow (Van den Akker 1999), or as 'a set of procedures and conditions for successful dissemination and implementation' (Plomp & Nieveen 2013a, p. 22). However, if the full complexity and dynamics of educational contexts are considered, design principles as specific guidelines become less useful, since the specific use of ICT is always seen as context dependent. An important contribution of this thesis is therefore to shift the focus from the generation of design principles for specific 'types' of design to teachers' design processes. Such a shift increases the hope of identifying fruitful ways of thinking about and practically designing for added pedagogical value, and of generating theory that is useful in different design contexts. To this end, a conceptual tool at a higher level of abstraction is developed in the thesis to guide the reflective design thinking, rather than the specific practical design procedures. This is referred to as the design framework (DF). The use of this DF as a theoretical construct is described further in the chapter on theoretical frameworks.

Research on the challenges and possibilities for teachers as educational designers

Despite the considerable investment in ICT in many schools, the uptake and use of ICT by teachers is often described as limited and slow (Vrasidas 2015). There is also evidence to suggest that when teachers adopt new technology they do it in ways that mirror their analogue practice, which does not always contribute to a transformation of their teaching (Sanders & George 2017). Existing school cultures and teaching practices also influence how ICT is used amongst new teachers who are often inspired by the practices of more experienced colleagues (Tondeur et al. 2017). By adopting an international perspective on the challenges of ICT integration for teachers it is clear that differences in ICT access of functionality still pose a challenge in many countries, even if teachers' attitudes towards pedagogical ICT use are positive and their competence high (cf. Prasojo et al. 2018).

Another challenge for teachers is that of learning about and choosing between different technologies and how to use these as part of their practice. The expanded and transformed knowledge and skills that

teachers need to transform their teaching in digital contexts has been described as technological pedagogical content knowledge (TPACK). The complexity of developing this amalgam knowledge has been recognized in research (Mishra & Koehler 2014). Educational research has been critiqued both internationally (cf. Anderson & Shattuck 2012) and in Sweden (cf. Håkansson Lindqvist 2015; Willermark 2018) for not offering sufficient research-based strategies for teachers' uptake and use of ICT. It has also been shown that teachers often do not receive the support and time needed to develop their TPACK and their teaching practices in digital contexts (Willermark 2018). Another obstacle in the educational design process is the lack of a 'descriptive language' with which teachers as educational designers can describe and share ICT-supported teaching and learning ideas and experiences (Dalziel et al. 2016; Maina, Craft & Mor 2015).

The expressed concern for the uptake and use of ICT and the calls for additional teacher development efforts in the pedagogical use of ICT (cf. Vrasidas 2015) and for further research on teachers' pedagogical use of ICT can be connected to what is often expected from the pedagogical potential of ICT. Both internationally and in Sweden policy discussions often, either explicitly or implicitly, highlight the potential of ICT to transform teaching and learning (Håkansson Lindqvist 2015; OECD 2016). However, these expectations have a tendency to be formulated in a general, visionary and future-oriented way (Olofsson, Lindberg & Fransson 2017). Some publications also indicate that what is expected from ICT supported teaching and learning has been overrated and that pedagogical ICT use is only linked to increased student performance in certain cases (OECD 2015).

One reason for the differing research results in relation to teachers' use of ICT and the identified impact of this use can be connected to the length of the studies in which these results were generated. The numerous aspects and actors that are involved in the process of designing with ICT in ways that add pedagogical value take time to sort out and work through (Salavati 2016). Research shows that teachers' ability to adopt ICT can be described as evolutionary rather than revolutionary (Willermark 2018), and that multiple iterations of educational design refinement are often necessary before positive qualitative differences for teaching and learning can be discerned (Zheng 2015).

DBR research on teachers' development of ICT-supported pedagogical practices often illustrates how the adoption of ICTs as pedagogical tools can serve as a driver of change and lead to a reframing of the teachers' existing teaching and learning practices over time (cf. Fazio & Gallagher 2018; Foomani & Hedayati 2016). However, a prerequisite for such a change is a development of teachers' knowledge about and ability to use ICT (Zinger et al. 2017). The DBR format and the opportunities for collaborative professional development as part of this have been shown to contribute to such a reframing and development of teachers' practices (Reeves & McKenney 2013; Schmidt & Kopchka 2016).

Research on the potential added value of ICT for language and EFL teaching and learning

Applied research on the potential benefits of language teaching and learning with ICT recognize the profound impact that technologies are having (cf. Chapelle & Souro 2017). However, the view of the nature of this impact varies. For example, in relation to technology use in computer assisted language learning (CALL) and technology enhanced language learning (TELL), Carrier, Damerow and Bailey (2017) state that:

> *… the research results over many years of CALL, TELL, and digital learning approaches seem to show conclusively that the use of educational technology adds certain degrees of richness to the learning and teaching process. (p. 3)*

However, as exemplified by the above quote, the added values that are referred to are not described in detail.

A more negative account is given by Golonka et al. (2014), who write in their literature review of research on ICT use in foreign language learning that 'evidence of efficacy is limited' (p. 70). The authors list a number of technologies with very different characteristics, such as interactive whiteboards, iPods and wikis, and conclude that 'evidence' of the effectiveness of the use of these tools is very limited.

If we take into account the complexity and multidimensionality of educational design, the lack of consensus in relation to the added value of ICT in relation to (EFL) teaching and learning is to be expected.

Different teachers work in different contexts, with different students, and make different content-related choices using different digital tools. It is thus hardly surprising that the findings of Golonka et al. (2014) for example show that the use of wikis is viewed as leading to positive learning results by some researchers but not by others. In accordance with a view of educational design as a reflective conversation with the design situation as discussed in article 2 and exemplified in article 4 and article 5, how (and whether) ICT can be used to add value in a certain context is something that is worked out by teachers and students in their reflective conversations in this context. This realization can be used as an argument for DBR, with a focus on teachers' thinking and actions in the design process, in order to increase understanding of why some teachers are able to design for added value (or not) in certain contexts, and what characteristics of ICT use can be identified in designs that add pedagogical value. The focus here is thus not on the technology per se, but on what the technology enables the teachers and students to do.

Research that adopts this focus on pedagogical ICT indicates that certain pedagogical uses of ICT are emerging as more promising than others. For example, the use of Web 2.0 applications and mobile devices for student interactions with different actors in extended communities of practice can support learning irrespective of the content (Sloep 2016), but is described by some researchers as having a 'revolutionary' potential in language learning (Kukulska-Hulme, Lee & Norris 2017). Moreover, studies show how the use of ICT can be used to facilitate collaborative learning and to provide opportunities for peer modelling and coaching and create a variety of perspectives that can support students' meaning-making (Kukulska-Hulme & Viberg 2017). The field of Computer Supported Collaboration (CSCL) explores different topics in relation to this, such as the influence of social aspects in different collaboration scenarios, the kind of learning that takes place in collaborative groups and how to design in ways that stimulate and support collaboration and interaction (Cress et al. 2015; Goodyear, Jones & Thompson 2014; Sung, Yang & Lee 2017).

Studies also show that the ability to study and practice anywhere and with anyone through ICT means that language learning can become more personalized, since the individual student can access learning resources as and when they are needed (cf. De Groot 2017). Language learning research on so-called task-based language teaching (TBLT) explores the use of ICT to construct meaningful tasks in the target language (Long

2015). The ability to interact with artefacts and people outside the classroom also means that 'authentic' activities can be carried out in the target language. This has been shown to create increased student motivation and an increased ability to not only learn *about* language, but *how to* use language in real-life scenarios (Ozverir, Osam & Herrington 2017). Some studies describe this as an ability to design a more seamless learning environment for language students in which learning opportunities are not limited to a single context, but are situated in the context of future use (cf. Wong et al. 2015). Designing a seamless learning environment thus involves creating incitements and opportunities for students to interact with people and other learning resources inside and outside the classroom. Such designs can also include the ability for students to use of ICT to design their own personalized language learning based on their specific needs (Foomani & Hedayati 2016).

The ability to support learning through different media to design for a more multi-modal learning experience is another area in which the use of ICT is in focus (cf. Hattie & Yates 2014). This includes the possibility for teachers to let students use ICT to communicate in different and new ways (e.g. through screenshots or short video messages), which can lead to increased student engagement and a shift of focus from form to meaning (Ware 2017). However, although digital tools create new opportunities for the use of different modalities in interaction, collaboration, reflection and expressions of language competencies, their use often requires a re-thinking in relation to assessment (cf. Wang & Chen 2013).

There is also a growing amount of research on how ICT can be used to support more 'teacher controlled' language practices, such as the use of internet corpora for data-driven learning and the use of different digital tools for language specific uses, e.g. lexico-grammatical acquisition with or without automated feedback, or listening and reading comprehension. Three contemporary works that present further examples and analyses of this type of research are Carrier, Damerow and Bailey (2017), Chapelle and Sauro (2017) and Farr and Murray (2016).

Previous research on the pedagogical use of ICT has been considered in the planning and evaluation of educational designs elaborated during this thesis, albeit not primarily as guidelines for *how* to design, because this

decision must be taken in relation to the specific teaching content and the students in question, the available technologies, and the teacher's own TPACK, but as examples of *what has worked* in other contexts *and why* according to the available research.

Previous design-based research on the educational use of ICT

In a literature review of 162 DBR studies from 2004 to 2013, one of the conclusions is that future DBR research would benefit from an increased emphasis on how the DBR was carried out and the potential effect this had on the outcomes (Zheng 2015). The importance of developing an 'educational design language' with which to describe, discuss and compare DBR methodology and educational designs is also stressed by others (cf. Reimann 2011).

However, in parallel with the increased interest in DBR, a number of studies have been published that focus on the 'design methodology' and the outcomes of DBR. Kennedy-Clark (2013) analyses six PhD theses on DBR- and concludes that the labour intensity of DBR often forces researchers to limit the number of design iterations, but that this can be problematic in that 'the cycles of iteration and evaluation of the design process might actually reduce the overstating of assertions and conclusions' (p. 29). This finding is supported by Zheng (2015), whose own literature review revealed that multiple iterations allow for the refinement of DBR theory and methodology, but that a majority of the DBR studies only 'tested the intervention by one cycle' (p. 409).

Plomp & Nieveen (2013b) present a collection of 51 illustrative cases of research studies using DBR as a research approach and present an analysis of some of the characteristics of these cases. This analysis illustrates how educational designs often involve the use of ICT for subject specific teaching. Moreover, 43 of the 51 cases have as their main focus the development and evaluation of practical interventions in situated contexts (e.g. the use of ICT as part of different teaching-learning strategies and/or in the creation of educational materials), while only eight of the cases focus on the development or validation of theory (e.g. how a design can support learning processes). Like Zheng's (2015)

literature review, the cases also illustrate how DBR studies are most common in the natural science domain.

In an analysis of the 47 most-cited DBR articles published in educational research journals from 2002 to 2011 it was found that only two focused on language learning (Anderson & Shattuck 2012). Another literature review with wider search criteria confirms this scarcity of DBR research in the computer assisted language learning (CALL) literature (Reeves & McKenney 2013). Moreover, it describes how CALL research often tends to focus on emerging technologies and what might be possible tomorrow, and that 'insufficient research and development work appears to be focused on what is practical and needed today' (ibid., p. 12). DBR is described as a research approach with 'enormous potential' for this purpose, but the authors speculate that the inherent complexity of CALL and EFL research, in combination with the complex and developing nature of DBR, deters researchers from using the research approach (ibid, p. 17). More current research continues to highlight the considerable potential of DBR in CALL, as well as the fact that it is still a potential that is 'largely untapped' (Rodriguez 2017, p. 374).

Theoretical frameworks

In this chapter I describe the theoretical frameworks that have been used to study the educational design practices and processes that are in focus in this thesis. However, I first discuss the complexity of teaching, learning and ICT-supported educational design and how this has necessitated the use of different theoretical frameworks in the thesis.

The complexity of ICT-supported educational design

As has been indicated in the previous chapters, a basic standpoint in this thesis is that teaching and learning, and consequently also educational design, are multidimensional and constantly changing activities (Biesta 2010; Fransson & Grannäs 2013; Hopmann 2007). If learning is understood as an activity of individual and collaborative meaning-making that is always situated in specific contexts, it means that what has worked in one context might not work as intended in another. In fact, what has worked in one context will *never* work in an *identical* fashion in another context, because the exact focus and outcomes of learning are always elaborated in the situated contexts through the interactions of different actors using different mediating artefacts.

In line with this, teachers are seen as constantly manoeuvring amongst often conflicting alternatives, expectations and needs at policy, collegial and classroom levels. This also involves an 'intrinsic' manoeuvring of teachers' own beliefs and understandings of tasks, their roles as teachers etc. (Fransson 2016). The introduction of ICTs with multiple and opaque affordances arguably adds to this complexity. Policymakers, colleagues, students, parents and teachers themselves explicitly or implicitly expect teachers to integrate ICT into their practices, even though this might conflict with the teachers' own readiness or conviction of the need to do so (Howard 2013; Salavati 2016). In relation to the educational design considerations and decisions that teachers make as educational designers with ICT in situated contexts, manoeuvring can be described as teachers engaging in a reflective conversation with the design situation (article 1; Schön 1983).

The complexity of teaching, learning and educational design as phenomena makes educational research an equally complex endeavour. Due to this, different theoretical and methodological approaches to educational research are necessary (Sawyer 2014). DBR is based on a belief that a lot can be learned about the process of educational design when researchers participate and study educational design in complex educational settings. However, due to its ambition to make practical contributions in situated contexts *and* to generate theory that can also be useful outside the situated DBR design context(s), DBR is regarded as a very challenging research approach (McKenney & Reeves 2012; Plomp & Nieveen 2013a). The fact that DBR research involves both the use and generation of theory in the processes of practical design and scientific study often necessitates an openness to theoretical pluralism (Bell 2004).

In this thesis, a number of theoretical perspectives and frameworks have been used as analytical lenses in order to achieve the research aims. All these perspectives and frameworks rest on an underlying view that learning requires active processes of meaning-making and that the teacher's role is to design for conditions and activities that stimulate and support these processes. The frameworks that are made use of are Schön's view of design as reflective practice (Schön 1983, 1987, 1992), Biggs' theories about constructive alignment (Biggs' 1996), the TPACK framework (Mishra & Koehler 2006), Shulman's model of pedagogical reasoning and action (Shulman 1987), Goodyear's conceptualizations of the problem space of educational design (Goodyear 2005) and the Conversational Framework (Laurillard 2002, 2012). Below, the frameworks are first described and discussed individually with a brief motivation as why they were chosen for use in this thesis. This is followed by a discussion about how the frameworks have complemented each other in the thesis.

Schön's view of design as reflective practice

Schön's view of (educational) design as a reflective practice contrasts with a view of design as rational problem-solving in which designers, e.g. teachers, simply apply theory (Schön 1983, 1987). Schön criticizes this view of 'technical rationality' and stresses how designers engage in reflective conversations to apply their ideas, knowledge and skills in practice and reflect on the 'back talk' from the design situation. He

points out that teachers' reflective conversations are always inextricably linked to the teacher (e.g. their view of learning and knowledge of content) and the situated context in which the problem solving is done (e.g. the school and the pupils in question). This does not mean that experiences, theories or ways of framing problems that have been described by others are not useful to designers, but rather that they will always be interpreted by teachers in their role as educational designers in relation to the situated design context. Schön describes the esoteric and often tacit knowledge that designers draw on and display as knowing-in-action. He further discusses how this knowledge is constantly applied, evaluated and modified in iterative and mainly tacit processes of reflection. Reflection-in-action refers to the iterative *in situ* problem-solving process in which teachers interpret and react to the back talk that their knowing-in-action elicits, make on-the-spot modifications of this knowing-in-action, interpret and react to the new back talk etc. Reflection-on-action, on the other hand, is used by Schön to describe the process in which designers' reflect on their reflection-in-action and the knowing-in-action that preceded it. Reflection-on-action is thus 'a process of getting in touch with the understandings we form spontaneously in the midst of action' (Schön 1992, p. 126). However, 'seeing', verbalizing and reflecting on our knowing- and reflection-in action is not easy due to the tacit nature of these activities and the fact that they are always dependent on the situated contexts in which they are performed. Schön describes how learning through reflection involves teachers' observing themselves 'in the doing' and describing what they do in ways that are understandable to themselves and possibly others (ibid). In my interpretation of Schön, this includes an understanding that educational design theory must always be interpreted in relation to the situated contexts in which it was generated and in relation to the contexts in which it is adopted.

In this thesis, Schön's view of design as conversations with the design situation is used to interpret the experiences made during the self-study (article 1). It also guides the focus of this DBR, making teachers' reflective design conversations with situations the focus of attention (article 2). Moreover, it guides the methodology of the DBR and the use of design conversations in multiple design contexts as the principle method of data generation to further the understanding of teachers' reflective conversations with design situations.

Biggs' model of constructive alignment

Biggs' describes how his use of 'constructive' refers to a view of learning as an active creation of meaning, i.e. what is referred to as meaning-making in this thesis (Biggs 1996, Biggs & Tang 2011). Teaching and educational design cannot impart learning, but can only function as a catalyst for learning by creating opportunities for it. Biggs stresses how adopting this view of learning affects decision-making in all the stages of the educational design process (Ibid). Further, he underlines the importance of 'alignment' in this process between: the intended learning outcomes (ILOs), the design of tasks and learning environments that provide opportunities for the students to achieve those learning outcomes and the forms and criteria that are used to assess students' performances. Biggs' model of constructive alignment thus provides a structure for the central aspects of educational design at a general level. Consistent with a view of learning as individual and collaborative meaning-making, an important aspect of educational design is designing a learning environment that supports activities that stimulate collaborative creation and interaction in ways that align with the desired learning outcomes.

In this thesis, Biggs' model is used to provide a structure for the questions asked in the design conversations with the teachers, i.e. to guide the main data generation method. After receiving positive feedback from the teachers about how my questions provided them with a structure for their designs, the idea of constructive alignment was also implemented in the conceptual design framework (DF) developed during the DBR[1].

The TPACK framework

Shulman introduced the concept of pedagogical content knowledge (PCK) to describe the special teacher knowledge that is a 'blending of content and pedagogy' and which includes 'the ways of representing and formulating the subject that make it comprehensible to others (Shulman

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[1] The design framework, its development and use is described under the heading 'The use of different theoretical frameworks in combination'.

1986, pp. 8-9). Mishra and Kohler argue that in today's digitalized teaching contexts, teacher knowledge needs to include technology knowledge (TK). Building on Shulman's notion of PCK, they have thus introduced an extended conceptual framework referred to as Technological Pedagogical Content Knowledge (TPACK) to describe and analyze the knowledge that teachers need to successfully blend technology, content and pedagogy (Mishra & Koehler 2006, 2008). The underlying idea of the TPACK framework is that teaching is complex and that teachers need to combine and integrate their knowledge of content, pedagogy and technology into a meaningful whole in their role as educational designers. The TPACK framework includes three major teacher knowledge domains: content knowledge (CK), which refers to knowledge of the subject matter that is to be taught, pedagogical knowledge (PK), which refers to knowledge about different ways of promoting students' learning with consideration to the student(s) in question and technology knowledge (TK), which refers to knowledge about technologies, e.g. their functionalities and affordances. These can be analogue and more 'traditional' technologies such as books or video recorders, as well as new and digital technologies like the internet, web- or software applications, or virtual reality (VR) technologies. The TPACK framework illustrates how these three analytically construed knowledge domains overlap and interact to form four additional distinguishable sub-domains. The PCK concept is described above. Technological content knowledge (TCK) refers to the understanding of how technology and content influence and constrain each other (e.g. how the introduction of the digital calculator influenced maths as a subject and calculation as part of this). Technological pedagogical knowledge (TPK) refers to the understanding of how the use of technology may afford or constrain existing pedagogical practices, or make new pedagogical strategies possible. Finally, technological pedagogical content knowledge (TPACK) refers to knowledge about the complex and reciprocal relationships between the different knowledge domains and sub-domains described above – CK, PK, TK, PCK, TCK and TPK.

Figure 1. The TPACK framework. Source: http://tpack.org

Figure 1. The TPACK framework. Source: http://tpack.org
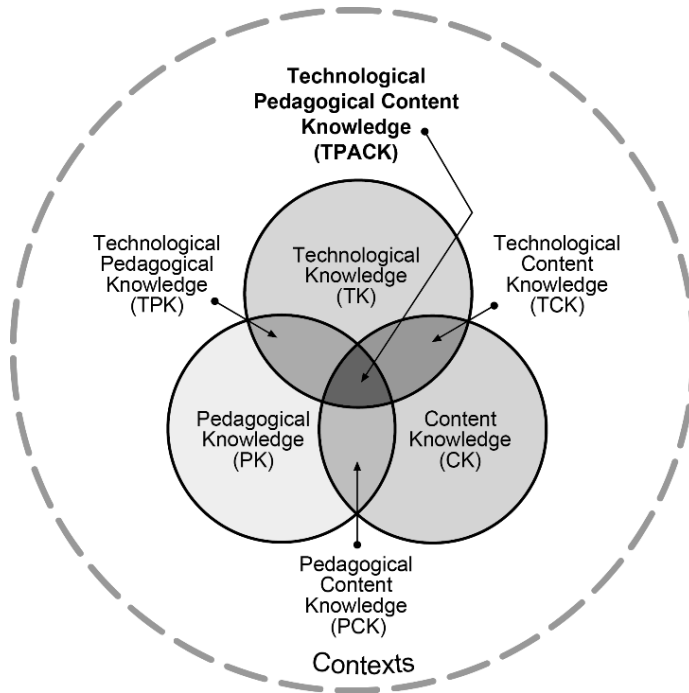
TPACK is thus envisioned as knowledge about all the above mentioned components and how they reciprocally affect each other (Koehler et al. 2014). This means that TPACK is not static, but is constantly developed, enacted and interpreted in situated contexts. A teacher displaying TPACK in one educational context is likely to be able to do the same in another context; not 'automatically' or by copying an existing design, but by reflecting on which technologies could be used to support learning and how and by whom, depending on the subject matter and the students' needs and abilities.

The TPACK framework is increasingly used as a framework to study teachers' pedagogical use of technology and their reframing of practice in digital contexts (Harris et al. 2017). Despite this, the framework has been criticized on different accounts. Critics have pointed to what they believe to be vague definitions of the seven different domains within the framework, especially with reference to the technology domain in which TK does not distinguish between knowledge of analogue and digital technologies (Angeli & Valanides 2009; Graham 2011). This critique can

be connected to the focus in a lot of research using the TPACK framework to try to 'measure' teachers' TPACK or their 'TPACK development'. Archambault & Barnett (2010) suggest that identifying the different domains and sub-domains in the TPACK framework is difficult due to their integrated nature and that 'measuring each of these domains is complicated and convoluted' (p.1656).

However, if the TPACK domains are seen as integrated and reciprocally dependent on each other, as well as by the situated context, TPACK (or PCK, TCK, TPK, etc.) should be understood as something complex and always constructed in situated contexts, rather than something that is static and easily or accurately measurable. In line with this view, a teacher cannot 'have' TPACK independent of the context, but can only display TPACK in context (Willermark 2018). This understanding of TPACK is similar to what EU policies refer to as *educator-specific digital competences* (Redecker 2017, p. 8) and even more to *professional digital competence* (PDC), which is a research-based concept that has been introduced in order to move away from 'understanding digital competence as a set of generic skills suitable for all situations, both personal and professional, and toward an understanding of PDC that includes both generic and specific teaching-profession skills' (Lund et al. 2014, p. 284). This interpretation is also in line with Mishra and Koehler's own description of TPACK as an emergent form of knowledge, where its different components exist 'in a dynamic transactional relationship' with each other and the educational context, as indicated by the dotted circle in the TPACK model (Koehler et al. 2014, p. 102).

The TPACK framework was originally created for teacher educators as a means of talking about pedagogical technology integration and the kind of knowledge that teachers needed to be successful in this (Brantley-Dias & Ertmer 2013). Over time, the TPACK framework has proved useful as a conceptual tool to support these kinds of discussions and at a general level as an analytical lens with which to study teachers' design decisions (Graham, Borup & Smith 2012; Harris et al. 2017). In article 1 the framework is used in this capacity to visualize and problematize my own and a colleague's use of ICT. In the conceptual article 2, I discuss how studying teachers' reflective conversations with situations could be a way of studying TPACK development as an integral aspect of these reflective conversations. In article 3, 4 and 5, the TPACK framework is used to study and describe general aspects of the participating teachers'

educational design processes, for example the extent to which and/or how their technology knowledge affects their understanding about and use of technology for pedagogical purposes.

However, as the TPACK framework proved to be less well suited as a conceptual tool for studying teachers' specific ideas for, and specific situated use of, ICT for pedagogical purposes (Willermark 2018), Shulman's model of pedagogical reasoning and action was used for this purpose instead.

Shulman's model of pedagogical reasoning and action

Shulman's theoretical model of pedagogical reasoning and action (Shulman 1986, 1987) has proved successful for studying developments in and characteristics of teachers' specific thinking about and use of ICT to generate added pedagogical value (Starkey 2010; Smart 2016). Shulman (1986, 1987), in line with Schön (1983), emphasizes how the development of PCK, or here in digitalized contexts TPACK, is an iterative process of situated actions and reflection on these actions and their outcomes. Shulman's model of pedagogical reasoning and action includes a number of central aspects in this integrated process of teacher thinking and practice. In article 4 and article 5, this integrated process is referred to in shorthand as *teachers' pedagogical reasoning*. Shulman's model includes six aspects of teachers' reasoning: *comprehension, transformation, instruction, evaluation, reflection* and *new comprehensions*. These aspects are described in brief below.

Comprehension: teachers must comprehend their purpose as teachers, the subject matter to be taught etc.).

Transformation: this aspect of pedagogical reasoning, together with instruction and evaluation (see below) is described by Shulman as three central parts of pedagogical reasoning in which pedagogical content knowledge, or in digital contexts TPACK, is used and elaborated. Transformation is described as the way in which a teacher's understanding of central ideas in the subject matter are illustrated through *the design of a representational repertoire* to support learning in

a particular group of students, including specific adaptations for students who might need these. A representational repertoire might thus include analogue and digital multimodal aspects (e.g. texts, images, videos and screencasts illustrating aspects of what is to be learned through analogies, examples, or demonstrations).

Instruction: includes different aspects of teachers' 'active teaching' to support learning, including the *design of learning activities*. These might include the students watching screencasts in which the teacher describes and explains central ideas in the subject matter, participating in group work, or taking tests.

Evaluation: this includes teachers' continuous evaluations of their own educational designs (is the design 'working' as planned?) and assessments of students' knowledge representations as indications of what they have learned.

Reflection: this is looking back at the teaching and learning that has occurred and reflecting on what happened and why, and how to learn from these experiences. In the thesis, reflection on educational designs is a central part of the design conversations that are the main source of data.

New comprehensions: Shulman describes this as a 'new beginning'; at this point the teacher has a modified or 'new' set of comprehensions that will affect his/her pedagogical reasoning.

Research has shown how the use of ICT affects all aspects of teachers' pedagogical reasoning (cf. Pang 2016; Smart 2016). For example, in relation to transformation, ICT allows the use of different modalities in the design of a representational repertoire, e.g. in the form of a website. However, the fact that this website becomes inaccessible when an internet connection is not available means that backup strategies need to be developed as part of teachers' pedagogical reasoning processes (Smart 2016). Analyzing teachers' pedagogical reasoning is thus a way of enhancing understanding of teachers' decisions about pedagogical ICT use, their reframing of practice and how these aspects are affected by and affect their existing TPACK and TPACK development (Harris et al. 2017). In article 4, Shulman's model is used to focus on the three central aspects of teachers' pedagogical reasoning about how to use ICT to create added value in relation to: the design of a representational

repetoire (Transformation), the design of learning activities (Instruction) and the evaluation of educational designs and assessments of students' knowledge representations (Evaluation), and how these aspects are expressed in the design conversations and enacted in de facto designs over the course of the DBR. Shulman's model thus helps develop my understanding of the central dimensions of teachers' pedagogical reasoning and action in relation to the use of ICT for added pedagogical value and how this is affected by and affects teachers' TPACK. In article 5, Shulman's model is used to analyze and discuss the results.

Goodyear's conceptualization of educational design as a 'layered' process

As described above, Shulman's model of pedagogical reasoning and action is used to focus on different dimensions of teachers' pedagogical reasoning and action in relation to their TPACK. However, this DBR thesis also aims to support and analyze the development of the teachers' abilities to reason and act as designers of learning environments, where ICT is used by teachers *and* students to create added pedagogical value and support learning in new, complimentary and enhanced ways. In other words, to achieve my research aims I needed a theoretical construct to a) analyze and interpret the design process, b) support the teachers' design processes in their situated contexts and c) create a suitable research design.

Goodyear's conceptualization of the process of educational design provides a broad perspective of the complex and situated character of teachers' educational design (Goodyear 2005). Recognizing that students' learning cannot be designed, he argues that central aspects that can be designed are *tasks* and a physical and digital environment that can stimulate and support learning through interaction and collaboration with different *actors*. In the design process, teachers consider, test and evaluate the use of different digital *tools* that can help to perform these tasks and that also support interaction and collaboration between actors (Goodyear 2005, 2015). Goodyear underlines that the educational design process must be understood in relation to the educational setting in which teachers perform their educational designing. Moreover, he conceptualizes teachers' pedagogical thinking and educational design

practice as a 'layered' process in which hierarchical relations exist between teachers' ideas about teaching and learning and their enacted practice. These 'layers', which are explained in more detail below, are referred to as *pedagogical philosophy*, *high level pedagogy*, *pedagogical strategy* and *pedagogical tactics*.

Goodyear illustrates how teachers' *pedagogical philosophy*, i.e. their beliefs about knowledge and learning, affect which teacher and student actions are foregrounded (or downplayed) when teachers think about how to design. These overarching ideas of how to go about teaching in line with pedagogical philosophy are referred to as *high level pedagogy*. Goodyear refers to the two above-mentioned 'layers' of pedagogical philosophy and high level pedagogy as 'declarative' or 'conceptual'. He stresses that teachers' pedagogical philosophy is not automatically manifested in terms of ideas for high level pedagogy, but that the educational setting, e.g. factors such as available technologies, school cultures, work load, colleagues' ways of working etc., affects how high level pedagogy is finally envisioned. Moreover, he emphasizes that ideas for high level pedagogy are not prescriptive of specific action, but foreground certain ideas and actions before others. The extent to which, and in what form, ideas for high level pedagogy are enacted in practice is affected by the same factors and also by the teachers' TK, CK, PK, PCK, TCK, TPK and TPACK.

Goodyear describes the two remaining layers of pedagogical strategies and pedagogical tactics as 'procedural' or 'operational' and as directly concerned with action. *Pedagogical strategies* are defined as broad plans and descriptions of how to design in accordance with high level pedagogy in order to achieve certain objectives, e.g. to help students to distinguish between different types of texts. *Pedagogical tactics* are defined as the specific detailed decisions and actions that teachers make and take in class. How the specific nature of tactics is enacted in educational designs is affected by the educational context and by teachers' professional considerations and decisions in relation to content, technology and students. This means that educational designs based on similar pedagogical strategies might 'look' different 'on the surface', e.g. teachers might decide to test the students' preconceptions in different ways, and/or use different digital tools in their designs. Similarly, educational designs might seem to share similar 'surface characteristics',

e.g. the digital tools used, but be based on differing pedagogical strategies.

Goodyear's conceptualization of design illustrates that if two teachers, or a DBR researcher and a teacher, have very different pedagogical philosophies and ideas about high level pedagogy they may have trouble understanding each other in conversations about how to formulate and implement pedagogical strategies. The notion of educational design as a layered process can also help to explain why teachers sometimes describe their practices in ways that are not reflected in real life. Finding out more about the individual teachers' pedagogical philosophies and ideas for ICT-supported high level pedagogy, was thus an important first step in our collaborative design process (see the methodology chapter).

To conclude, Goodyear's conceptualization of the process of educational design provides a broad perspective of the complex and situated character of teachers' educational design work. This conceptualization of educational design as a multifaceted and multi-layered process has guided the design of this thesis and the nature of the DBR collaboration. Moreover, I have chosen to describe the outcomes of my analysis of the teachers' practices in article 4 and article 5 at the 'pedagogical strategies level' with examples of how they are enacted using different tactics. By not describing the individual designs in detail, i.e. at the 'tactics level', it is possible to describe the design intentions and actions 'on a level which hides confusing details' (Goodyear 2005, p. 87). The DF that emerges from this research is also intended to support the formulation and enactment of pedagogical strategies without advising which specific tools to use.

Laurillard's Conversational Framework

Just as the TPACK framework provides a broad perspective of the knowledge domains that teachers need to develop and integrate in digital contexts, Goodyear's conceptualization of educational design provides a framework with which to analyze and understand the multifaceted and reciprocal process of educational design. However, although Goodyear's framework highlights important aspects of teachers' designs, it is not suitable for analyzing specific uses of ICT. A theoretical framework that

has been developed with this specific intention in mind is Laurillard's Conversational Framework (CF) (Laurillard 2002, 2012), which was used in this capacity in article 3. The intention with the CF is:

> to try to use the salient ideas in the principal theories of learning to give us the basis for understanding how to design teaching and learning now that digital technologies are making more impact on education. *(Laurillard 2012, pp. 93-94)*

Laurillard highlights the interdependence of individual and social processes in learning and recognizes the importance of creating educational designs that reflect this by creating conditions for communication and the exchange of knowledge representations between individual learners, teachers and peers (Laurillard 2012).

Figure 2. The conversational framework (Laurillard 2012)
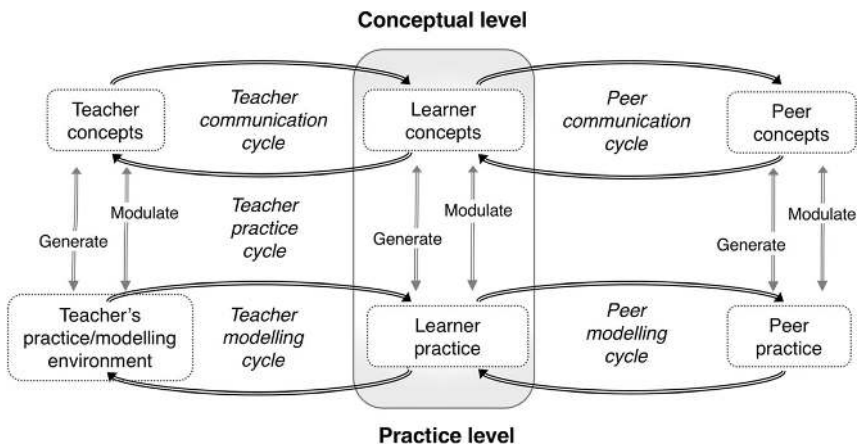
The individual learner is placed at the centre of the CF. The grey area in figure 2 represents the individual learner whose conceptual understandings and practice capabilities are developed in an integrated and reciprocal process. The CF illustrates that individual learners can interact with other actors by means of five communicative cycles at two levels: the conceptual level and the practice level. At the conceptual level, the students' meaning-making processes are supported by communication about what is to be learned. Depending on which actor(s) the individual learner communicates with, the cycles are referred to as the *teacher communication cycle* (TCC) or the *peer communication cycle* (PCC). The CF also illustrates how teachers can design a

practice/modelling environment (TPME) that helps students to achieve the learning goals. The teacher can give feedback in relation to individual learners' and peers' representations of practice in the teacher practice cycle (TPC) – the top and bottom arrows on the left hand side of figure 2 – to help students develop their conceptual and practice capabilities. The TPC also provides teachers with feedback on students' performances that they can use to evaluate whether their design is supporting learning as intended.

Laurillard describes the teacher modelling cycle (TMC) as one in which ICT can be used to provide automated feedback and allow learners to 'see the results of their actions in comparison with the intended model' (2012, p.90). Finally, teachers can design a peer modelling cycle (PMC) to motivate and enable students to share and access peer knowledge representations. Through the use of ICT, these knowledge representations can be used in the PMC to support modelling independent of time and place. The same knowledge representations can also be referred to as examples at the 'conceptual level' as part of the TCC or PCC. In short, the CF provides a theoretical frame for analyzing and thinking about how to design to support meaning-making through interaction and modelling in relation to the external representations of different *actors* (student, teacher or peers) of what is to be learned (e.g. concepts, ideas, relationships, procedures, skills) and communication about these *knowledge representations* with the same actors.

In this thesis Laurillard's CF is used for two reasons. In the preliminary exploration phase of the DBR[2] the CF is used as an analytical research tool to study and compare the teachers' ideas for ICT and their de facto use of ICT in enacted designs. In article 3 the CF is then used to describe the differences found.

In the design and development phase Laurillard's CF was used to inform the conceptual design framework (DF) that was developed to support the planning and evaluation of educational designs in this DBR. This is described in more detail below (see also article 5).

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[2] The different phases of the DBR are described in the methodology chapter.

The use of different theoretical frameworks in combination

In this section I describe how the different theoretical frameworks accounted for above have been used to complement each other. It is important to underline that my use of these frameworks in combination reflects my own interpretation of them. This can be said to illustrate that theory is not something that researchers 'find' and apply, but that a theoretical framework for specific research is something that is *constructed* in relation to the research aims and research data (Maxwell 2013). Mor et al. (2015) discuss the importance in DBR of not imposing theory on the problem domain as an a priori dogma, but to constructively use theory to build a dynamic theoretical structure that can help a researcher to frame and analyze what is going on in the situated research context.

Three of the frameworks described above were used to guide the focus of the DBR and how it was carried out in practice. Schön's (1986, 1987, 1992) view of design as a reflective conversation with the design situation was drawn on to discuss and problematize the design of the DBR (see article 2). Goodyear's (2005, 2015) conceptualization of educational design guided the design of the DBR collaboration (see article 5 and the methodology chapter). Bigg's model of constructive alignment (1996) informed the formulation of the overarching start questions in the design conversations.

Four theoretical frameworks were used to analyze the teachers' design processes, their framing of practice and the development of aspects of their TPACK. Two of these – the TPACK framework and Goodyear's conceptualization of educational design – provided broad perspectives on teachers' knowledge in digital contexts and educational design as a process. Two of the frameworks – Shulman's model of pedagogical reasoning and Laurillard's CF – helped me to focus on certain aspects of the teachers' design processes and practices. Using the TPACK framework and Shulman's model as complimentary constructs provided a compound conceptual tool with which to analyze teachers' situated decisions about pedagogical ICT use, their reframing of practice and how these aspects are affected by and affect their existing TPACK and TPACK development. Using Goodyear's and Laurillard's theoretical frameworks as complimentary constructs helped me as a researcher to

gain a more nuanced and complete picture of the teachers' educational design practices and how they could be understood and supported.

Three frameworks were drawn on in the construction of a *design framework* (DF) as a new theoretical construct to guide the development and evaluation of the educational designs. The DF was formulated dynamically in relation to the teachers' expressed design intentions and ideas for high level pedagogy, theirs and my experiences of successful educational design practices and previous research on teaching, learning and educational design. The DF reflects an underlying view of learning as a development of understanding by participating in social processes in which individuals' interactions with other actors affect personal and group understanding in an integrated, reciprocal and dialectic process (cf. Brown, Collins & Duguid 1989; Lave & Wenger 1991; Wertsch 1998; Vygotsky 1978, 1986). According to this view, it is important that educational designs support learners' meaning-making through communication, interaction, collaboration, modelling and reflection in relation to different *actors'* *knowledge representations* of what is to be learned (e.g. concepts, ideas, relationships, procedures, actions and skills) (Goodyear 2015; Laurillard 2012).

The DF is inspired by Laurillard's Conversational Framework (2002, 2012). However, it also includes interactions with external actors as a way of supporting learning through the use of ICT. Moreover, it reflects Goodyear's (2015) views that three central aspects of teachers' educational design are *tasks* that stimulate and support students as active learners*,* a physical and digital learning environment that allows students to interact with different *actors* in these tasks and the (digital) *tools* that are needed to achieve this. An additional theoretical perspective in the DF is Biggs' model of constructive alignment (Biggs 1996, Biggs & Tang 2011). The DF was used both as a tool for supporting the teachers' practical design with ICT and for evaluations of existing designs. The design framework also provided a common point of reference as part of an 'educational design language' for comparing and discussing design ideas and enacted designs (Reimann 2011). The principal aim and function of the design framework was thus to guide the design thinking and provide a 'structure' for designs in line with the research and empirically-based theory that had been developed during the DBR.

Figure 3. The design framework developed during the thesis

Tasks — ILOs, teacher & student activities, assessment

Actors — creation, interaction, modelling, feedback/-forward, reflection

Tools — hardware, software, web services

Knowledge representations of understanding

Student — Teacher — Peers — External actors

Knowledge representations of practice
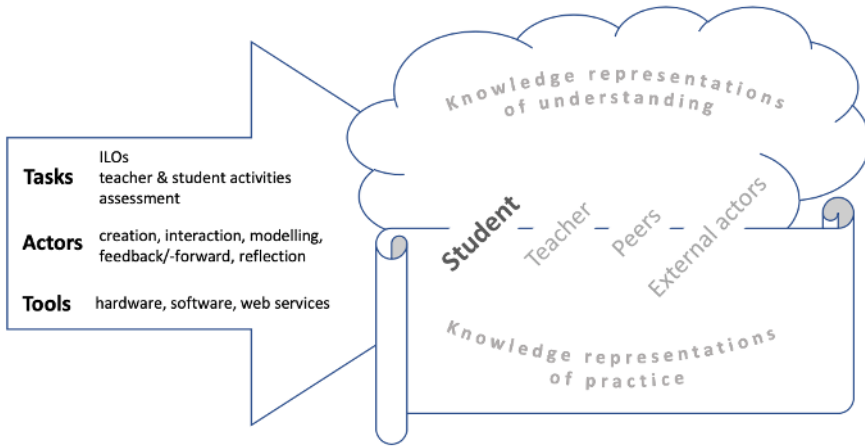
The DF presented in figure 3 should be 'read' like this:

Tasks: What are the intended learning outcomes (ILOs) in focus in the design? Which teaching tasks should I perform and which learning tasks should the students perform? How will I assess whether the students have reached the ILOs?

Actors: Which actors can students collaborate and interact with in the creation of knowledge representations of understanding and practice illustrative of the ILOs and for interaction, feedback, feedforward, modelling and reflection in relation to these knowledge representations?

Tools: Which digital tools, i.e. which specific hardware, software and web services, facilitate the creation of tasks and the collaborations and interactions with the envisioned actors?

The DF is an example of a theoretical construct that was developed through DBR but also guided the educational design in DBR. Its use in the construction of qualitative educational designs is discussed further in the methodology chapter.

Methodology

This chapter describes the research design, the research context, the participants and the research data and how this was generated, documented and analyzed. To achieve the first two aims of this thesis I considered it important to adopt a research approach that provided me with access to teachers' accounts of experiences and intentions in relation to educational design, as well as to practical enactments of educational designs in different context. Two research approaches with these benefits are self-study of practice and design-based research (DBR). These research approaches are designed by and for educators and account for teaching as an activity in which theory and practice are integrated and reciprocal (Anderson & Shattuck 2012; Pinegar & Hamilton, 2009; Vanassche & Kelchtermans 2015). Both approaches also strive to contribute to an increased understanding of teaching by studying situated practices/theory enactments and presenting results that are useful outside the context of study (Pinnegar & Hamilton 2009; Tidwell, Heston & Fitzgerald 2009). Here, it should be emphasized that ontological and epistemological vantage points affect how the role and potential use of research results are envisioned. Adopting a view that the formulation and interpretation of theory is affected by the situated context in which it is generated, or given meaning, means that theoretical contributions are not envisioned as 'prescriptions' for action that are transferable from one context to another. Instead, they can be thought of as conceptual tools that can help to mediate analyzes and descriptions so that the reader can make meaning of them. In digitalized educational contexts, self-study researchers examine their own experience as educational designers, whereas in DBR the focus of attention is often the characteristics of the constructed educational designs and, as is the case in this thesis, the design process and the experiences of the participating teachers and students.

Self-study

Before the start of the DBR project I carried out a collaborative self-study with a colleague (article 1). Self-study research has been recognized for its ability to illuminate certain aspects of tacit teacher practice and for its contributions to the research community and professional development (Pinnegar & Hamilton 2009; Vanassche &

Keltermans 2015). However, self-study research has also been criticized for not sufficiently building on and relating its findings to previous (self-study) research on teaching and learning (Zeichner 2007). It has also been illustrated how self-studies are seldom integrated into more comprehensive research programmes (Vanassche & Keltermans 2015). Another critical point that has been made is the apparent challenge of critically questioning one's own experience and actions (Loughran 2007).

The self-study covered two areas that had been suggested for focus but which in actual fact have received little attention in self-study research, namely the understanding of educational theories and teachers' ICT-supported educational design. The aim was thus to develop our understanding of the challenges and opportunities in educational design and of the TPACK framework as an analytical tool with which to study educational design.

The self-study was planned and carried out as an initial part of the thesis work. We collaboratively addressed the problem of self-scrutiny and self-critique by sharing and reflecting on our experiences and perspectives with the intention of problematizing and informing our experiences and understandings of collaborative research and educational theory. The setting for the self-study was the planning, teaching and evaluation of a course attended by a total of 38 preschool, compulsory school and upper secondary school student teachers, which we taught together. The course focused on the students' practical educational design with ICT in ways that they considered contributed added pedagogical value. The course assignments also required the students to reflect on and externalize their knowledge and use of ICT for added pedagogical value by referring to the course literature and theory, e.g. the TPACK framework. The recorded conversations relating to our own and the students' experiences as educational designers during the course served as the main data. The TPACK framework was used to discuss and analyze these experiences.

The self-study methodology provided me with opportunities to gain systematic experience of design-based collaboration and develop an in-depth understanding of the TPACK framework as an analytical tool for studying and discussing teacher knowledge in digital contexts. It also helped me acquire in-depth knowledge of collaborative design processes and the complexity involved in exploring the affordances of ICT. This

provided me with additional valuable perspectives for understanding the teachers' coming endeavours as DBR participants in collaborative educational design and exploring the affordances of ICT. My participation in the self-study also showed me how externalizing design experience and subjecting this experience to analysis can reveal how theories are embedded in practice and how practice can theoretically guide our future understanding and practices (Pinegar & Hamilton 2009). It was also illustrated how the educational design process involved a constant testing, evaluation and development of our own conceptual understandings and practical implementations of educational design in what could be referred to as reflective 'conversations' with different design situations (cf. article 2; Schön 1983). Moreover, I experienced how these mostly tacit conversations could be externalized and analyzed through collaboration with another teacher and researcher.

In summary, the results of the self-study (article 1) supported my view of DBR as a suitable research approach for studying teachers' educational design and its outcomes. However, in relation to the critique of self-study mentioned above, I was made more aware of the importance of collaborating with various teachers in multiple design contexts over time and relating the findings from these design contexts to each other and to existing educational research in order to increase trustworthiness. Moreover, the critique related to the self-critical nature of self-study illustrated the importance of contemplating and clearly defining my roles as research *and* designer during the upcoming DBR.

Design-based research

Design-based research (DBR), or Educational Design Research (EDR) as it is also referred to, particularly in European contexts (Sandoval 2013), is an approach that is increasingly employed for studying teachers' educational design processes (Harris et al. 2017). Although the term EDR describes the focus on teachers' situated educational design better, design-based research is the most commonly used international term for this research approach and is therefore used in this thesis. However, both terms are used interchangeably by important researchers in the field, who also refer to the seminal work and articles by Brown (1992) and Collins (1992) and what they refer to as 'design experiments' as their historical

roots (cf. Barab & Squire, 2004; McKenney & Reeves 2012; Plomp & Nieveen 2013a).

Design-based research combines scientific study with a systematic development and implementation of educational designs with the dual aim of: (a) supporting teaching and learning in situated contexts and (b) generating theoretical and context independent understandings about educational design processes and practices. This duality in goals is perhaps the most defining characteristic of DBR (McKenney & Reeves 2012). In addition, an often implicitly mentioned goal and outcome of DBR is the professional development of the participating researcher(s) and teachers. DBR can thus be described as research belonging to what Stokes (1997) refers to as Pasteur's quadrant, i.e. research that aims to have immediate practical use *and* that contributes to a fundamental understanding of scientific problems. DBR is characterized by the researchers' active participation in the design process in an effort to make research-based contributions to the development of educational designs, rather than (simply) studying them (Amiel & Reeves 2008). In the research described in this thesis I have thus acted in the dual roles of researcher and co-designer.

The ability to participate in the design and evaluation of educational designs has been shown to provide DBR researchers with opportunities to gain a deeper and often more nuanced understanding of the strengths and weaknesses of educational designs and the pedagogical reasoning behind them (Van den Akker et al. 2006). It is also important to build on teachers' ideas about what constitutes 'good' education when developing an ICT-supported practice (Tondeur et al. 2017). Moreover, in the design process, the participating teachers' knowledge of the subject matter, educational context, student group and individual students is invaluable, as is their previous experiences of educational design with ICT. A DBR approach can also offer opportunities to study, discuss and stimulate the situated reciprocal interaction between these knowledge domains as part of teachers' emergent TPACK development over time.

Being actively involved as a dialogue partner, advisor and facilitator and contributing with experience- and research-based examples, suggestions and technical assistance meant that I could participate in the design process from outside the classroom. This would not have been possible if the research had been conducted as, for example, a multiple case study. Moreover, I was able to explore the developments in the teachers'

reflective design thinking and practices throughout the the DBR. I was also able to explore how and why certain educational designs 'worked' in different situated contexts, and whether there were identifiable common characteristics in the design thinking, practices and educational designs. Thus, the collaborative nature of DBR meant that myself as researcher and the participating teachers could use our respective competencies in both the design process and the understanding, use and generation of theory (McKenney & Reeves 2012, p. 39).

Research design of the main design-based research project

In this section the design of the main DBR-project reported on in articles 3, 4 and 5 is accounted for. However, it is important to stress that although the research design described below was based on a predefined structure, it evolved during the research process. This flexibility in research design is arguably not only important, but also a defining characteristic of DBR (Wang & Hannafin 2005).

Context and participants

I have collaborated with a total of eight different teachers in four different municipal upper secondary one-to-one schools. The DBR was carried out over a period of two years (June 2014 to June 2016). The teachers all had between six to twelve years of EFL teaching experience.

DBR projects require that researchers maintain close contact with the participating teachers for a long period of time in order to understand their respective teaching contexts and create relationships that enable collaboration in practical design (McKenney & Reeves 2012; Plomp & Nieveen 2013a). As the teachers' design intentions and processes are important foci in this thesis, the creation of good relationships was vital so that the teachers felt safe and could talk about their doubts, shortcomings etc. (McKenney & Reeves 2012; Plomp & Nieveen 2013a). Considering the amount of time a researcher has to spend in the field during DBR, collaboration with as many as eight teachers can be seen as atypical for a DBR project. However, I found it important to gather experiences of situated educational design work and of using the

DF in multiple design contexts. By working with eight teachers in four different schools, data generation/collection triangulation (Lincoln & Guba 1985) was also achieved. Given the fact that teachers' pedagogical use of ICT was in focus, I also wanted the included schools to have the necessary digital infrastructure to allow for different kinds of ICT. The choice of one-to-one schools, i.e. schools that equip every teacher and student with their own computer, was made for this reason.

In this thesis I decided to collaborate exclusively with EFL teachers. One reason for this was to keep one of the parameters (the subject for teaching) constant. However, the primary reason for focusing on EFL teachers was my own background as an EFL teacher. This meant that I could draw on my own understanding of secondary school teaching and the teaching subject, curricula and syllabi and how they can be interpreted and realized in practical teaching. Having this kind of knowledge also means increased opportunities for researchers to ask knowledgeable questions related to opportunities and challenges in the profession and in teaching (Berger 2015). At the same time, my previous experience as an EFL teacher potentially increased the risk of taken for granted assumptions and 'reading' personal interpretations into the teachers' accounts. However, this risk was limited by the fact that I had not worked as an EFL teacher for five years, had been employed by a different municipality and had not taught in a one-to-one context. Moreover, as will be discussed in relation to my efforts to ensure the trustworthiness of this research, the use of a reflexive journal was a conscious measure to reduce this risk.

Four schools were identified as potentially interesting study objects as they were all within a geographical area that would allow me to physically meet the teachers on a weekly or even daily basis as and when necessary. The schools were municipal upper secondary schools that had implemented the one-to-one concept and used a learning management system (LMS) to which I could be given access. I contacted the principals of the four schools to plan meetings with the EFL teachers. At these meetings the teachers received information about the DBR project and the opportunity to participate. My contact information was given to potentially interested teachers. The teachers who reported interest in participating in the study were given the opportunity to ask supplementary questions.

After these meetings the teachers from all four schools expressed an interest in participating. However, considering the fact that this was my first DBR project and that I was the only researcher involved in the field work, I considered it unwise to start collaborations with too many teachers at the beginning of the DBR. This decision was taken in relation to research quality, but also in consideration of research ethics, as I did not want to start a collaboration and then not be able to follow through with it. There was also a pragmatic reason for limiting the DBR collaboration to two schools during the first year, in that some of the teachers who had expressed interest in participating expressed concerns about the time needed to participate due to their current workload.

For the reasons discussed above, an active collaboration, i.e. design conversations, the keeping of a reflective log and focus group interviews with students, was initiated in two schools and with five teachers. At the end of the first year of collaboration one of the teachers received notice that s/he would not be teaching EFL during the next academic year and would therefore not be able to actively participate in the DBR. However, another teacher at the same school who had previously received information about the DBR project and kept him-/herself informed about the nature of the DBR collaboration volunteered to participate in the project. The two schools in which the teachers had previously been informed about the project were contacted again, which resulted in one teacher from each school volunteering to participate in the DBR. This meant that during the second year of the DBR I continued to work with four of the five teachers from year one and with three new teachers, two of whom worked in schools that had not been represented in the DBR during year one. Thus, during the second year of the DBR I worked with seven actively participating teachers in four different schools.

The participating teachers all described themselves as somewhat more digitally competent than the average colleague and were interested in exploring the potential of ICT for pedagogical purposes. Three of the teachers had a special role at their schools as someone to whom colleagues could turn to for advice about how to use ICT for pedagogical purposes. Altogether, at the time of their active participation in the study, the teachers taught eighteen classes in four theoretical and two vocational study programmes. Pupils aged 17-19 years in years one, two and three were represented in the study.

Research phases

Although DBR is perceived and carried out differently, certain common phases are often discernible. These phases are referred to in different terms in the literature (cf. McKenney & Reeves 2012; Plomp & Nieveen 2013a). I have used the following formulations to describe them as clearly as possible: (1) the preliminary exploration phase, (2) the design and development phase and (3) the retrospective evaluation phase.

The preliminary exploration phase

Previous research illustrates the importance of not suggesting ways of using ICT that conflict with and/or do not take teachers' ideas about how teaching and learning should be performed into consideration (cf. George & Sanders 2017). During this phase, a needs and context analysis was therefore performed in order to provide the researcher with an improved understanding of the different educational design contexts, including the teachers' pedagogical philosophy, their ideas for and de facto educational design and their technological, pedagogical and content knowledge. To do this I engaged in design conversations with the individual teachers. Design conversations can be described as informal, open-ended interviews about design ideas and examples of enacted designs (see the section on data generation and analysis). These design conversations revolved around the teachers' ideas and intentions for how ICT could be used to create added pedagogical value, i.e. how ICT could be used to support learning in ways that were not possible without it. Previous educational designs and design elements created by the teachers themselves or their colleagues were often used as examples. I sometimes accounted for my own and others' practical experiences of using different ICT-supported pedagogical approaches and digital tools, but did not provide any active design input as far as the construction, enactment or elaboration of educational designs was concerned during this phase.

In parallel to the design conversations, I studied research literature relating to educational design. In this, I related the teachers' accounts in the design conversations to research. However, the design conversations also helped to direct my literature studies, which covered classical theories of learning, technology enhanced learning (TEL), learning English as a foreign language (EFL), research on teachers' knowledge, skills, attitudes and use of ICT etc. The results of the data generation and analysis during this phase are described in article 3.

The design and development phase

In this main phase of the DBR I actively participated in the planning, construction, enactment, evaluation and elaboration of the designs in an iterative process. At the beginning of this phase I presented the results of my data analysis in the preliminary exploration phase to the teachers (see article 3). The identified differences between their expressed design intentions and de facto design practices were described and possible reasons for them discussed. In subsequent design conversations ideas about how to design in ways that correlated with the teachers' intentions *and* were supported by TEL and CALL research were discussed and elaborated on. As a result, high level pedagogy and design intentions for the upcoming collaborative design work were identified. These design intentions were thus both research-based and formulated in accordance with the teachers' ideas for high level pedagogy.

The formulated design intentions were used as a basis for the development of context specific pedagogical strategies. The specific uses of ICT for added value in the different design contexts were then elaborated on in a reciprocal process of forward-looking and evaluative design conversations and practical enactments and elaborations of educational designs. In this implementation of pedagogical strategies the teachers always had the final say and were also the on-site implementers. However, the preceding educational design work was a collaborative effort, in which I used my knowledge of educational theory and my experience as an educational designer to make suggestions and contributions as a co-designer[3].

The outcomes of the educational design process in the different design contexts, i.e. the enacted educational designs and design elements and the teachers' and students' views of whether, how and to what extent the use of ICT contributed to added pedagogical value, were then interpreted and evaluated in collaborative reflective design conversations to inform future educational designs. However, the outcomes referred to above also became new research data to be analyzed in relation to the research aims. It was thus during these design conversations that my dual role as co-

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[3] During this phase the conceptual design framework (DF) was elaborated and refined in use as a conceptual tool for the analysis of educational design. This is described in more detail under the heading 'The development of a design framework'.

designer/researcher was most entwined. The use of a reflexive journal was important in helping me to distinguish between these roles and to reflect on how and to what extent my own background, values and previous experience affected my research[4].

The iterative collaborative educational design process described above continued throughout the DBR project. Theory was thus applied, interpreted and generated in relation to enacted educational designs and design conversations before and after their implementation.

The retrospective evaluation phase

During the final *retrospective evaluation phase* of the DBR I acted solely in the role of the researcher, continued to work with data reduction and data analysis, draw and verify conclusions etc. (Miles & Huberman 1994).

Data generation

The dual purpose of theory generation and the creation of educational designs for practical enactment means that in DBR research data is not so much collected but is *generated* (Willermark 2018). In this DBR, existing design theory was used in the creation of educational designs and the experiences gained led to the confirmation, rejection and elaboration of some aspects of it and to the production of new theory in an iterative and reciprocal process. I actively participated in this process as a design partner and thus helped to generate some of the data that I then 'collected' for analysis in my role as researcher. Having made this clarification to motivate my choice of the term *data generation*, it should nevertheless be pointed out that the term *data collection* is often used in DBR (cf. Herrington et al. 2007; McKenney & Reeves 2012) and that this practice was followed in the articles included in this thesis.

The data consists of: (a) 103 hours of semi-structured audio recorded and transcribed design conversations, (b) enacted educational designs and

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[4] This is discussed in more detail under the heading 'Keeping a reflexive research journal'.

design elements as parts of these, (c) 42 written reflective log entries written by the participating teachers, (d) 11.5 hours of transcribed focus group interviews with students in groups of 4-6, and (e) the researcher's field notes.

The data was generated between December 2014 and June 2016.[5] The nature and intensity of the collaboration with individual teachers varied during the time of the DBR, primarily due to factors such as scheduling, workload, pre-planned educational activities etc. As a consequence, the data generation in the three research phases described above occurred at varying intervals and frequency with different teachers, who also contributed different amounts of data.

Design conversations

The main research data in the thesis is the audio recorded design conversations with the participating teachers. The term design conversations is used to emphasize that although they often took the form of 'interviews' in which I asked open-ended questions about the teachers' design ideas and intentions for enacted designs, they were also opportunities for the teachers to ask questions or air ideas or arguments that they wanted my views on. The design conversations often revolved around: (a) general and specific design ideas about, or intentions for, how technology could be used to realize certain pedagogical objectives and (b) enacted designs and the extent to which intentions had been realized, the reasons for this and new ideas about pedagogical ICT use that emerged during the design experiences. This often involved me and a teacher looking at and interacting with the digital representations of design elements as part of an educational design, or an idea for an educational design represented in the form of text and/or described in relation to the conceptual DF. Video recording of the design conversations was considered, but because they often related to a visual representation of something on a computer screen, and because video recording was considered to add a layer of formality to the conversations that could possibly affect the teachers' willingness to express themselves freely, the design conversations were not video recorded.

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[5] As indicated under the heading 'Context and participants', some teachers were actively involved all the time and some only during the second year of the DBR.

A total of 128 hours of design conversations were audio recorded. After listening to the recordings, the parts in which I gave detailed 'technical' explanations of how to use a certain digital tool, or where the topic did not relate to the DBR project at all, were excluded. A total of 103 hours of design conversations were selected for transcription and further analysis.

Enacted educational designs and design elements

Another source of data was the enacted educational designs and their different design elements. Examples of design elements included conceptual elements (e.g. the inclusion of explanatory elements, or a round of peer reviewing of documented knowledge artefacts) and tangible and often digital elements (e.g. written instructions, YouTube videos, screencasts and wikis). The teachers included me as a teacher in their courses in their LMS and gave me access to design elements created through the use of social media, e.g. they included me as an organizer in wikis or shared links to private YouTube channels.

The teachers' reflective log entries

At the beginning of the project I used a digital tool to create a shared web-based space where the teachers could keep their individual reflective logs and share them with me. These log entries mainly contained written text and, on some occasions, hyperlinks, photos and screenshots. I could also comment on these logs and create entries for the teachers to read. I explained that the purpose of the logs was to offer a forum for the externalization and sharing of feelings, insights and questions that might arise during the DBR and the process of designing for added pedagogical value. The reflective logs thus offered a space for asynchronous design conversations with me and, if they so wished, for self-reflection. A total of 42 log entries, varying in length between 60-250 words plus hyperlinks, photographs and screenshots, were shared with me and used as data in this thesis.

The researcher's field notes

Even though all the design conversations were audio recorded, preliminary field notes were sometimes jotted down during the recordings to capture my ideas, connections and observations. This

practice could have made the teachers more aware of the fact that their design intentions and actions were objects of study (Bryman 2012). However, I had discussed this practice with the teachers beforehand and explained that this was done in order to capture important aspects of their accounts that 'struck me in the moment' or to remember to ask a follow up question later instead of having to interrupt them. Moreover, the field notes were used to describe my visual impressions and were thus an important complement to the design conversations, especially as these were not video recorded. The field notes related to observations made during design conversations and to my own reactions during them, which made them part of the tentative analysis of data. I had access to private areas in the participating schools where I could make more detailed field notes immediately after the design conversations.

Keeping a reflexive research journal

Even though field notes were used to document things such as my reactions during the design conversations, the use of a reflexive journal was important in helping me to become aware of why I reacted in certain ways, the kind of questions I tended to ask, things I tended to say and the reasons for this etc. Sometimes field notes and the reflexive journal were written in parallel, but with the different foci described above. Many entries were also written in relation to discussions with other researchers, for example my supervisors. Although the reflexive journal was not coded like the other sources of data, it made me more aware of my own positionality, subjectivity and reactivity. Moreover, it provided additional documentation of the research process, such as the elaboration of preliminary hypotheses, the choices that were made and the reasons for them (Probst 2015).

Focus group interviews

Focus group interviews were conducted with the students who volunteered to participate in them. Each focus group consisted of four to eight students. Students from both theoretical and vocational programmes and from seven of the eight different design contexts were represented in the study. No focus group interviews were conducted in any of the classes taught by the teacher who had to end his/her active participation after the first year of DBR due to not being able to teach EFL in the following academic year.

Before the focus group interviews I presented myself as a researcher who both studied and discussed practical educational designs with the teachers. I explained that their participation as students was voluntary and that their identities would not be documented or revealed. I stressed that their teachers would not listen to the recordings and that I was interested in their honest opinions as students. I told them that although I was involved in the design process I was equally interested in positive and negative views of the educational designs. To avoid being seen as having a vested interest in positive views of design, I never participated actively as a teacher in the classroom or signed my name to digital artefacts that I had helped to create as part of a design.

Each focus group interview lasted approximately 30 minutes. As a moderator I asked open-ended questions about the students' learning experiences during the time of the educational design in focus for the focus group interview. I began by asking each student group about their general experiences of and thoughts about the design. For example: ''for the last six weeks you have been working with a theme referred to as 'Identity', what are your experiences of working with this theme in the way you did?'' I then asked the students about their experiences of certain design elements, e.g. how they experienced the teachers' use of screencasting, or how they experienced using their smartphones to document themselves and share these recordings with their peers. I also asked questions about the potential added value of ICT in the design. For example, what they had learned during the last couple of weeks, what had helped them to learn this and whether and how the use of ICT had contributed as a tool for learning?

A total of 28 focus group interviews were audio recorded lasting 14 hours and six minutes. After listening to the recordings some parts were excluded if they did not relate to the design experience of the students and were considered as not relating to the focus of the study. A total of 11 hours and 28 minutes of focus group interviews were selected for transcription and further analysis.

Data analysis

As is common in qualitative research data generation, the data analyses were conducted concurrently and iteratively in the thesis (Vaismoradi, Turunen & Bondas 2013). I engaged in the process of familiarizing

myself with the data (Brown & Clarke 2006) from the very start of the DBR and used my tentative understanding generated through this analytical process to make choices about data generation in relation to the research questions. For example, my listening to recorded design conversations and the taking and reading of field notes helped me to identify aspects to focus on in upcoming design conversations or studies of enacted designs.

The use of multiple methods of data generation and data sources enabled me to explore the different levels and perspectives of different phenomena during the DBR. This arguably increased the trustworthiness of the analysis (Lincoln & Guba 1985). For example, the recording of design conversations and focus group interviews allowed for multiple listening and the detection of nuances that had not been captured in the transcriptions, such as intonations and hesitations. Writing down and later reading about these kinds of observations in the different design contexts over time in the reflexive diary provided me with yet another perspective on the data analysis. The triangulation of data sources and contexts for data analysis helped me to determine whether and how the emerging theoretical codes and categories could be used in different contexts and whether new observations confirmed that I had reached a sufficient depth of understanding in relation to them (Saunders et al. 2018).

The analytical process of the data collected during the DBR is described as deductive content analysis in article 3 and as thematic analysis in article 4 and article 5. Descriptions of content analysis and thematic analysis are very similar and the labels are sometimes used interchangeably (Nowell et al. 2017). However, differences can be discerned between these methods of analysis. Deductive content analysis is often used to retest existing theories and/or models in different situations (Hsieh & Shannon 2005; Vaismoradi, Turunen & Bondas 2013), such as in the preliminary exploration phase of this thesis and where Laurillard's CF (2012) was used in the creation of a coding frame to support a deductive content analysis of the teachers' design intentions and de facto designs (see article 3). Through this process the teachers' tentative design theory *and* the usefulness of the CF as an analytical tool in educational design were tested.

The data collected during the design and development phase of this DBR was subjected to thematic analysis. Thematic analysis is considered as a

suitable method for inductively generating codes and categories from a large data set (Ayres 2008; Braun & Clarke 2006). It is also described as a suitable method for examining the perspectives and practices of different research participants, for example by facilitating the highlighting of similarities and differences (Braun & Clarke 2006). In content analysis and thematic analysis codes and categorization/theming are created. However, in thematic analysis the researcher carefully considers the relationship of the categories and their connection to the data sources. This practice distinguishes thematic analysis from content analysis and reduces the risk of decontextualization through coding (Ayres 2008). Moreover, its theoretical freedom and flexibility means that thematic coding can be used to fulfil different needs in a research project (Nowell et al. 2017), such as the analysis of data in relation to design intentions, enacted educational designs and the teachers' research processes. However, this flexibility also means that it can be difficult for researchers to decide which aspects of data to focus on (Braun & Clarke 2006). In this thesis, the use of deductive content analysis and already existing theory (i.e. the CF) in the preliminary exploration phase of the DBR and the development of a conceptual design framework for focusing and guiding the design work and design analysis in the design and development phase of the DBR was a way of avoiding this disadvantage in thematic analysis.

Another disadvantage of thematic analysis is its inability to yield results that allow fine-grained descriptions of functionalities or guidelines for actions (Braun & Clarke 2006). However, as has been discussed, the situatedness of teaching and educational design makes it very difficult to offer these kind of guidelines, which is why the aim of this thesis is to produce theory that can offer guidance for design thinking at a higher level of abstraction.

In relation to the organization of codes into categories, three different uses and/or types of categories can be distinguished in line with previous research (cf. Maxwell & Chmiel 2014). Generally speaking, I first used *organizational* categories to sort the data for further analysis. In the next 'round' of reviewing codes and categories *substantive* categories and sub-categories were created. These categories were largely descriptive and although they often stayed close to the categorized data (e.g. reflected concepts used by the teachers) they also reflected my emerging understanding of the meaning of concepts, their relation to other concepts used, potential added values etc. A third type of category was *theoretical*.

For example, in article 3 the categorized data was placed in a pre-existing theoretical framework and the communicative cycles of the CF were used to label the theoretical categories. However, as the process of defining and naming categories progressed, inductively developed labels were increasingly used, for example to describe the most common pedagogical strategies that emerged from the analysis of the data and the ways in which ICT was used to add value in the realization of these strategies. Similarly, the design framework developed in this thesis was used in the coding and (sub-)categorizations.

Throughout the analysis process I read and re-read, listened and re-listened to the data whilst coding and categorizing it. During this extended iterative process of coding and categorizing new insights were continuously gained that affected my understanding and made the use of new or reformulated codes and categories necessary. The use of Nvivo software was helpful for gathering together, visualizing, reviewing, defining and naming the codes, categories and sub-categories and their connection to the different data sources. I also continuously created memos in Nvivo and text in the reflexive journal as part of, and in relation to, this process. During what can be described as a parallel and reciprocal process of data *and* code *and* category analysis, the codes and categories were thus elaborated to capture important concepts within the data. These reformulated or sometimes new codes and categories then needed to be considered in context (i.e. not only in relation to the selected portions of data) in order to avoid de-contextualisation through coding (Maxwell & Chmiel 2014, p 26.). This fine-tuning of codes and categories continued during the data generation period but was especially pronounced during the first eight months. As the process described above proceeded and provided increasing clarity of the characteristics of educational designs, I continued to fine-tune the theoretical categories to describe the 'latent' content of the educational designs (Graneheim & Lundman 2004), i.e. the underlying pedagogical intentions of the designs and the main added values of ICT.

Efforts to establish qualitative educational designs and trustworthy research

As DBR strives to generate two types of output – the practical development of qualitative educational designs *and* theoretical insights -

there is a need for two sets of quality criteria: one set that can be used to produce high quality educational designs and one that can be used to establish the trustworthiness of the qualitative research process and its theoretical outcomes.

Ensuring qualitative educational designs

Plomp & Nieveen (2013a) present a number of criteria for qualitative educational designs. These criteria, indicated below, are used to describe how quality in educational design was pursued in the research process. First of all, it is important that an educational design is perceived as *relevant* in the design context, i.e. that there is a need for the educational design and that it is based on 'state-of-the-art (scientific) knowledge' (Plomp & Nieveen 2013a, p. 29). In this thesis I did not enter the DBR with a set idea of how to use ICT, but started by tentatively asking the teachers about their views of teaching and learning and how they thought ICT could be used to add value in their design contexts. These questions were also asked with research ethics in mind. I did not want to suggest theories or ways of working without first hearing the teachers' opinions or considering what the possible effects on them might be. A design intention was considered relevant when it was based on a perceived need and could be supported by previous research and the tentative findings of the DBR.

It is also important to consider the *practicality* of a design (Plomp & Nieveen 2013a). For example, an educational design (intention) that requires too much hardware or technological knowledge is not practical. A distinction can be made between *expected* and *actual* practicality. There were instances in this DBR when a design idea that was expected to be practical was not due to limitations in the schools' LMS in relation to file sharing, or when a teacher realized that his/her students had to spend too much time learning how to use the technology.

Finally, a qualitative design needs to be able to produce the intended added pedagogical value. Again, a distinction can be made between *expected* and *actual* added value. A design can be *expected* to add value if it is considered relevant and practicable and things work out as planned. However, whether or not a design is able to add *actual* pedagogical value can only be determined through the enactment of the design. Still, a design that is relevant and practicable but does not

generate the expected added pedagogical value can be redesigned to generate the intended added pedagogical value. For example, in this thesis the use of a wiki failed to generate the intended added value in three different design contexts. However, by using a different wiki tool, slightly modifying the basic structure of the collaborative task and re-writing the student instructions, the use of wikis later contributed to adding pedagogical value in a number of different design contexts. This exemplifies the importance of empirically testing the practicality and the added value of educational designs. Moreover, it shows that the characteristics of a design are not 'inherent' to the design, but are dependent on the teacher's interpretation of the situation and adaptation of the design in the unique context. Thus, the quality of an educational design, i.e. the actual added value that it might bring to the educational situation, depends on the teacher's ability to adapt and enact the design in the unique context (Eckert et al. 2010; Schön 1983).

The development and use of a design framework

During the DBR a design framework (DF) was elaborated and refined in use as a theoretical model to support practical design and design evaluation. The theoretical underpinnings of the DF and how it was elaborated in relation to the teachers' expressed design intentions and experiences, as well as research, are described in the chapter on theoretical frameworks. The purpose in this chapter is to account for its function and use as a tool to support qualitative educational design.

As described above, one of the most important factors for the successful implementation of an educational design is the teacher's ability to enact this design in the situated context. This means considering a number of factors in the design process, such as the content to be taught, the specific curricular goals, the students and their relation to the content, ways of orchestrating the learning experience for example through 'real-life' tasks in which students can interact with different actors, considering the affordances of different digital tools and how these can be used to support teaching and learning etc. Previous research indicates that experienced designers often create and use a conceptual model to structure their design process (Ertmer et al. 2008; Kirschner et al. 2002) and that developing ways and tools for communicating educational design is crucial in collaborative design projects (Ertmer, York & Gedik 2009). In this thesis, a conceptual model to support the development of

qualitative educational design was developed in the form of the DF. The DF was used as a common point of reference in the design conversations and design planning. It provided a structure to guide design thinking and a vocabulary to describe design intentions, evaluate and compare designs and so on (cf. Reimann 2011).

The fact that the DF does not suggest specific digital tools or ways of using these tools, but focuses on important basic aspects in the design of a learning environment supportive of individual and collaborative meaning-making, means that its usability in different design contexts in increased. However, this also means that it does not provide the designer with *specific* guidance on how to design in his/her situated context. However, given the fact that different schools have different digital tools at their disposal, and that the teacher is ultimately the person who knows his/her class best (e.g. students' pre-existing knowledge of the content, their digital competence and preferred ways of working etc.), providing a model with more specific design guidance is difficult and could even be counter-productive.

Moreover, the DF should not be seen as a standalone conceptual tool, but as one that can be complemented with other more specific theoretical and practical advice on possible ways to stimulate and support interactions that are supportive of meaning-making. In my role as a design partner I was often able to provide this type of advice based on research, previous experience and experiences from the other design contexts in the DBR. However, the design conversations showed that the teachers' specific design practices were also discussed with and inspired by other colleagues, examples from the internet and external authorities on educational design.

Establishing the trustworthiness of the research process and findings

The use of multiple sources of data and data generation methods facilitated the representation and 'capture' of multiple dimensions and perspectives and arguably contributed to the credibility of my findings. Moreover, through the use of field notes, a reflexive research journal and writing articles to illustrate my research findings, a systematic process of documentation, analysis, publication for peer scrutiny and personal reflection was maintained.

The development of educational designs in eight different designs contexts enabled the transferability of findings between these different contexts to be tested. This may have also increased the potential for the transferability of findings to other design contexts. Previous research shows that multiple design contexts in which new data can be generated to confirm or disprove tentative design theories contribute to the credibility of the analysis (cf. Fusch & Ness 2015; Morse 2015; Saunders et al. 2018). However, as has been shown in this thesis, the transferability of design theory will ultimately always be dependent on the context in which it is applied.

In DBR the researcher must be prepared to assume different roles, such as designer, advisor and facilitator, and at the same time never lose sight of being a researcher (Kennedy-Clark 2015). Acting in these different roles means that the risk for bias is increased, since the researcher evaluating a design has also been involved in its creation (Design-Based Research Collective 2003). The amount of time that DBR researchers spend in the design context also involves risks of becoming a part of what is being studied and losing objectivity and distance (Plomp & Nieveen 2013a). To reduce the risks of bias I collaborated with two other researchers who had not actively participated in the field work and were able to scrutinize and critique my work in a process of peer debriefing (Lincoln & Guba 1985). The research was also continuously peer reviewed by people outside the DBR project, for example in research seminars at the two universities to which I am affiliated, or by experts as part of the review process for the five articles included in the thesis. Moreover, my findings were member-checked with the participating teachers.

However, a prolonged engagement in the field can also contribute to the credibility of research (Lincoln & Guba 1985). An educational design is not created in a vacuum. Design decisions are affected by a number of factors, such as school culture, available technologies, the participating teachers' technological competence, the teaching content in question and the students being taught (Tondeur et al. 2017). Being able to form a well-grounded understanding of these factors was important both from a research and a co-designer perspective, for example when interpreting data or giving design advice. To understand the complexity of the teachers' educational design process it was also vital to create professional and personal relationships with the teachers so that they felt

comfortable sharing their thoughts and feelings about different aspects of the design process, such as their own insecurities in relation to technology or doubts about a design idea that I had suggested. My prolonged engagement in the field was thus a way of contributing to the credibility of DBR and qualitative research in general.

In order to deal with the challenges involved in adopting multiple roles during the DBR I consciously defined and adopted different roles during the different phases of the DBR (cf. Plomp & Nieveen 2013a). In *the preliminary exploration phase* I was primarily a researcher with prior teaching experience and secondly a dialogue partner with extended knowledge about the practical educational use of different digital tools and theories on educational ICT use. During *the design and development phase* I adopted different roles at different times, depending of the nature of the collaboration. This was most clearly illustrated in the design conversations, where I used my knowledge of educational theory and my experience as an educational designer to make design suggestions and contributions as a co-designer. However, I also asked questions that increased my understanding of the teachers' design process. When analyzing the recorded and transcribed design conversations and other data I adopted the role of a researcher and endeavoured to treat the data as though someone else had generated it. During *the retrospective evaluation phase* I acted solely in the role of the researcher by continuing to work with data reduction and data analysis, drawing and verifying conclusions etc. (Miles and Huberman 1994).

Switching between these different roles was not straightforward. Being aware of the extent to which I succeeded was also difficult. Acknowledging that the qualitative researcher is the principal 'research instrument' is important in order to ensure that this research instrument works to the best of its capacity. For this reason, the role of reflexivity in qualitative research cannot be underestimated (Berger 2015). To help me in this effort I kept a reflexive journal for self-examination, in which I wrote down my thoughts and feelings about the research process and my different roles in it. This practice allowed me to focus on the field of study whilst in the role of a researcher or designer, and then asynchronously to reflect on and become more aware of my emotional reactions, assumption tendencies or personal agendas. The use of a reflexive journal also helped me turn the researcher lens back towards the design context and become more aware of how my being in the design context might affect the participants. In a sense I adopted a third role

while writing and reading this reflexive journal, namely that of a researcher studying myself in the role of a researcher and co-designer. One example of this is when during the preliminary exploration phase I realized that the teachers assumed that I, as a former teacher, was familiar with their realities and that this made them omit certain parts of their experience during our design conversations. I discussed this tendency with the teachers, reminded them that my teaching experience at upper secondary school was not current and asked them to try not to assume that I already knew things about their teaching contexts. I also made it a practice to ask certain questions that I considered to be especially important a second time during the design conversations, but in a reformulated way. Moreover, in dialogue with the teachers it was agreed that I could interrupt them to ask them to explain something that was unclear to me, or if I needed to confirm that a certain interpretation I had made during a design conversation was correct.

For me the striving for reflexivity was not only motivated by considerations of trustworthiness, but was an important part of research ethics. It has been shown how striving for reflexivity can help to ensure non-exploitative relationships between researchers and participants (Pillow 2003). In this thesis I made it a habit to document when I noticed that teachers did not take my design advice, and considered it as a sign of a sound researcher-participant relationship when I noticed that teachers did not always implement the changes I had suggested.

Ethical considerations

Before, during and after the dissertation I have considered and followed the ethical requirements described by the Swedish Research Council (2002, 2011). As an example, the participating teachers received information about the study and were given the opportunity to ask questions in connection with it. In close proximity to this, although not during the same meeting, they were asked to give their voluntary written consent to participate in the project, which they did. In the written consent, the researcher committed to protect the participants' integrity by ensuring confidentiality and anonymity. In order to prevent the participants' lives being adversely affected by their involvement, I made it clear that the teachers themselves decided their level of commitment in

the project. They were always free to set time limits for the DBR collaboration, take a break, or even terminate their participation.

In the striving for transparency and participation in the decision-making process the forms of DBR collaboration were negotiated with the teachers. It was agreed that my role was to collaborate with them to try and design for added pedagogical value. I would make suggestions, but as they were responsible for both the overall teaching and the implementation of the design, they would always have the final say in the design decisions. It was also made clear that as a researcher I was interested in how this could be done and what teachers needed to know to do this, meaning that the teachers would become both design partners and the objects of study.

The focus group interviews with the students were always voluntary. To avoid the students feeling pressured, and perhaps thinking that participation was expected by their teacher, I made it clear that participants who volunteered would remain completely anonymous even to their teachers. Moreover, I emphasized that neither the audio recording that was made nor the content of the conversation would be made available to anyone other than the researcher. It was stressed that their individual participation and expressed thoughts and opinions would not be discussed with their teacher and would not affect their grades. As all participants in the survey participated on a voluntary basis, were informed about their rights to discontinue their participation at any time, were not exposed to experiments and were guaranteed anonymity, no ethical permission was sought for this research. In relation to this, it should be noted that the requirements for researchers to obtain ethical permission for their studies is more pronounced today than at the start of the study.

Although I have fulfilled my formal ethical obligations as a researcher, it has nevertheless been important for me to ethically reflect on and consider how the participants might have been affected throughout the DBR. For example, before I presented the results indicating that their described practice did not correlate with their de facto practice, I carefully considered how the teachers would react and be affected by this. I also continuously considered and discussed with the teachers what I could ask of them and how much time they actually spent on the DBR collaboration. Another example is how the focus group interviews with the students were not only seen as opportunities to hear their views of the

quality of the educational designs, but that I also used the time before and after the formal recording of the interviews as opportunities to ask 'informal' questions to assess whether the DBR, which included using a number of new digital tools and often working in ways that the students were not used to, affected the students negatively. Simons and Usher (2000) refer to this responsibility of the researcher to continuously consider how different aspects of a research engagement might potentially affect individual research participants as situated ethics.

An example of how these situated ethical considerations sometimes took precedence over what might have been optimal from a research point of view related to screencasting. I mentioned the possibility of providing feedback on text via screencasts, but also warned the teachers that this might be time consuming. However, three of the teachers tested with positive results and felt that the time investment was acceptable. Despite this, I did not recommend this way of working. Rather, if screencasting came up as a subject during the design conversations I explained, as objectively as I could, the possible pros and cons of this practice according to research, my own experiences and those of their colleagues.

To summarize, in this research I have done my utmost to constantly try to take the perspective of the participants and consider the consequences of their participation and my actions on their professional and private lives.

Summary of the articles

This chapter presents a synthesis of the five articles and their contribution to answering the research questions. Article 1 and 2 present the findings related to my own empirical and literature-based exploration of DBR as a potential research approach with which to achieve my research aims. Article 3, 4 and 5 present the results from the main part of my research in which I worked with eight teachers over a period of two years to develop educational design where the use of ICT contributed added pedagogical value.

Table 1, on the next page, provides a visualization of the different articles and their main 'functions' in the thesis. Included is a condensed description of the articles' key objectives, the research approach taken, the context of the study, the data and method of analysis and the theoretical frameworks used.

After summarizing the five articles I provide a condensed description of their contributions in relation to the research questions.

Figure 4. A visualization of the articles and their main 'function' in the thesis

Main 'function' in thesis	Article	Objective	Methodology/research approach and Context / Data / Method of analysis	Theoretical frameworks used for analysis of data and/or in the educational design process
	1	To acquire a deeper understanding of: (a) the challenges and opportunities involved in educational design and collaborative design processes, and (b) the TPACK framework as an analytical tool	Collaborative self-study - 30 teacher students, University course. Field notes, recordings of researchers' reflective conversations. Content analysis	TPACK
	2	To discuss Schön's view of design and how it could inform the focus and design of DBR-research on teachers' use of ICT	Conceptual paper. Contrasts Simon's (1996) and Schön's (1983) views on design and presents arguments for how Schön's view can guide DBR. Article 1 used as empirical example. Literature analysis	Schön's conceptualization of design as reflective practice
	3	To: (a) analyze the extent to which teachers' design intentions and enacted designs support the different communicative cycles in Laurillard's CF DF, and (b) empirically test the usefulness of the CF as a design framework.	2 year DBR-project - 8 teachers in 4 one-to-one schools. Design conversations (19h), enacted designs+design elements, reflective teacher logs (31), field notes. Deductive content analysis	Laurillard's CF, TPACK
	4	To advance the understanding of teachers' reframing of practice in digital contexts by analyzing aspects of their pedagogical reasoning processes as they explore ways of using ICT for added pedagogical value	2 year DBR-project - 8 teachers in 4 one-to-one schools. Design conversations(23h), enacted designs+design elements, reflective teacher logs (35), field notes + focus group interviews with students (8h). Thematic content analysis	Shulmans model of pedagogical reasoning and action, TPACK
	5	To: (a) analyze how ICT is used in educational designs to create what the teachers and students describe as added value, (b) describe the characteristics of this use, and (c) discuss what requirements that needed to be fulfilled to enable teachers and students to use ICT in ways that added value	2 year DBR-project - 8 teachers in 4 one-to-one schools. Design conversations (103h), enacted designs+design elements, reflective teacher logs (42), field notes + focus group interviews with students (11,5h). Thematic content analysis	*The design framework (DF)*, The design framework (DF), Shulmans model of pedagogical reasoning and action, TPACK, *The design framework (DF)*

Analysis of design processes and added pedagogical

DBR-process refinement

Elaboration of DBR-design and methodology

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Article 1

Fransson, G., & Holmberg, J. (2012). Understanding the theoretical framework of technological pedagogical content knowledge: A collaborative self-study to understand teaching practice and aspects of knowledge. *Studying Teacher Education*, 8, 193–204.

This article presents the findings of a self-study that I conducted with a colleague. The aim was to develop our understanding of teachers' educational design processes and the TPACK framework (Mishra & Koehler 2006) as a conceptual tool for analyzing and discussing the challenges and opportunities that teachers encounter while working with, and learning about, ICT-supported educational design.

Self-study methodology was used to focus and analyze the authors' experiences as educational designers during the planning, teaching and evaluation of a course in which the principal educational goal was to support the development of students' pedagogical use of ICT to enhance learning in preschool/school contexts. The student group consisted of 38 preschool and secondary school student teachers taking their last course before graduating. The course goals required the students to use ICT in practical educational designs in ways that they considered contributed an added pedagogical value to teaching and learning in their future teaching contexts. The students were asked to motivate and reflect on their knowledge about and use of ICT for added pedagogical value with references to theory, e.g. the TPACK framework, during a live presentation and in a reflective text assignment.

The main source of data for analysis was our common reflections. A total five hours of reflective conversations were recorded on eight separate occasions during the self-study. The reflective conversations related to our teaching and learning experiences during the course and included discussions about the manifestation of TPACK-related knowledge and skills in the students' assignments. Other sources of data were the reflective notes that we took during the teaching of the course and two surveys undertaken by the students at the beginning and end of the course.

The findings show how we elaborated and developed our understandings of the TPACK framework during the self-study. The TPACK framework was used as a tool to describe and analyze our planning, teaching and

evaluating (e.g. of our own and the students' educational designs) during the course. At the same time, our practical experiences during the course were used to contextualize and expand our understanding of TPACK as a theoretical framework. This dialectic process between theory and practice was crucial in our learning process.

Another finding was that the teacher with a more developed technological knowledge and practical experience of different types of teaching-related uses of ICT found it easier to understand and relate to the different knowledge domains in the TPACK framework than the teacher who was more academically oriented. This indicates that an extended experience of the practical use and implications of ICT can make it easier to understand aspects of ICT-related theory. This in turn can help the integration of theory and practice in situated subject-related educational design considerations and decisions, and thus increase the likelihood of a teacher displaying TPACK.

Moreover, the article illustrates how comparing impressions and understandings of theory and practice with another teacher and researcher can add an extra dimension to the development of teachers' pedagogical reasoning and TK, TPK, TCK and TPACK. The differences in our technological-, pedagogical- and subject-related knowledge also led to differences in how we interpreted and tried to solve practical and theoretical problems. By visualizing and discussing these differences, variations in solutions and understanding emerged that helped to expand our practical and theoretical perspectives. The study thus contributed to an insider perspective on a design-based way of working.

In conclusion, the findings of the article contribute to the understanding of how in an increasingly digitized world teachers' practices and educational theories can change in parallel. Examples are given of how the TPACK framework can be used a tool to describe and analyze the complex knowledge that teachers are expected to develop in increasingly digitized teaching contexts. The findings also illustrate how the development of one knowledge domain in the TPACK framework affects other knowledge domains in an ongoing reciprocal process and that developing TPACK thus means developing and reframing all aspects of teachers' practices. Moreover, they illustrate how design-based collaborations in which skills and theoretical understandings are highlighted and problematized through an integrated process of educational design work and structured collaborative reflections on the

work can be a fruitful way of supporting teachers' professional development and reframing of practice and promoting a deeper theoretical understanding of this process.

Article 2

Holmberg, J. (2014). Studying the process of educational design—revisiting Schön and making a case for reflective design-based research on teachers' 'conversations with situations'. *Technology, Pedagogy and Education*, 23(3), 293–310.

This conceptual article takes the findings of article 1 as its starting point and expands the theoretical reasoning started there. Previous research, in particular Schön's view of design as a reflective conversation with the situation (Schön 1983; 1987), is used to support the argument that design-based research (DBR) has considerable potential as a research approach to studying and supporting teachers' educational design with ICT.

The article discusses how the current digitization of teaching contexts has meant that teaching as an activity has become even more complex. The introduction of technologies with potential affordances means that teachers will increasingly have to re-evaluate their practices in terms of TPACK instead of PCK. In view of this, a view of teaching as rational problem-solving (Simon 1973) becomes problematic. Such a dualistic view of teaching separates theory and practice and portrays teaching as largely a matter of finding the right theoretical formula and /or the right tool to solve the practical problem. However, deciding what is 'right' in educational contexts is always a matter of interpreting the situation at hand; a situation that is constantly affected by teachers' actions and interactions in relation to subject matter, students and technology. The article argues that teachers' pedagogical reasoning can be understood as a reflective dialogue with the (teaching/design) situation (Schön 1983; 1987). In reflective educational design and reflective teaching, the teacher has to constantly apply and reflect on theory and practice in situated contexts, as described in article 1.

In view of the speed of technical development and the complexity of ICT-supported educational design, which also involves a re-

conceptualization of teachers' practices, there is a need to explore ways of working in which practising teachers and researchers collaborate in a reflective educational design process to contribute their respective perspectives and abilities (Reeves, McKenney & Herrington 2011). One way of envisioning these kinds of collaborations is that researchers provide or develop methods and approaches for teachers to apply in practice. Based on this approach, the 'problem context' has been studied from the outside and theoretical 'solutions' have been offered for practical testing by teachers. However, in today's rapidly changing digital educational contexts, teachers' educational designs, and research that can contribute to the understanding and support of teachers' educational design, need to be developed in a parallel reciprocal relationship. In other words, the argument made in the article is that if teaching and educational designs are seen as reflective activities in constant development and change, the theoretical perspectives and research approaches to studying teaching should reflect this.

In line with this argument, DBR is discussed as a promising research approach to studying *and* supporting teachers' educational design processes and TPACK development. However, the current main focus in DBR on developing design principles risks contributing a simplified view of teaching as an activity that can be improved simply by 'applying' these principles. If educational design is seen as a process in which teachers are constantly acting and reflecting to make sense of complex situations, it seems appropriate for DBR to focus on understanding and supporting these reflective conversations in design situations. The prolonged collaboration in such conversations between researchers and teachers is already a characteristic of DBR and arguably makes it a powerful research approach for this end. In such reflective DBR, the main focus shifts from the development and testing of design principles to teachers' educational design processes as ongoing development activities and how these can be understood, studied and supported. The theoretical contributions of research with this focus, for example the refinement of research-based strategies and the generation of theoretical constructs to be used as conceptual frameworks to guide teacher's reflective conversations with different design situations, have the potential to be useful in the local context of their generation and/or for predefined problems.

Article 3

Holmberg, J. (2017). Applying a conceptual design framework to study teachers' use of educational technology. *Education and Information Technologies*, *22*(5), 2333–2349.

The article presents findings from the initial part of the two year DBR project in which the author collaborated with eight upper secondary school teachers of English as a foreign language (EFL) in four municipal schools with 1-1 laptop programmes. In line with the argumentation in article 2, the focus of this DBR is not the development of design principles for how to design an intervention or product, but teachers' intentions with the design and factors that affect how and the extent to which these intentions are realized in their de facto design practice.

However, this shift in research focus requires a re-thinking of the theoretical research tools and theoretical research contributions of DBR. Therefore, this article explores the use of a conceptual design framework as an analytical tool in DBR. The hypothesis is that a design framework at a higher level of abstraction than design principles and formulated in accordance with previous research on how to support teaching and learning could serve as a conceptual tool for studying and guiding teachers' pedagogical reasoning about how to design with ICT in different contexts. In the article, Laurillard's Conversational Framework (CF) (Laurillard 2002; 2012) is used as a design framework to analyze teachers' intentions with, and practical use of, ICT in educational design.

Data was collected over a period of 15 weeks, starting in December 2014. The primary source of data is 19 hours of recorded and transcribed design conversations (open-ended interviews about the teachers' design intentions for, and de facto use of, ICT in educational designs). Other sources of data are the digital representations of the educational designs constructed by the teachers to support teaching and learning, the teachers' written entries in their reflective logs (N=31) and the researchers field notes. The data was analyzed through a process of qualitative content analysis (Elo & Kyngäs 2008; Hsieh & Shannon 2005) in which the CF was used to inform an initial coding frame.

The findings illustrate how the CF is used to distinguish and analyze different aspects of the teachers' formulated intentions with the educational design and their de facto design practices. One outcome of

this analysis is the revelation of a discrepancy between design intention and design in practice. The findings illustrate how teachers primarily use ICT to support communication and exchange of knowledge representations between teacher-student and student-teacher. Only to a limited extent is ICT used in educational designs to support communication, collaboration and creation between peers. However, analyzes of design conversations reveal that teachers often express intentions to apply ICT to support these kinds of interactions. One reason for the discrepancy between teachers' expressed intentions and their actual use of ICT is their perceived limitations in ICT skills. Moreover, the use of ICT to support dialogue and collaboration between students is thought to conflict with the teachers' task of assessing individual students in relation to constant and measurable course goals. Finally, the findings show that even if teachers see the potential of ICT as a tool for supporting collaborative learning, such use may be contrary to the dominant school practices of individual tasks and individual assessment.

In conclusion, the findings support the idea of a design framework as a potentially useful research tool in DBR. Moreover, the potential of a design framework as a conceptual design tool is recognized and discussed. However, based on the empirical findings, a further development of Laurillard's CF is proposed to include interaction with actors outside the classroom.

Article 4

Holmberg, J., Fransson, G. & Fors, U. (2018). 'Teachers' pedagogical reasoning and reframing of practice in digital contexts, *The International Journal of Information and Learning Technology*, 35(2), 130-142.

The aim of this article is to advance understanding about how teachers reframe their practice in digital contexts. This is done by analyzing the pedagogical reasoning processes of the eight teachers participating in the DBR project as they apply and reflect on different aspects of their professional knowledge and practice.

Article 3 revealed that teachers' intentions with ICT-supported design and their de facto design practices did not always correlate. These findings and other current research (cf. Harris t al. 2017; Smart 2016)

signal the importance of understanding teachers' pedagogical reasoning in digital contexts, i.e. the integrated process in which the teachers apply and reflect on different aspects of their professional knowledge and practice.

Having presented and discussed the findings of article 3 with the teachers, this article presents findings from the continuation of the DBR project. The article analyzes certain aspects of the teachers' pedagogical reasoning during the ensuing process in which I, as the on-site researcher, and the individual teachers collaboratively discussed, formulated and evaluated pedagogical approaches and specific ways of using ICT to add pedagogical value that was more in line with the pedagogical intentions expressed by the teachers. In this process I mainly contributed with questions, ideas, experiences and advice. The teachers performed the actual 'hands on' design work, sometimes with support from me. This design work was then collaboratively discussed and evaluated in relation to theories of learning, use of technology and the teachers' and students' expressed experiences. The lessons learned and the new or modified ideas that emerged from these design conversations and focus group interviews were used to support elaborations of the teachers' subsequent designs.

Shulman's model of pedagogical reasoning (1987) is used to discern and analyze different aspects and developments of the teachers' pedagogical reasoning about how to use ICT for adding pedagogical value in relation to: the design of a representational repertoire (e.g. multimodal examples and demonstrations), the design of learning activities and the evaluation of their educational design and assessment of students' knowledge representations (e.g. texts, recorded speech or other digital multimodal representations of student performance in relation to the learning outcomes). The TPACK framework is used in both the analysis and presentation of the findings.

The data consists of 23 hours of transcribed design conversations, the digital representations of the teachers' design intentions, 35 written reflective log entries written by the teachers, 8 hours of transcribed focus group interviews with students in groups of 4-6 (which provided information about the teachers' educational designs from the students' points of view) and the researcher's field notes. A preliminary coding frame inspired by Shulman's model of pedagogical reasoning was constructed and the data was coded in consecutive rounds of thematic

coding, where the codes gradually became less descriptive and more analytical (Ayres 2008).

The findings illustrate the complex and multidimensional nature of teachers' pedagogical reasoning and how they reframe their practices during the DBR project through a reciprocal process of pedagogical reasoning and TPACK development. When developing their understanding and practical experience of the use of different digital technologies the teachers' pedagogical reasoning process was affected by their technological, pedagogical and content knowledge in different ways. The findings thus illustrate how educational design can be described as a dialogic and transactional process in which the construction of meaning and the elaboration of understanding and skills are intrinsically connected to teachers' situated design work.

The findings also show that TPACK as a conceptual construct does not distinguish between *knowing about* technology and pedagogical technology use and *knowing how* to use technology for pedagogical purposes. In this article, TPACK is therefore discussed in general or specific theoretical or practical terms in order to illustrate that TPACK can be understood both as theoretical understanding and practical knowledge, which in turn can be general or specific in nature.

Finally, the findings present some common discernible characteristics of the teachers' reframing of practice during the time of the study and how this reframing of practice was dependent of a reframing of students' practices as learners.

Article 5

Holmberg (submitted). 'Identifying the added pedagogical value in teachers' educational design with digital technologies'.

This study aims to: (a) explore how ICT is used in educational designs to create/contribute to what the teachers and students describe as added value, (b) analyse the characteristics of this use and (c) describe the requirements that needed to be fulfilled to enable the teachers and students to use ICT in ways that added value.

The article describes how Goodyear's (2005) conceptualization of educational design as a 'layered process' was used to guide the DBR collaboration in which I functioned as a dialogue partner, an advisory design partner and technology consultant. Moreover, the article describes how a conceptual design framework (DF) was developed as a conceptual tool for use in situated enactments, evaluations and elaborations of pedagogical strategies and tactics.

The data, collected over a period of 15 months, consists of: (a) 84 hours of transcribed design conversations, (b) enacted educational designs and design elements as parts of these, (c) 42 written reflective log entries written by the participating teachers, (d) 11.5 hours of transcribed focus group interviews with students in groups of 4-6 and (e) the researchers' field notes.

The findings show how the teachers' use of ICT in educational design added pedagogical value by facilitating the implementation of different pedagogical strategies and tactics in line with the teachers' expressed ideas for high level pedagogy and in ways that would not have been possible without ICT. The main values that are added by the use of ICT in educational designs through the identified pedagogical strategies and tactics are described in the article.

First, the use of ICT added value by allowing teachers to situate learning in more 'authentic learning environments' (Herrington, Reeves & Oliver 2014), i.e. creating a more seamless learning that was not dependent on time or place and included interaction with both in-class and out-of-class actors and other learning resources (Wong, Milrad & Specht 2015). For example, the use of ICT meant that learning could be situated in 'real-life' contexts, e.g. with external actors on the internet.

Second, the teachers' use of ICT added value by facilitating the documentation of and interaction with digital multimodal knowledge representations between teachers, individual students, peers and external actors. For example, the teachers were able to provide their students with externalized representations of expert understanding and performance and use ICT to annotate these representations to illustrate their tacit qualities. ICT was thus used to support 'cognitive apprenticeship' (Collins & Capur 2014) and help students to 'break the code' when learning a specific content. Moreover, the documentation and access to

multimodal knowledge representations also added value in relation to the students' metacognitive monitoring, control and self-regulation.

Third, ICT was used to create added pedagogical value by creating tasks and support for collaborative learning irrespective of time and space. For example, ICT was used to create, document and share students' externalized thinking and performances. This gave access to a variety of perspectives and allowed students to compare and model their own thinking and performances on those of others.

The article concludes by discussing and exemplifying how the identified ways of using ICT to add pedagogical value were made possible through a reframing and elaboration of the teachers' pedagogical reasoning and TPACK. It also illustrates how the use of ICT for added pedagogical value was dependent on a similar reframing of the students' learning practices and technological developments.

The contributions of the articles in relation to the research questions

Below I provide a condensed description of how the articles contributed to answering the research questions.

How can educational design as a process be conceptualized and what challenges and opportunities for teachers are identifiable in this process?

Article 1 illustrates how learning to design with ICT is a multifaceted process that involves developing and reframing different aspects of teacher knowledge.

Article 2 discusses how the development of teacher knowledge in digital contexts and the parallel process of reframing teacher practice can be understood as reflective conversations with the situation, rather than a process of rational problem solving. The argument in article 2 is that such reflective conversations are challenging because they require teachers to subject their existing pedagogical practice to scrutiny, including the underlying and often tacit thinking that is involved.

Article 3 presents empirical findings that illustrate this complexity and examples of how and why the teachers' design intentions were not enacted in practice.

Article 4 shows how teachers' pedagogical reasoning and TPACK development are interconnected and reciprocal processes and how the externalization of, and reflection on, these processes is necessary to develop the specific and practical TPACK needed to realize design intentions in situated contexts. A number of identified challenges and opportunities for the teachers' in these processes are discussed.

Article 5 illustrates how by simultaneously developing and drawing on their specific and practical TPACK in situated design contexts the teachers were able to use ICT in educational designs to create new opportunities for teaching and learning. Article 5 also complements the findings of article 4 by showing how the realization of these opportunities depended on the development of students' digital competence, as well as a reframing of the different teacher and student roles and teaching and student practices in general.

What are the characteristics of educational designs that are considered as successful in supporting teaching and learning by the teachers and students, and how is ICT used to create added pedagogical value in these designs?

Article 3 illustrates how at the start of the DBR the teachers mainly used ICT to add pedagogical value by supporting communication and the exchange of knowledge artefacts for explanations and/or assessments between themselves and their students. However, the findings also show the teachers' expressed intentions to use ICT to support for example collaborative creation, interaction and meaning-making with different actors in and outside the classroom.

Article 4 exemplifies how during the DBR the teachers reframed their teaching practices and simultaneously developed different aspects of their TPACK. The characteristics and consequences of this reframing are described, for example how ICT was increasingly used to add pedagogical value by supporting collaborative learning and the exchange of digital knowledge representations for modelling and peer-review. An

added value was also achieved by increasingly designing for students as the main users of ICT, often through the use of 'authentic' digital tools in real-life contexts.

Article 5 presents an analysis of the main characteristics of educational designs and how ICT is used to add value to teaching and learning during the DBR. In short, ICT contributed to added value in the designs by facilitating: (a) more authentic and seamless learning experiences by increasingly designing for learning opportunities in external online contexts with external actors irrespective of time and place, (b) an exchange of digital knowledge representations of understanding and practice between different actors, e.g. for the purposes of modelling, supporting cognitive apprenticeship, meta-cognitive self-regulation and formative assessment, and (c) new and extended forms of, and opportunities for, collaborative creation and meaning-making.

How can educational design as a process be studied and supported through DBR?

Article 1 illustrates how the TPACK framework can be used to analyze and discuss the challenges and opportunities related to teachers' ICT-supported educational design. Moreover, it shows how collaborative reflection on educational design practices can contribute to increased understanding and development of these practices.

In article 2 I relate my experiences from the self-study (article 1) to theory and present research-based arguments for an increased focus in DBR on teachers and their design processes, e.g. their pedagogical reasoning and TPACK development.

Article 3 illustrates how the DBR format allowed me to analyze the teachers' expressed intentions for design and their practical examples of design and to identify the differences between these intentions and examples and the underlying reasons for them.

Article 4 provides a more in-depth view of how the DBR format allowed me to study the integrated processes of teachers' pedagogical reasoning and TPACK development as they were externalized, discussed and constantly elaborated in practice and in the design conversations. Moreover, article 4 illustrates the different ways in which the DBR

collaboration supported the teachers' transformation of theoretical and general TPACK to practical and specific TPACK to realize many of the pedagogical intentions that had previously been unattainable.

Article 5 illustrates how the DF elaborated as part of the DBR was useful as a conceptual tool to support the practical design work and as a model with which to discuss, compare and evaluate the design ideas and enacted designs. It also shows how the collaborative design process contributed to the successful generation of educational designs in which ICT was used to add pedagogical value. Article 5 thus illustrates how the DBR format created opportunities and a structure that allowed the participants to use their respective competencies in collaborative reflective conversations with design situations.

Discussing the findings

The large-scale introduction of ICT in schools is an ongoing and historically very recent phenomenon. Teachers have a dual task in preparing their students for a life in a 'connected' world and considering whether and how they, as educational designers, can use the various and constantly updated technologies and services to add pedagogical value to teaching and learning. Through a DBR approach I have explored the educational design processes of eight EFL teachers over an extended period of time in order to better understand the processes, challenges and opportunities that are involved. In my role as a researcher and design partner I have also collaborated with them to develop educational designs in which ICT has been successfully (according to the teachers and students) used to add pedagogical value. By focusing on the teachers' design processes and the generation of design theory to guide the design process, rather than practical enactments of design principles, this thesis also contributes to the development of DBR methodology and theory.

In this chapter the findings of the thesis are discussed and elaborated in relation to the research questions. Next, the methodological, conceptual, theoretical and empirical contributions of the thesis and their implications for research and practice are discussed. This is followed by a discussion about the limitations of the study and suggestions for future research.

Understanding teachers' educational design processes

In order to determine what can reasonably be expected from teachers in their use of ICT in teaching and how they can best be supported as educational designers, it is important to increase our understanding of the educational design process. By presenting findings to this effect, this thesis offers research-based contributions to the field of the educational sciences and subjects like curriculum studies, pedagogical work and education.

In line with previous research (cf. Cross 2006, Schön 1983, Shulman 1987), the findings of the thesis illustrate how the educational design process can be conceptualized as a reflective conversation with the

design situation in which aspects of teachers' pedagogical reasoning, action and TPACK are applied, reflected on and developed in an integrated, reciprocal and iterative process. It is shown that when teachers' understandings of technology, teaching content and pedagogy change it affects how they reason and act. When this 'reframed reasoning and actioning' is concretized in educational designs it again influences the teachers' experiences, how they are interpreted and which aspects of their TPACK are developed further. The situated nature of the educational design process is also illustrated, which involves understanding and considering the students' willingness and ability to use ICT in the intended ways. Moreover, it is shown how the educational design process is affected by, and potentially affects, teachers' understanding in relation to: (a) pedagogical philosophy and ideas for high level pedagogy, (b) the affordances of digital tools and (c) how the pedagogical use of ICT is conceptualized, valued and implemented.

The conceptualization of educational design that is described above means that claims that teachers are not using ICT 'as expected' (Vrasidas 2015, p. 371) in relation to the uptake and use of ICT for added pedagogical value (Sanders & George 2017) can be problematized. Moreover, an understanding of educational design as a situated reflective conversation with the design situation affects how we envision supporting teachers in their efforts to use ICT as educational designers.

The findings of this thesis illustrate that there cannot be any 'expected' uses of ICT without a comprehensive understanding of the situation at hand. This also means that it is not possible to simply 'move' a specific educational design from one context to another. As described above, the decision about whether and how to use ICT is always made in relation to a number of factors, many of which are unique to the situated context. If a teacher is presented with detailed prescriptive design principles that do not take into account his/her ideas for high level pedagogy or TK, or the students' digital competence or previous knowledge , the chances of the 'expected' results coming to fruition will be limited.

The expectations on teachers to become educational designers that take advantage of the affordances of ICT, and the time and effort needed for this, are also put in another light when educational design is conceptualized as a situated and constantly ongoing exploratory development process (and not as a procedure to be learnt and applied). This thesis illustrates the complexity of this process and how it often

involves a reframing of different aspects of teachers' practices over time. For example, exploring how to use ICT for pedagogical purposes often involves an opportunity for teachers' ideas about the nature of teaching and learning to be visualized and reflected on. The question of whether ICT can contribute added value is dependent on what a teacher wants or expects ICT to contribute, which in turn relates to how they perceive the nature of teaching and learning (Tondeur et al. 2017). When thinking about whether and how a digital tool could be used to support teaching and learning, the pedagogical purpose of this use is 'automatically' in focus. For example, being shown certain affordances of a digital tool, or presented with examples of how to use ICT, gives teachers opportunities to reflect on whether the suggested practice makes sense to them or not, i.e. whether the suggested pedagogical strategies or tactics align with their ideas for high level pedagogy and their pedagogical philosophy. Certain affordances and ways of working will seem more appealing than others and will therefore be selected for potential or de facto use. This selection of which affordances or uses to explore can 'reveal' aspects of teachers' pedagogical philosophy that are not currently expressed in their practice. In this DBR, the teachers' convictions about the importance of collaborative learning in real-life settings (often on the web) are strengthened, visualized and accentuated in their designs.

However, the possibility of identifying aspects of envisioned practices that are not currently realized when thinking about how to include ICT for added value is a double-edged sword, in the sense that that it can help teachers to see opportunities or to become acutely aware of seemingly insurmountable challenges. The introduction of ICT adds complexity to an already complex activity, where actions are observed and judged by others and where the decisions that are made may affect students in unforeseeable ways (Albion et al. 2015). Even though the teachers in this study describe themselves as being above average as far as ICT-skills and interest are concerned, they nevertheless sometimes express being unable to meet the expectations of ICT implementation from school leaders, students or in comparison to other teachers. Realizing through self-reflection that your current practice is not always in line with how you would like to teach, and that there seems to be no easy remedy for this, can be challenging (Howard 2013). When expecting teachers to become educational designers who use ICT to add pedagogical value, these challenges, together with the increased workload and potential stress that this might lead to, need to be considered.

Finally, in relation to developing as educational designers, the teachers in this DBR often had a theoretical and general TPACK that allowed them to describe how they wanted to use ICT for pedagogical purposes. However, as described in article 3, 4 and 5, designing in line with their expressed intentions requires both the development of *specific* and *practical* TPACK in the situated context and a development of students' digital competences. Moreover, it requires that teachers and students accept certain changes in relation to how teaching and learning have been and are conducted in existing school cultures. This includes a re-conceptualization of the teacher and student roles and a willingness to collaboratively create and share knowledge representations and undertake peer reviews and reflections. Being hesitant about teaching in ways that deviate too much from school cultures and other colleagues' ways of working is expressed by a majority of the teachers in the study and has meant that the process of educational change has been slow and gradual. It often takes at least a term and sometimes up to a year for any re-negotiation of the teaching and learning approaches and practices to be accepted and 'take effect'.

By describing the complexity of the educational design process, this thesis supports previous research that stresses the importance of having realistic ideas about how fast and extensively ICT can be expected to change educational practice (Sanders & George 2017). It also illustrates the need for a more holistic understanding of the different factors that affect whether, how and the extent to which ICT can be used to add pedagogical value. Moreover, it shows the importance of supporting teachers' development as educational designers over time (cf. Willermark 2018) and that such support is not limited to theoretical and general information about how ICT can be used. Instead, the development of specific and practical TPACK for situated use can be successfully developed in practice if design ideas and actions are allowed to be subjected to the back talk from the design situation and reflected on in collaboration with others. This thesis, both in the self-study (article 1) and the DBR (article 3, 4 and 5), illustrates how having a design partner who asks questions and makes suggestions can contribute to an increased understanding and development of teachers' educational design processes and practices.

Added pedagogical value

Despite an increased access to ICT in schools around the world, the effect of these investments in relation to teachers' use of ICT is often described in negative terms (cf. OECD 2016; Sanders & George 2017). As discussed above, this can partly be explained by a limited understanding of the complexity of the educational design process. Other explanatory factors are related to the kind of 'effects' the use of ICT is expected to have and the strategies and evidence that are used to determine whether or not pedagogical value has been added. This thesis has shown how ICT is used to add value by creating new and/or extended opportunities and forms for:
- seamless learning with different actors in real-life contexts
- the exchange of digital knowledge representations between different actors, e.g. for modelling, cognitive apprenticeship, meta-cognitive self-regulation and formative assessment
- collaborative creation and meaning-making.

However, as described below, it is difficult to point to any specific and measurable effects of these added values. Nevertheless, the existence and impact of the added values are confirmed by the central stakeholders, i.e. the teachers and the students (cf. Scheerens, Luyten & Van Raavens 2011). The evidence used to confirm and describe these added values are analyses of the research data over time. The uses of ICT for added value described in this thesis are identified in all the design contexts and on multiple occasions over time. However, this does not mean that the teachers use ICT in exactly the same way to design for added value, or to the same extent. Neither does it mean that these are the only ways in which ICT could have been used to add value. Moreover, in the situated practice the identified added values and the pedagogical strategies for adding value often co-exist and are reciprocal. For example, the ability to use ICT for annotation, sharing and commenting in relation to the multimodal knowledge artefacts created by different actors is a central aspect in the realization of all the pedagogical strategies. Another example of identifiable yet largely 'unmeasurable' effects is how the use of ICT to support collaborative learning and meaning-making is mentioned as helpful in shifting the focus from the construction of artefacts for assessment to an increased focus on students' learning processes. This in turn is described by the teachers, and by many students, as reducing stress and increasing motivation to teach and learn.

The above description illustrates the challenges of analyzing, understanding and describing whether and how the use of ICT contributes to added pedagogical value and how this can be confirmed. The 'measurement of effectiveness' that some researchers call for (cf. Golonka et al. 2014) seems to presuppose a view of knowledge as something that is clearly identifiable and unchanging and that largely disregards the challenges of assessing learning and what brought this learning about. For example, how can we 'measure' with any degree of certainty the effects and the causes of the effects of students using web-conferencing software and sharing documents for communication and collaborative writing with native speakers in relation to their learning about vocabulary, pronunciation, spelling, grammar, intercultural competence, or for that matter in relation to their motivation for language learning?

In addition, this thesis illustrates the importance of several different factors in the creation of added value. Even though the teachers' development of specific and practical TPACK is central to the creation of added value, the value that is added is also dependent on students, colleagues and school leaders accepting the changes and the new ways of working. As the teachers increasingly design for students as the main users of ICT, their digital competence is an important factor to consider when analyzing whether and why (or not) the use of ICT leads to added value. Thus, efforts to create opportunities for teachers to use ICT for added pedagogical value also need to include these considerations.

Studying and supporting educational design through DBR

DBR is increasingly recognized as a fruitful way of studying and supporting the highly complex educational design process and teachers' reasoning and action in this process (cf. Harris et al. 2017). However, to date the focus of much DBR has been on the formulation of design principles to guide the construction of educational designs and design elements (see article 2). However, if educational design is viewed as a reflective conversation with the design situation, the formulation and use of predetermined design principles for ICT use become problematic. Prescriptive design principles at a low level of abstraction do not take the

situated nature of educational design into account, including factors such as the teachers' pedagogical philosophy or TPACK, or the students' pre-existing knowledge and digital competence. This thesis is an example of how the current focus of DBR on design products can be supplemented with an increased focus on teachers and their design processes and how this shift in focus can contribute new knowledge about and offer new ways of supporting teachers' educational design processes.

By not only focusing on the de facto design activity, i.e. pedagogical tactics, but also generating data in relation to the teachers' pedagogical philosophy, ideas for high level pedagogy and envisioned pedagogical strategies, significant differences in what the teachers say they want to achieve via design with ICT and how they actually use ICT in practice are expressed. These findings can be related to Argyris and Schön's research on espoused theories and theories-in-use (1974), which describe how people are sometimes able to theorize and describe what they do in ways that are not necessarily reflected in their practices. This insight can be used as an argument for the use of DBR as an approach for studying teachers' design processes, because in theory it can offer access to expressions of teachers' espoused theories and theories-in-use. However, this thesis also shows how participating in DBR can make teachers aware of and even sometimes doubt their own competences and/or practices. The effects that DBR may have on teachers' self-efficacy and general view of themselves as teachers thus need to be considered in DBR research.

An important part of understanding as much as possible about teachers' design intentions and design practices is to find ways of generating data that illustrates both these aspects of the design process. The use of design conversations that are dialogical in nature and that focus on both the design thinking and action is an important part of this. In the design conversations the teachers are asked to describe their ideas and intentions for educational design but also, if possible, to do so in relation to their own or others' previous examples of enacted educational designs and design elements. This means that the discussions are not hypothetical, but are related to actual, or sometimes envisioned, design artefacts that practically illustrate what is being discussed. This also arguably leaves less room for misconceptions and misinterpretations on my part as a researcher. Although I provide a structure for the design conversations through initial questions, the teachers are free to, and often do, take the conversations in different directions.

According to the teachers' statements and the analysis of their enacted practices, the design conversations, as an integrated part of the DBR collaboration, also help the teachers to develop their ICT-supported design practice. In the design conversations the teachers are asked questions about how to formulate learning outcomes and align the teaching, tasks and assessment in relation to them. They are also asked how ICT could be used to add value in this process. According to the teachers, the questions about alignment provide them with a structure for thinking about the educational design process in new ways. Similarly, the practice of allowing them to reflect on possible ways of using ICT before being presented with examples or suggestions, forces them to reflect on what they want to achieve with ICT, i.e. the added value that ICT is supposed to contribute to the teaching and learning of a specific content. This way, the search for ways of using ICT and for digital tools with affordances that can add pedagogical value becomes an integrated part of their pedagogical reasoning.

The increased focus on teachers and their design process in this DBR thus contribute to the generation of qualitative educational designs and also the development of the most central factor for qualitative designs, namely the teachers and their competence as educational designers. This hopefully increases the chances of this DBR contributing to qualitative educational design also in the future.

Methodological contributions

The thesis makes a methodical contribution by developing and applying a design framework (DF) as a conceptual tool to both analyze and practically guide educational design intentions and design practices. The idea of design frameworks is not new in DBR. However many can be described as scholars' thought experiments that are disconnected from practice, especially as very few have been developed and tested empirically (Bower & Vlachopoulos 2018).

The thesis also introduces design conversations as a data generation method with the dual aim of informing research and supporting teachers as educational designers. Design conversations are dialogical and explorative in nature, where both parties are encouraged to take the conversations in different directions, thus (in theory) allowing the

professional competence of both parties to contribute to the design process and the quality of educational designs. In this thesis, the DF is used to provide a common point of reference in the design conversations.

Through the development and use of the DF and the use of design conversations as a data generation method, the thesis illustrates how DBR can be implemented methodically to study design intentions and design practice, develop research-based educational designs in line with teachers' pedagogical philosophies and support their development as educational designers.

Theoretical contributions

The thesis contributes to theory development in DBR by problematizing and challenging the current focus on prescriptive design principles and by presenting arguments for, and an empirical example of, DBR with a primary focus on teachers and their educational design processes. The empirical findings of this thesis can help to increase the understanding of the situated and reciprocal nature of teachers' TPACK development and pedagogical reasoning and support their development as educational designers.

Moreover, existing theories on teaching, learning and educational design are drawn on in order to develop the DF used in this thesis as a new theoretical construct to guide the analysis of design intentions and enacted designs. The thesis illustrates how this DF is also used to guide the practical planning, enactment and evaluation of educational designs.

This thesis contributes to TPACK development by using empirical observations to problematize the inability of the TPACK concept to distinguish between knowing about pedagogical ICT use and knowing how to use ICT for pedagogical purposes. It illustrates how teachers sometimes display *theoretical* or *general* TPACK to convincingly describe and motivate how and why ICT could be used to support learning in new ways, even though they may lack *practical* and *specific* TPACK to realize these intentions. This can be related to previous research that describes how TPACK is constructed in use into a unique TPACK for every teacher (cf. Olofson, Maureen & Neumann 2016; Willermark 2018). However, this thesis illustrates how the TPACK framework can nevertheless serve as a conceptual tool with which to

carry out more de-contexualized discussions about the competencies that teachers need as educational designers.

Empirical contributions

The thesis contributes to the understanding of teachers' educational design processes as a reflective conversation with the situated design situation in which the teachers' design theories and practices are applied, reflected on and developed in a reciprocal and iterative way. The importance of this reflective design conversation for the generation of added pedagogical value in situated contexts has also been illustrated.

Another empirical contribution is the identification of a number of challenges and opportunities in teachers' educational design processes and how these are not only teacher related, but also include considerations of the ability and willingness of students to adopt digital tools and new ICT-supported pedagogical ways of working.

The thesis also contributes empirically by applying and evaluating a design framework (the DF) as a conceptual tool for design analysis and design enactment. It shows how the DF is used to analyze, describe, compare and enact characteristics of educational designs in the different design contexts. This in turn illustrates how a design framework can support design discussions and planning at a higher level of abstraction than specific design principles and across situated contexts.

Moreover, the thesis illustrates how having a design partner who asks questions and makes suggestions can help to visualize and contribute to the development of different aspects of teachers' design processes and practices. This finding can be used as an argument for professional development initiatives in which teachers are given the opportunity to collaboratively discuss, compare and develop design intentions and enacted designs over time.

Finally, the findings illustrate how ICT is used in educational design to add pedagogical value to teaching and learning and how this added value is confirmed by teachers and students in eight different contexts. The characteristics of the ICT use that contribute to this added pedagogical value are identified and described in the thesis.

Limitations

Although the data in this thesis has been generated in eight different design contexts, these contexts are all EFL upper secondary situations. This decision was made in order to keep one of the parameters (the subject for teaching) constant and allow me to draw on my previous experience as an EFL teacher. However, it has also meant the generation of a more limited empirical material.

All the participating teachers were positive about using ICT to contribute added value to teaching and learning and described themselves as somewhat more digitally competent than the average colleague. This was perhaps to be expected, considering that participation was voluntary. However, it also meant that the findings were based on data that was generated in collaboration with teachers who were in favour of trying out new pedagogical ways of working with ICT.

This research was carried out in one-to-one schools where the students had smartphones that could, and were, increasingly used for different pedagogical purposes during the time of the study. Although this, or a similar kind of access to technology is common in Sweden, it may not be the case in countries with differing digital infrastructures and/or where students' access to smartphones are more limited.

What could be considered as a limitation of this research is that no attempt was made to 'measure' the effects of the added pedagogical values described by the teachers and students. For example, no formal testing of the students was carried out as part of the DBR, which theoretically could have been done to indicate whether a certain added value contributed to improvements in specific knowledge. However, considering the complexity of teaching and learning and the various reasons that could be used to explain the differences in for example test scores, the extent to which this could be considered a limitation is open to discussion.

Future research

Considering the complexity of educational design and the speed of technological development, several issues of importance for continued research can be identified in relation to the research foci of this thesis. Follow-up longitudinal studies with the participating teachers in this DBR could be fruitful, for example by exploring and assessing their described and enacted use of ICT in the creation of added pedagogical value today. Further research is also needed to increase the understanding of how the educational design process is expressed and enacted by teachers of different subjects. This could entail research that compares whether and/or how different subject logics affect the educational design process and the envisioned and enacted added values in educational designs.

As has been described, the participating teachers in this thesis were generally positive and knowledgeable about the theoretical ability to use ICT for added value. However, there is a need for further research on the educational design processes amongst teachers with varying attitudes to the potential of ICT to support teaching and learning and with varying theoretical, general, specific and practical TPACK. Such research could increase the understanding of how these factors affect how the design process is described and enacted, which aspects of teacher knowledge are foregrounded and how this is manifested in the educational designs and the realisation of added value.

In relation to the generation of added value through the pedagogical use of ICT, further research is also needed to study the (potential) generation and characteristics of this in other EFL contexts and in other subjects. Research is also needed to further the understanding of educational design and potential ICT-supported added value in contexts in which emerging technologies like virtual- or augmented reality, or educational games etc., are used. In relation to the possible areas for future research described above, it would be possible to use the DF as both an analytical tool and as a tool to support practical design. This would enable its applicability and function in different design contexts to be evaluated and the potential outcomes of its use to be analyzed.

Considering how many publishers of educational materials produce materials intended for consideration and potential use by teachers in their educational design processes, it is also important to analyze how the

teachers use these materials and what kind of ICT-supported added value they identify in them. In relation to this, researching the educational design process of those who design these materials would also be worthwhile. In this thesis, the educational design process has been described as a reflective conversation with the design situation. In relation to this, some possible questions to be explored are: How can the educational process be understood and described for these educational designers? How do they overcome the challenges of designing for teachers and students whose pre-knowledge, digital competence, preferred ways of working and so on are unknown? To what extent are they able to adapt their designs in relation to the back talk of the design contexts and, if this is not possible, what might this mean for the enactment and value of their educational designs in practice and over time?

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