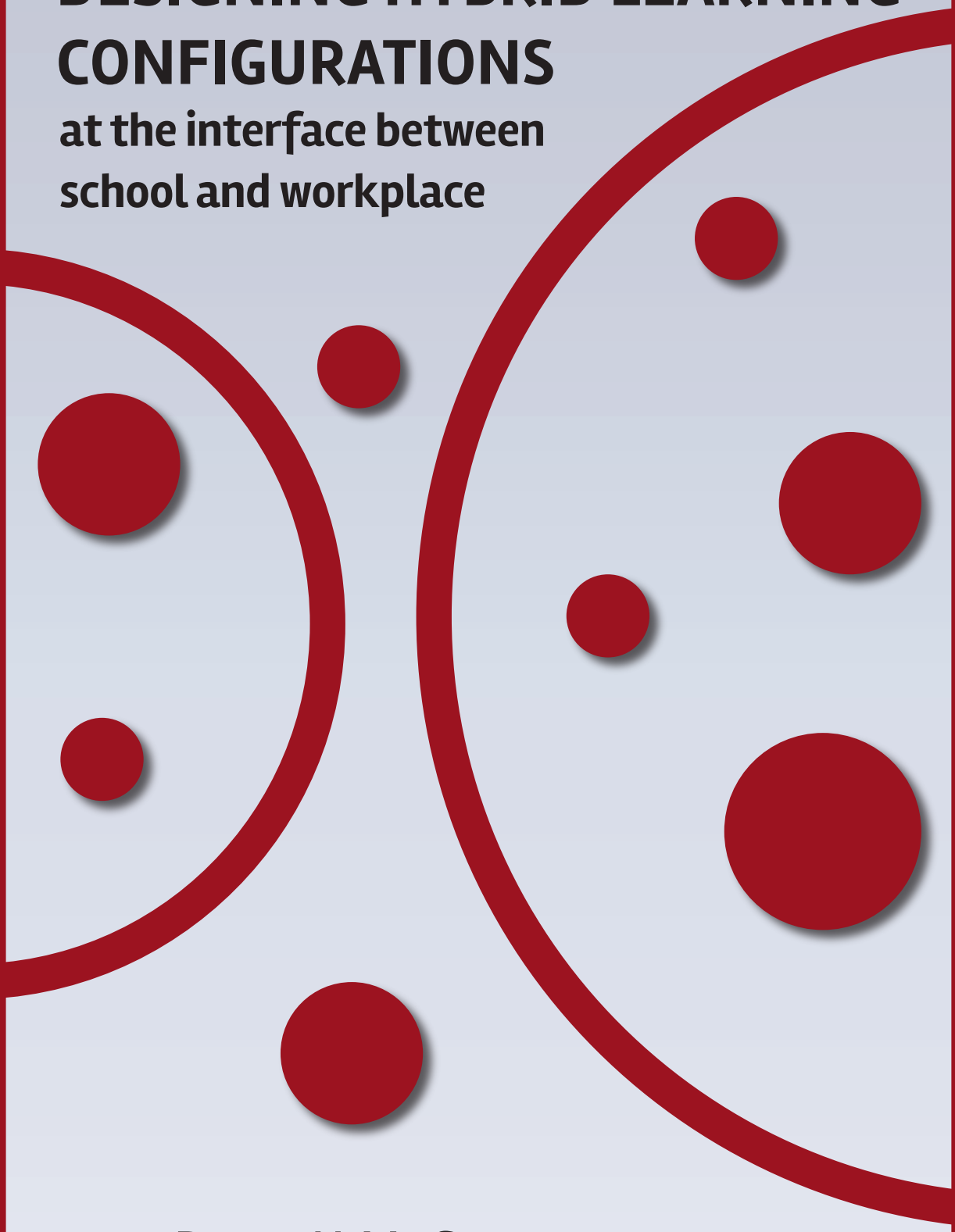
DESIGNING HYBRID LEARNING CONFIGURATIONS

at the interface between school and workplace



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

DESIGNING HYBRID LEARNING CONFIGURATIONS

at the interface between school and workplace

Petronella Hermanus Maria Cremers

Thesis
submitted in fulfilment of the requirements for the degree of doctor
at Wageningen University
by the authority of the Rector Magnificus
Prof. Dr A.P.J. Mol,
in the presence of the
Thesis Committee appointed by the Academic Board
to be defended in public
on Wednesday 10 February 2016
at 1.30 p.m. in the Aula.

Petra H.M. Cremers
Designing hybrid learning configurations at the interface between school and workplace
156 pages.

PhD thesis, Wageningen University, Wageningen, NL (2016)
With references, with summaries in English and Dutch

ISBN 987-94-6257-632-2

Voorwoord

"I am a slow walker, but I never walk back"
Abraham Lincoln

Toen ik in 2008 startte met mijn promotieonderzoek had ik geen idee waar ik aan begon. Ik wist alleen dat ik heel graag een keer tijd wilde hebben om meer te weten te komen over de nieuwe onderwijsvormen waarbij ik betrokken was. Tijd om te lezen, tijd om mijn werk te kunnen onderbouwen. Tijd om studenten en docenten te vragen hoe ze nieuwe onderwijsomgevingen ervaren en om opgedane kennis en ervaringen overdraagbaar te maken zodat anderen er ook van kunnen profiteren.

2008 was een jaar waarin mijn leven op meerdere manieren veranderde. Ik verhuisde na 18 jaar in Groningen te hebben gewoond naar Epe, waar ik ging samenwonen met Freek. Van het Groningse platteland terug naar de bossen van mijn studietijd.
Ik ging een deel van mijn aanstelling bij de Hanzehogeschool besteden aan onderzoek bij de Wageningen Universiteit, weer terug bij mijn 'alma mater'.
En in de muziek ging ik van klassiek naar jazz; toen ECS-collega Thomas me vroeg om een keer te komen meedoen met 'The New Black & White Dance Orchestra' was ik meteen verkocht; heerlijke muziek waar ik elke keer weer vrolijk van word.

Nu, in 2016, heb ik het gevoel een lange reis te hebben gemaakt waarin ik veel nieuwe werelden heb leren kennen en met elkaar heb kunnen verbinden. In termen van de 'boundary crossing-theorie' ben ik een echte 'grensganger' geworden. Ik werkte en deed onderzoek in de praktijk en probeerde de onderzoeksresultaten te verantwoorden in de wereld van de wetenschap. Ik woonde in Epe en werkte in Wageningen en Groningen. Ik speelde in een klassiek strijkkwartet en zong in een jazz band. De reis is met de verdediging van het proefschrift niet afgelopen, want ik heb er heel veel plezier in gekregen om steeds weer nieuwe werelden te ontdekken, nieuwe mensen te ontmoeten en kennis en mensen met elkaar te verbinden.

Het was niet altijd een makkelijke reis. Soms schoot het niet op, werd een manuscript afgewezen door een tijdschrift of er was zoveel feedback dat ik voor mijn gevoel weer terug bij af was. Het gevoel van 'Phil' in de film Ground Hog Day, die steeds opnieuw dezelfde dag beleeft. Maar elke keer waren er toch weer verrassende nieuwe dingen die ik leerde doordat ik er weer opnieuw mee aan de slag ging. In de loop van de tijd wist ik steeds beter waar ik heen wilde, koos ik vaker de juiste paden om er te komen en kon ik ook sneller vooruit komen. Het was een lange reis, maar juist door er zoveel tijd aan te besteden ben ik op een plek gekomen waar ik heel graag wil zijn.

Dat was niet mogelijk geweest zonder de steun van heel veel mensen om me heen. Ik wil ze hierbij allemaal van harte bedanken.

Rianne Valkenburg: jij raadde me aan om promotieonderzoek te gaan doen. Zonder jou was ik nooit op dat idee gekomen en had ik ook niet gedacht dat ik het zou kunnen.

Frans Hoetink: jij was de visionair die de term 'leerwerkarrangement' al had bedacht lang voordat de tijd er in Groningen rijp voor was. Mede door jouw ideeën en visie hebben we bij 'Value in the Valley' een geweldige tijd gehad.

De collega's en studenten van Value in the Valley, de minor Da Vinci en de andere 'hybride leeromgevingen' bij de Hanzehogeschool waar ik bij betrokken ben geraakt: het was en is ontzettend inspirerend om met jullie samen nieuw onderwijs te ontwikkelen, uit te voeren en weer te verbeteren.

Collega's van de Hanzehogeschool en met name Marjan Groenhuis: jullie hebben het mogelijk gemaakt dat ik tijdens en naast mijn werk onderzoek kon doen. Het was niet alleen meewerken en faciliteren maar ook meeleven, een warm bad.

Mijn begeleiders in Wageningen Arjen Wals, Renate Wesselink en Martin Mulder: jullie hebben eindeloos veel versies van mijn artikelen gelezen en van feedback voorzien en jullie bleven erin geloven dat ik op dit onderzoek zou gaan promoveren. Heel erg bedankt daarvoor. Ook alle andere collega's bij ECS: bedankt voor het sparren, elkaar scherp houden maar ook voor de gezellige etentjes en gesprekken op de gang.

De ontwerponderzoekers van de Design Science Research Group: jullie waren mijn 'community of learners' waarin ik ontzettend veel geleerd heb over ontwerpgericht onderzoeken, maar waar ik ook mijn zorgen kon delen als deze manier van onderzoek doen weer eens lastiger bleek te zijn dan gedacht.

Voor het Engels was Philip Robichaud mijn steun en toeverlaat. Phil, ik heb genoten van jouw kritische redactiewerk en onze mailwisselingen daarover. Ik heb er veel van geleerd.

Alle vrienden die ik soms te weinig gezien heb de afgelopen jaren: bedankt voor jullie geduld en ik beloof jullie dat ik de schade ga inhalen!

Eric en Carla, ik ben heel blij dat jullie mijn paranimfen zijn.

Ik wil tot slot mijn lieve familie en schoonfamilie, Ma, Cobi en Karel bedanken.

Pap, mam, Eric, Jacqueline, Marthe, Daan en Martijn, bij jullie gaat het nooit om prestaties zoals promoveren, voor jullie ben ik gewoon Peet, jullie houden van me zoals ik ben en daar ben ik enorm dankbaar voor.

En ten slotte Freek: jij bent er altijd voor mij en je helpt me om met beide benen op de grond te blijven bij alles wat ik onderneem. Bij jou ben ik thuis, dank je wel daarvoor.

Contents

Chapter 1

Introduction

"Education needs to prepare students for jobs that do not yet exist, to use technologies that have not yet been invented, and to solve problems that we don't even know are problems yet" (Darling-Hammond et al. 2008)

In today's fast changing world, knowledge is considered the driving force for creating an economically and ecologically sustainable society. There is a demand for professionals who are able to create new knowledge across boundaries of disciplines, professions and perspectives. These so-called knowledge workers are lifelong learners who continually acquire and develop new knowledge. Universities and institutions for vocational education are all challenged to educate these knowledge workers.

In this chapter we present research that can be used to support institutions for higher and vocational education that aim to create learning environments for educating knowledge workers. In four studies we investigate the design and implementation of 'hybrid learning configurations' at the interface between school and workplace.

Two research questions are central to this thesis: "Which heuristics can underpin the design of a hybrid learning configuration?" and "In which ways can interprofessional teams be supported when designing hybrid learning configurations?"

HEALTH HUB RODEN

In Roden, a small town in the North of the Netherlands, a new type of business has taken its residence. Or perhaps it is not a business, as it seems more like a research institution. But it also has some characteristics of a university or school. This hybrid organization is called 'Health Hub Roden'. A large hall is the home of the 'Hub', which is staffed with students, lecturers, researchers, and representatives from health technology companies. They are all committed to finding innovative solutions to challenges in health care. For example, a university has discovered a way to produce dental implants with a 3D-printer. The challenge is how to proceed with the development? Questions are for instance: which material is most appropriate? Does it need a special coating? How to prevent infections? How can the implants be produced in large numbers? By which company? What are the implications for dental practices?

Working and learning are integrated at Health Hub Roden. When the participants are engaged in their projects, they learn while they are working. Moreover, they create new knowledge as they experiment and develop solutions to urgent and pressing challenges in health care. The students, who are regarded as the 'junior professionals', are offered coaching and instruction by more experienced 'senior' participants from business, research and education. This way the students develop personal and professional compentencies in a real-life situation that resembles the complex, multidisciplinary context of their future professions.

The participants in the Health Hub are inspired and enthusiastic about this new form of collaboration. However, they also encounter challenges such as: how do we organize the 'Hub'? Which roles and tasks should participants fulfil? What is a suitable financial or business model? How can we attune schedules and expectations of the different stakeholders to each other?

The Health Hub Roden is only one example of the hybrid coalitions between educational institutions and other parties such as companies and governmental institutions that are emerging increasingly in our knowledge-based society. These new practices are called 'hybrid' (Akkerman and Bakker 2011b) because they incorporate characteristics of each of the constituent practices. Learning and knowledge creation are central processes within these practices, therefore we refer to them as 'hybrid learning configurations' (HLC). With this thesis we intend to provide theoretical and practical support for interprofessional teams who design and implement HLCs.

In this chapter we will first elaborate on the type of professional that is needed in the knowledge society. This is followed by a general overview of relevant conceptions of learning. Next we will discuss possible learning environments for educating knowledge workers and focus on the hybrid learning configuration. We then present our research approach, educational design research (EDR), and we conclude this chapter with a statement of the main research questions and an overview of this thesis.

FUTURE PROFESSIONALS

Students of universities and institutions for vocational education today are expected to function in a knowledge-based society. Innovation is needed for creating economically and ecologically sustainable communities (Dumont and Istance 2010; Capra 2007). Innovation depends on the capacities of people, organizations and networks to create and utilize knowledge (Boreham and Lammont 2000).

Today's practitioners must function in societal structures and organizations that are constantly changing. Expertise is no longer manifested exclusively in performing known tasks in a particular setting. New challenges that often cannot be addressed by routine solutions are constantly arising. These challenges have to be addressed by experts from different fields collaborating across different contexts (Engeström, Engeström and Kärkkäinen 1995; Tynjälä 1999). Hence, there is a need for 'horizontal' expertise that requires practitioners to move across boundaries. Such 'knowledge workers' must be able to critically select, acquire and use knowledge, wherever this is available (Engeström et al. 1995; Konkola, Tuomi-Gröhn, Lambert and Lidvigsen 2007). In addition, the fast pace with which society changes requires knowledge workers to continually construct and reconstruct their expertise in a process of lifelong learning (Tynjälä 1999).

CONCEPTIONS OF LEARNING FOR KNOWLEDGE WORKERS

The demands on practitioners in the knowledge society have led to new requirements for higher and vocational education. In order to meet these requirements, it is necessary to rethink the objectives and the basic elements of learning environments, which includes learners, educators, content and resources (OECD 2013; Lakkala, Ilomäki, Paavola, Kosonen and Muukonen 2012). For instance, the set of learners might include non-students, the set of educators will not be limited to lecturers, learning content may not always be known beforehand, and resources or facilities will not always be school-based. Moreover, learning outcomes or assessment requirements will have to be more open and flexible, such that they allow students to go beyond the programme's requirements and to develop self-assessment abilities (Tan 2007).

In order to be able to design or redesign learning environments in higher and vocational education, we conceptualized learning in light of the abilities of the knowledge worker. As stated above, these abilities include not only the acquisition and utilization of knowledge, but also the co-creation of new knowledge across disciplines, professions and perspectives. Therefore, we consider three main metaphors of learning relevant for our studies.

As Sfard (1998) pointed out, the oldest metaphor of learning is that of acquisition. This metaphor is rooted in cognitive constructivism, in which individual learning of concepts is central. Learners are expected to actively construct and reconstruct knowledge in dialogue with others (De Kock, Sleegers and Voeten 2004; Engeström

1999). Two aspects of cognitive constructivism are believed to enhance learning: (a) a realistic context and tasks (authenticity) and (b), self-direction and ownership of learning (De Bruijn and Leeman 2010; Tynjälä, Häkkinen and Hämäläinen 2014). In light of this theory, knowledge can be applied or transferred to different tasks and contexts, or be shared with others.

A more recent perspective on learning is expressed by the participation metaphor (Sfard 1998). This metaphor is related to situated perspectives on learning, according to which knowledge is not only mentally structured but fundamentally bound to particular situations. Learning and knowing are processes of participation in communities of practice (Brown, Collins and Duguid 1989; Lave 1988). By participating in different contexts, learners are able to conceptualize their experiences and recontextualize and transform their knowledge (Tynjälä et al. 2014). Moreover, by participating in communities of authentic practice, learners acquire a professional identity (Lave and Wenger 1991; De Bruin and Leeman 2010).

Both the acquisition and participation metaphors provide valuable input for the design of learning environments for the knowledge worker. However, Paavola, Lipponen and Hakkarainen (2004) stress the need of a third metaphor, which can be related to the collaborative creation of new knowledge across the boundaries of disciplines, professions and perspectives. This 'knowledge creation metaphor' is considered especially relevant for educating knowledge workers, who are challenged to create new knowledge in order to solve ill-defined problems that are characterized by uncertainty and complexity (Wals, Lans and Kupper 2011).

Although the three metaphors might be considered controversial, they are not mutually exclusive. They actually complement each other with each one highlighting different elements of professional expertise that are needed in 21st century working contexts. As many authors argue, these elements of expertise, i.e. conceptual knowledge, practical or experiential knowledge and 'polycontextual skills' are interconnected (e.g. Tynjälä et al. 2014; Guile and Griffiths 2010). Therefore these three metaphors combined, or the 'trialogical approach to learning' (Paavola and Hakkarainen 2005) can inspire the design of HLCs in such a way that they educate the knowledge workers that are needed in our society.

LEARNING ENVIRONMENTS FOR KNOWLEDGE WORKERS

Institutions for higher and vocational education have applied several strategies for realizing learning environments for knowledge workers. A dominant strategy is competence based education (De Bruijn and Leeman 2010). The concept of competence integrates knowledge and skills in relation to practical contexts and can therefore guide curriculum development for comprehensive professional competence (Wesselink 2010). The curriculum is derived from an analysis of a prospective or actual role in modern

society and attempts to certify the student's progress on the basis of demonstrated performance in some or all aspects of that role (Mulder 2014).

According to Billett (2001) competence-based curricula should provide students ample opportunity to access and participate in social practice. Participation in real-life and working situations is realized by, for example, internships (practice-based), projects (school-based), or shared developmental project work through partnerships that connect school and workplace (Konkola et al. 2007). However, one of the greatest challenges in integrating real-life and workplace learning contexts into the curriculum is managing connectivity between school-based learning contexts and those outside school (Guile and Griffiths 2001; Tynjälä, Välimaa and Sarja 2003; Akkerman and Bakker 2011b).

Another challenge for higher education is that the third metaphor of learning, i.e. knowledge co-creation, is not yet strongly reflected in features of programmes of institutions for higher and vocational education. Such programmes are mostly monodisciplinary, and the role of stakeholders in professional practice is usually restricted to that of a client, rather than a co-creator of new knowledge. However, many institutions for higher and vocational education are seeking collaboration with companies, governmental institutions, research institutions and societal groups or organizations. By connecting education, research and professional practice, they aim to address complex problems in society by interprofessional, or 'horizontal' collaboration (Tuomi-Gröhn and Engeström 2003). Konkola et al. (2007) speak in this respect of 'boundary-zone activity' in which a team consisting of one or more teachers, students and practitioners develop work practices.

Increasingly, this collaboration is developing into hybrid learning configurations (HLCs) at the interface between institutions. In HLCs, different stakeholders co-create knowledge and learn in the process (Wals et al. 2011). HLCs are referred to alternatively as, for example, living labs, knowledge labs (Cremers 2013), regional learning environments (Oonk, Gulikers and Mulder 2013), or vital coalitions (Wals et al. 2011). They go beyond improving connectivity between organizations or practices; they actually become new practices themselves. In terms of activity theory (Engeström 2009) a new activity system develops at the interface between existing systems or practices.

HYBRID LEARNING CONFIGURATIONS

Wals et al. (2011) define a HLC as 'a social practice around ill-defined, authentic tasks or issues whose resolution requires transboundary learning by transcending disciplines, traditional structures and sectors, and forms of learning'. Thus HLCs provide opportunities for transboundary learning and knowledge co-creation in order to address complex real-life problems. Therefore, HLCs are considered promising environments for students (and other stakeholders) to acquire the skills of a knowledge worker (WRR 2014; Ministry of Education, Culture and Science 2015). In this study, the focus will be on HLCs that are

situated at the interface between school and workplace. At these HLCs working and learning are integrated as students work on assignments from or with clients or other stakeholders in the community (Huisman, De Bruin, Baartman, Zitter and Aalsma 2010; Zitter 2010; Zitter and Hoeve 2012).

Importantly, the term learning *configuration* is used here, rather than learning *environment*. The reason for this is that a learning environment can refer to an existing environment in which learning takes place, such as the school, workplace, sports fields, museums, etc. Furthermore, the term 'environment' encompasses the physical and technological infrastructure that is related to an education or training environment (e.g. Dumont and Istance 2010). In order to avoid confusion, the word configuration is used in order to indicate that an HLC is a carefully configured practice that includes the following: actors (i.e. students, lecturers, stakeholders in society); organizational structures; social relations and cultural aspects; physical and technological facilities; activities and approaches (i.e. working tasks, learning activities, and didactic or pedagogic approaches).

While many institutions for higher and vocational education are developing and experimenting with HLCs, this process is often one of trial and error. The HLCs often depend on highly motivated individuals (Ministry of Education, Culture and Science 2015). Practical expertise is becoming available, but only in an ad hoc and fragmented way. Although research on situated and social learning offers theories and concepts that are useful when designing an HLC, not much research has addressed the design of HLCs in a comprehensive way. The aim of this thesis is to address this lacuna in order to support the work of those involved in developing and implementing HLCs.

EDUCATIONAL DESIGN RESEARCH

An HLC can be considered a complex intervention in order to address a challenge in educational practice: how to support learners to become effective and efficient knowledge workers. Designing a novel, complex intervention is not a straightforward deduction of theory (Walker 2006). Innovative design is typically ill-defined and cannot be formulated at the drawing table alone (Van den Akker 1999). Therefore we take a design research perspective in this study. We are interested not only in the features or designed elements of such interventions, but also in the underlying principles or conjectures that are embodied in those features. These conjectures may contribute to a body of design knowledge that is useful to other practitioners outside the research setting (McKenney and Reeves 2012).

Educational design research (EDR) strives to address the dual goals of developing theoretical understanding that can be of use to others while at the same time designing and implementing interventions to solve problems in educational practice (McKenney and Reeves 2012; Sandoval 2014). Empirical investigation and intervention development are intertwined in EDR; theory informs design and vice versa (Brown 1992). Theoretical

knowledge is used to frame the research, and, alongside craft wisdom and creative inspiration, to shape the design of an intervention by way of heuristics or conjectures that are embodied in features of the design. Empirical testing is used to validate, refine or refute these conjectures and to improve the design (McKenney and Reeves 2012).

The design research approach described above is characterized by McKenney and Reeves (2012) as 'design research *on* interventions' since it focuses explicitly on characteristics of the intervention. Our research on HLCs is aimed at providing principles and guidelines for HLCs. As a contrast to research *on* interventions, McKenney and Reeves (2012) also discuss 'design research *through* interventions'. Within this orientation the intervention serves as the research context, providing a means for studying specific phenomena that are related to, but not the same as the intervention itself. Among these phenomena are the activities performed by the designers of an intervention.

HLCs are often designed and implemented by an interprofessional team that consists of, for instance, educational consultants, researchers, lecturers and other practitioners, reflecting the hybrid nature of the HCL (Zitter and Hoeve 2012). Research has shown that teachers generally have limited expertise as designers of educational interventions (Kirschner 2015). The same is most probably true for other practitioners, such as those from industry. These practitioners do bring other expertise, however. Lecturers provide valuable expertise from their own teaching practice. Other practitioners bring content knowledge and knowledge of workplace culture and organization. The team members face the challenge of implementing a complex educational intervention by bringing their different backgrounds and perspectives to bear in the collaboration.

Much educational design research focuses on curriculum design by individual teachers or teacher teams; far less research has been done on how to support interprofessional teams designing complex educational interventions. In this research we attempt to fill this gap through the design and development of different HLCs. Thus, the aim of this study is twofold. We intend to provide

1. principles and guidelines for designing hybrid learning configurations;
2. support for interprofessional HLC design teams.

We pursue these aims by studying six different case studies in the context of Dutch higher and vocational education. In the Netherlands, two kinds of educational institutions prepare students for particular professions: institutions for senior secondary vocational educational (which are called 'MBO' in Dutch) and universities of applied sciences ('HBO' in Dutch). Students can enter the MBO programme after four or five years of secondary education. They have access to universities of applied sciences after five or six years of secondary education or after having completed a MBO-programme. Traditional or research universities require completion of six years of secondary education (figure 1.1).

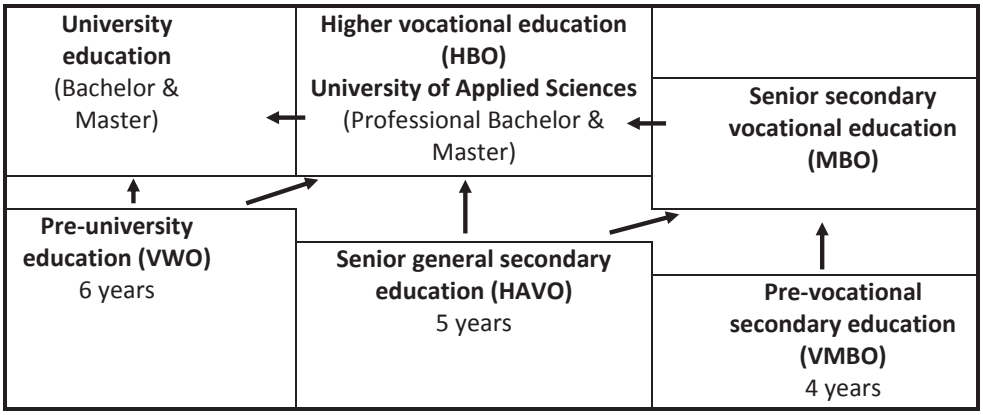

Figure 1.1 The Dutch educational system

In this research project one of the cases is a joint project of two Dutch MBO and two HBO-institutions in collaboration with two companies. The other cases are HLCs in different settings within the context of a university of applied sciences (HBO) in the Netherlands. In this thesis we refer to HBO and MBO as 'higher and vocational education'.

RESEARCH QUESTIONS AND OUTLINE OF THIS THESIS

The aims mentioned above lead to two general research questions:

1. *Which heuristics can underpin the design of a hybrid learning configuration?*
2. *In which ways can interprofessional teams be supported when designing hybrid learning configurations?*

As figure 1.2 indicates, the general research questions are addressed in four studies that are described in chapters 2 to 5.

Chapters 2 and 3 are both concerned with the first general research question. Chapter 2 focuses on the HLC as a whole. The central research question in this chapter is: *"Which set of design principles can underpin the design of a hybrid learning configuration for educating the knowledge worker?"* Based on a literature search and craft knowledge of the designers, a set of initial design principles was developed for an HLC. The intention was that four learning processes would be enabled by the HLC: self-directed learning, authentic learning, the development of a professional identity, and collaborative creation of knowledge across the boundaries of disciplines, professions and perspectives. These initial design principles were tested in three iterations, from the perspective of the participants (students, lecturers and other practitioners). This resulted in a set of seven refined principles underpinning the design of an HLC.

Chapter 3 elaborates further on the design principle 'facilitating reflexivity'. As knowledge workers have to constantly redefine and reconstruct their own expertise, they should be able to reflect on and pro-actively develop their professional competence

(Tynjälä 1999). This capacity for self-directed lifelong learning is an essential asset for them and should therefore be developed or enhanced in an HLC. In light of this, the main research question in this chapter is: *"Which design guidelines underpin an intervention that would foster self-directed lifelong learning while working on ill-structured, authentic professional tasks?"* This study yields five design guidelines and discusses examples of their manifestations in an HLC.

Chapters 4 and 5 concern the interprofessional team that designs and implements (iterations of) HLC. In chapter 4 the focus is on the creative utilization of the set of design principles generated in chapter 2 by HLC design teams outside the research setting. Research shows that while knowledge of design heuristics can increase the efficiency and effectiveness of design work, (teacher) design teams often have difficulty articulating the rationale for their design. In addition, it is important to facilitate ideation and nourish creative spirit while utilizing the intervention design heuristics (McKenney, Kali, Markauskaite and Voogt 2015).

To this end, the set of design principles has been 'reified' or embodied in a guidebook and conveyed through a workshop, inspired by boundary crossing theory and design thinking methods such as prototyping. Four design teams of different HLCs in the context of a university of applied sciences used the guidebook and attended the workshop while (re)designing an HLC. This spoke to the main research question in chapter 4: *"What is the perceived effectiveness of a boundary-crossing intervention (based on a set of research-based design principles) for (re)designing hybrid learning configurations?"*

Boundary crossing theory is also the starting point of chapter 5. Since an HLC-design team often consists of professionals from different organizations or practices, team members are likely to experience boundaries when they bring their different perspectives into the collaboration. Akkerman and Bakker (2011b) define boundaries as 'discontinuities in action or interaction'. These boundaries can hinder cooperation, but they can also provide opportunities for learning. In this study, an HLC design team's actions and interactions are analysed by applying concepts of boundary crossing theory. This analysis revealed three boundaries. In addition, different ways of boundary crossing and related learning processes became visible. This resulted in recommendations for enhancing cross-boundary learning in design teams of HLC. The corresponding research question in this chapter is: *"In which ways could a better understanding of boundaries enhance utilization of their learning potential?"*

Chapter 6 contains all study findings and frames the conclusions in a broader perspective. Next we discuss methods, the scope of the studies and directions for further research. The chapter concludes with implications for practice.

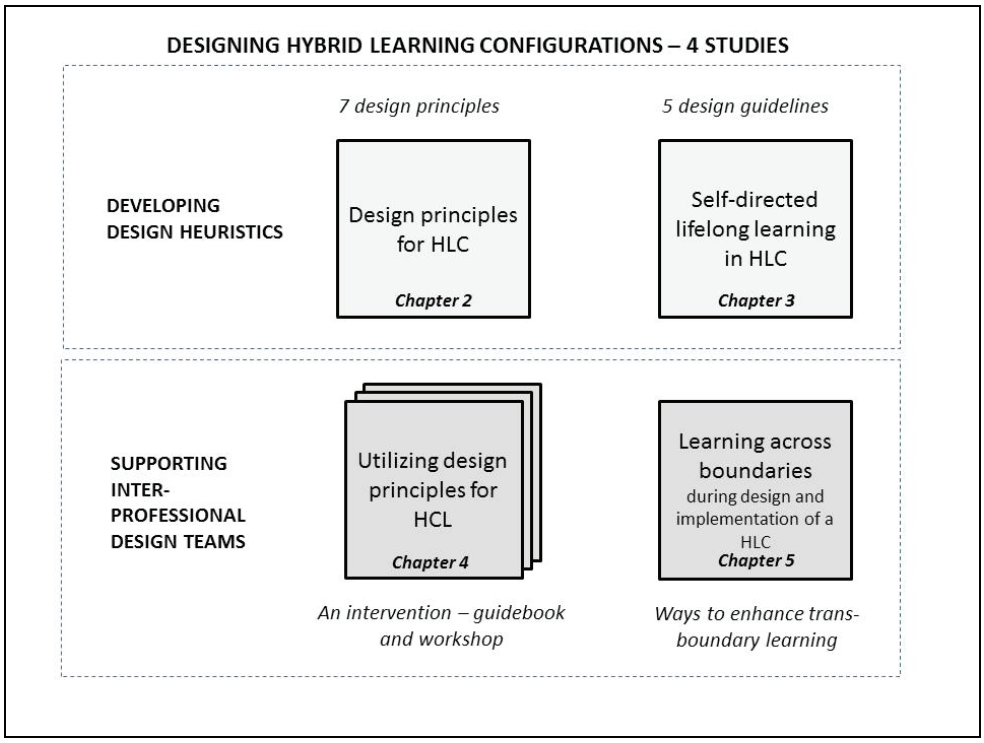

Figure 1.2 Overview of the research project

Chapter 2

Design principles for hybrid learning configurations[1]

In this chapter we identify a set of principles that can underpin the design of a hybrid learning configuration (HLC) at the interface between school and workplace.

The research approach consisted of educational design research (EDR). Starting from cognitive constructivist, socio-cultural and knowledge-creation perspectives a set of initial design principles for an HLC was developed. Next, these initial design principles were evaluated during three consecutive iterations of design and implementation of the HLC by way of interviews with students and staff of the HLC (lecturers, educational consultants and experts from industry).

The manifestations of each design principle were described in terms of features of the HLC and their effects on the participants. Finally, these features were related to the desired learning processes. This resulted in a set of seven refined design principles that can be used as heuristics to guide the design and development of HLCs in contexts that have similar goals and aligned tenets.

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1 This chapter is based on Cremers, P.H.M., Wals, A.E.J., Wesselink, R., & Mulder, M. (in-press). Design principles for hybrid learning configurations, *Learning Environments Research*

INTRODUCTION

As we explained in chapter 1, institutions for higher and vocational education are challenged to educate 'knowledge workers' (Kessels 2001) who are able to create knowledge collaboratively across boundaries of disciplines, professions and perspectives (Engeström 1999; Paavola et al. 2004). Accordingly, these institutions have developed competence-based study programmes that are intended to facilitate the development of comprehensive vocational competence. Many researchers claim that effective competence-based education should promote self-directed and authentic learning both within and beyond the workplace (e.g. De Bruijn and Leeman 2010; Wesselink, Dekker-Groen, Biemans and Mulder 2010). In addition, by participating in a working community students are given the opportunity to develop a professional identity (Billett and Sommerville 2004; De Bruijn and Leeman 2010).

Since some features of a working practice cannot be experienced or practiced exclusively in a school environment (Billett 2002), most programmes in vocational education offer students workplace experience, for instance by incorporating internships into their curriculum. Billet (2002) and Poortman (2007), however, claim that participation in a workplace setting has certain limitations and will not always facilitate effective learning. Moreover, learners often have difficulty integrating what they learned at school into their working practice (Guile and Griffiths 2001).

Educational institutions have addressed these limitations by improving connectivity between school and workplace (Tynjälä 2009). In this way they seek to bridge the gap between both theory and practice and on-campus and off campus learning. Examples of such 'cooperative education strategies' (Zegwaard and Coll 2012) are the connective model of work experience (Guile and Griffiths 2001) which provides a new curriculum framework that can take work in all its forms as the basis for the development of knowledge, skills and identity. Another example is the integrative pedagogy model (Tynjälä 2008) which connects conceptual theoretical, practical and self-regulative knowledge.

In this study we are interested in connecting school-based learning and work experience by interweaving learning and working processes in one setting, the hybrid learning configuration (HLC). In chapter 1 we defined an HLC as a social practice around ill-defined, authentic tasks or issues whose resolution requires transboundary learning by transcending disciplines, traditional structures and sectors, and forms of learning. We will focus on hybrid learning configurations that are situated at the interface between school and workplace in which working and learning are integrated as students work on assignments from clients or other stakeholders in the community (Huisman et al. 2010; Zitter 2010; Zitter and Hoeve 2012).

HLCs build on the concept of competence based education and have characteristics of 'context-based learning environments' (De Putter-Smits, Taconis and Jochems 2013), 'powerful learning environments' (De Bruijn and Leeman 2010), and 'authentic learning

environments' (Herrington and Oliver 2000) in the sense that they seek to promote self-directed and authentic learning and the development of a professional identity. Although there is a growing body of mostly conceptual literature emphasizing the importance of hybrid learning, there have not been many empirical studies on the design and implementation of such learning. In response, the goal of this study is to identify a set of principles that can underpin the design of hybrid learning configurations.

An educational design project called 'Value in the Valley' provided the context for this study. In this project a learning environment was developed that had the characteristics of an HLC as students were tasked with solving ill-defined problems related to sustainability issues for clients in the community. The HCL was a collaborative project of four different educational institutions and two companies and was thereby situated at the interface between school and workplace.

In the next section we describe this project in detail. In the following sections we explain the educational design research approach that was adopted and address the main research stages. Finally, we discuss conclusions drawn from the research.

RESEARCH CONTEXT: VALUE IN THE VALLEY

The educational design project 'Value in the Valley' was initiated by two Dutch institutions for senior secondary vocational educational (MBO) and two universities of applied sciences (HBO) in collaboration with two companies. The project aimed to address an increasing demand from industry and business for professionals who are able to contribute to sustainability-driven multidisciplinary and multi-sector innovations. The somewhat vague 'sustainability-driven' here refers to innovations seeking to develop business models, processes and products that are more capable in balancing ecological, environmental, ethical and socio-economic interests than those they seek to modify or replace.

Conventional study programmes (at MBO and HBO levels) are typically not aimed at educating this kind of knowledge worker, being dominantly monodisciplinary in nature. Questions to be addressed in the project were: "How should a learning configuration be designed and implemented so that it contributes effectively and efficiently to the development of capable and innovative professionals?" and "How can this configuration (or parts of it) be implemented in other educational institutions or other organizations?" (Antonides and Hoetink 2005).

In order to answer the first question a hybrid learning configuration was designed, implemented and evaluated in six iterations of one semester each. The learning configuration represented an authentic working context in the sense that it functioned as a consultancy firm in which assignments were carried out for companies and governmental institutions in the region. It was located at a business park. Students from the participating schools were the junior employees. The faculty, who were lecturers and educational consultants from the participating educational institutions and employees

from the participating companies, acted as the senior employees. They coached, instructed and guided the students while they worked on the assignments. Most of the faculty worked part time at the Value in the Valley project and spent the rest of their time at their own educational institution or their company.

The students were enrolled in several different study programmes, mostly from the technical and 'green' (e.g. agricultural, environmental, land use planning) sectors in MBO and HBO. The number of students varied in each iteration and ranged from 15 to 35. The students worked in multidisciplinary and 'multi-level' (MBO and HBO) teams on real-life assignments that involved issues of sustainability. For example, in the 'Sustainable village' assignment, students developed a step-by-step strategy for villages to become a sustainable community, and in the 'Rain in Groningen' assignment, the city council asked students to generate ideas for the temporary storage of excessive rain that is predicted in local climate change scenarios.

Students spent one semester at Value in the Valley, and the programme replaced a part of their regular curriculum (e.g. an internship or regular course). The faculty performed formative assessments at regular times during the semester. The summative assessment and assignment of study credits were conducted by lecturers within the students' own study programme.

EDUCATIONAL DESIGN RESEARCH

The research approach chosen for this study was educational design research (EDR). Design research is especially useful when existing knowledge about a certain phenomenon is wanting as is often the case with innovative curriculum improvement initiatives (McKenney and Reeves 2012). The research project started from a problem in educational practice. This problem was analysed and a tentative solution was designed that combined existing theory, practical knowledge and experience (craft wisdom), and creative inspiration (McKenney and Reeves 2012). This solution was implemented in practice and evaluated in three iterations.

The theoretical output of this study takes the form of an empirically tested set of design principles or heuristics that can be used to guide endeavours that have similar goals and aligned tenets (McKenney and Reeves 2012). Sandoval (2014) refers to design principles as 'high-level conjectures' which are reified in features of the learning environment design. Design principles may be theory-driven or constructed inductively from empirical findings (Lakkala et al. 2012).

Design research may be characterized as interventionist, iterative, process oriented, utility oriented, and theory oriented (Van den Akker, Gravemeijer, McKenney and Nieveen 2006). It is not aimed at measuring isolated variables but at capturing integral and meaningful phenomena in a naturalistic setting. In this study only one manifestation of a certain phenomenon, namely an HLC, was studied. Therefore, it will contribute theoretical understanding that is closely tied to the problem at hand, thereby yielding

'local theory' (McKenney and Reeves 2012). Consequently, this study does not strive for context-free generalizations: "Design principles are not intended as recipes for success, but to help others select and apply the most appropriate substantive and procedural knowledge for specific design and development tasks in their own settings" (McKenney, Nieveen and Van den Akker 2006, p. 73).

In order to describe the EDR approach used in this study, a model was created (see figure 2.1) that combines relevant features of existing models by Andriessen (2007), Wals and Alblas (1997) and McKenney and Reeves (2012). Following Wals and Alblas (1997) and Andriessen (2007), a distinction is made between a 'theory' or 'knowledge stream' and a 'practice stream'. The stage of 'Analysis and Exploration' was based on the model by McKenney and Reeves (2012), as well as the distinction made between 'Design' and 'Construction' and between 'Evaluation' and 'Reflection'.

Four main stages can be discerned in the model. They were carried out as follows:

I. *Diagnosing and agenda setting*: the problem in practice that was derived from the project plan was translated into the research question.

II. *Analysis and exploration*: researcher and practitioners collaboratively developed a conceptual framework that underpinned the design of the learning configuration. Craft knowledge from experienced practitioners was elicited and a literature search was conducted. This resulted in a set of initial design principles.

III. *Design, implementation and evaluation*: for this study three iterations of the learning configuration were evaluated in order to explore how, from the perspective of the participants, the initial design principles manifested themselves in practice. Design principles become more useful for designers when they are connected with features that exemplify how the principles can be applied in different contexts (Kali 2006). Therefore the manifestation of each design principle was described in terms of these features and their effects on the participants. This resulted in a set of refined design principles.

IV. *Developing knowledge*: the research question was answered by drawing conclusions from the manifestations of the refined design principles, thus linking their enactment to the desired learning processes.

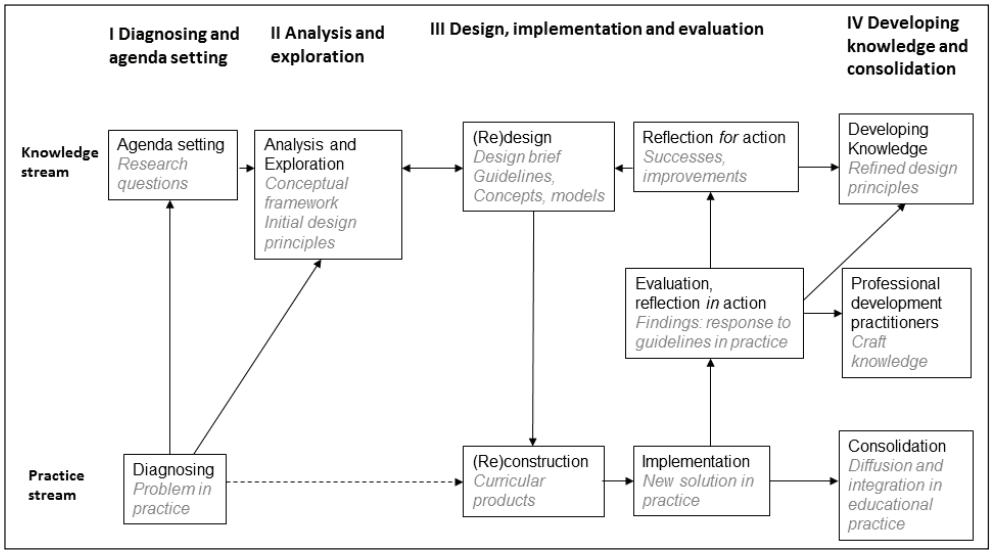

Figure 2.1 Model for Educational Design Research based on Andriessen (2007), McKenney and Reeves (2012), and Wals and Alblas (1997)

What follows is a detailed description of all four stages of this research approach.

STAGE I: DIAGNOSING AND AGENDA SETTING

According to the project plan (Antonides and Hoetink 2005), the objectives of Value in the Valley were of a very practical nature (reflecting the *practice stream*; see figure 2.1):

- an effective and efficient learning configuration that educates innovative, sustainability professionals (see also Wierenga, Cremers, Hekman and Buikema 2010);
- professional development of the participating faculty;
- design briefs, concepts, models, tools and instruments to be used for implementation in other contexts.

Based on this last objective the project team and the researcher chose to develop a set of theory- and practice-based design principles for the HLC and formulated the **central research question** in the *knowledge stream* (figure 2.1): *"Which set of principles can underpin the design of a hybrid learning configuration for educating the knowledge worker?"*

A further operationalization of the 'HLC for the knowledge worker' can be expressed by taking into account the learning processes it is intended to trigger. As described in the introduction, the HLC seeks to enable *self-directed learning, authentic learning* and *the development of a professional identity*. In addition, it is aimed at educating knowledge workers, who *create new knowledge collaboratively across the boundaries of disciplines, professions and perspectives*.

STAGE II: ANALYSIS AND EXPLORATION

The objective of this stage was to develop a set of initial design principles. First we introduce the method used to develop these principles. Next we present the conceptual framework underlying the design, which can be viewed as the 'epistemology of the designers' or the designers' perspective on learning (Kali, Levin-Peled and Dori 2009). This stage is concluded by describing how the design principles were derived from this framework, which links them to the key concept(s) they represent. In table 2.1 we provide a full description of the initial design principles.

Method

The initial design principles were developed collaboratively by the researcher and the Value in the Valley faculty which consisted of lecturers, educational consultants and business representatives. Because of this collaborative approach, we were able to draw on expertise and knowledge from both an educational and a business perspective (Könings, Brand-Gruwel and Van Merriënboer 2007).

The method used to arrive at a set of initial design principles consisted of the construction of a conceptual framework from which the principles could be derived. This was done by eliciting craft knowledge from experienced practitioners and by a literature search. Because the HLC aimed to interweave working and learning processes, literature on work-based learning and educational theory was studied. This was combined with and validated by personal experiences and observations in educational and working practice by the Value in the Valley faculty. External educational experts were also consulted, and two educational researchers who were not involved in the project were asked to comment on the initial design principles. Their questioning of the exact meaning of each principle led to a more detailed and focused description of the principles. This description was confirmed and approved of by Value in the Valley faculty. By the end of iteration 3 of the HLC a set of nine initial design principles had emerged.

Internal validity or a high 'truth value' (Guba 1981) was to be ensured by reaching consensus among the Value in the Valley faculty about the set of initial principles. External validity was enhanced by consulting external experts (e.g. from educational consultancy firms) during the development of the initial design principles and by involving external educational researchers.

Conceptual framework

One central function of the conceptual framework was to underpin the integration of learning and working activities. In order to do justice to each of the worlds of education and work, both cognitive constructivist and socio-cultural perspectives on learning were taken. The cognitive constructivist point of view emphasizes the active role of the student and the integration of theoretical and practical knowledge (Bromme and

Tillema 1995; Tynjälä 1999). From the point of view of socio-cultural and situated learning theories, it is important that education involves students in authentic practices and social interaction (Brown et al. 1989; Lave and Wenger 1991).

As we indicated in chapter 1, Sfard (1998) introduced two metaphors of learning that relate to these points of view. The acquisition metaphor refers to an individual's cognitive knowledge construction, and the participation metaphor refers to the socio-cultural view of learning. Both metaphors are helpful in coming to understand and support learning processes, and they may be seen as complementary (Billett 1996; Sfard 1998). Thus, Sfard's metaphors constitute a promising framework in which to develop expertise in the interface of education and work (Tynjälä et al. 2003).

This framework has been further developed by Illeris (2002). His model integrates the two learning metaphors as the processes of acquisition and interaction that take place within the following three dimensions of learning: content, incentive and environment. The content dimension concerns what is learned and how meaning is given. The incentive dimension involves motivation, emotion and volition. The environment dimension (which is also called the 'interaction dimension') is characterized by action, communication and cooperation within relevant social contexts and communities. These three dimensions "...must always be considered if an analysis or an understanding of a learning situation is to be adequate" (Illeris 2002, p. 25).

A third metaphor of learning was introduced more recently by Paavola et al. (2004), that can be related to the co-creation of new knowledge collaboratively, across the boundaries of different perspectives: the knowledge-creation metaphor. This metaphor provides yet another relevant perspective on learning that can inspire the design of learning environments for the knowledge worker, who not only acquires and applies knowledge, but also creates new knowledge.

Hence, the acquisition, participation and knowledge-creation metaphors (Sfard, 1998; Paavola et al. 2004) and the three dimensions of learning - cognition, incentive and environment (Illeris 2002) - were the starting point for the development of the initial design principles in this study.

Design framework

The design framework was developed via further elaboration on the conceptual framework. This resulted in the set of nine initial design principles summarized in Table 2.1.

Within the participation metaphor, the concepts of 'situated learning' (Lave and Wenger 1991) and 'situated cognition' (Brown et al. 1989) refer to the importance of an authentic context for learning. Many researchers emphasize the importance of engagement in authentic practice in vocational education programmes in order to develop the students' occupational capacities (e.g. Billett 2011). Hence the first design principle is '*fostering authenticity*'.

The participation metaphor is also reflected in the concepts of the knowledge-building community and the community of learners (Brown and Campione 1996; Rogoff, Matusov and White 1996; Scardamalia and Bereiter 1993). Lave and Wenger (1991) suggest that learning through work experience often occurs by participating in a 'community of practice' in which individuals learn through contact with more experienced others. Within a community of learners both experienced and less experienced participants have active roles, and learning becomes a shared endeavour. According to Rogoff, Matusov and White, (1996) participants in such a learning community appear to take responsibility both for managing their own learning and for supporting and leading others. Hence the second principle: *'creating a learning community'*.

Learning from participation in a workplace setting depends both on the extent to which opportunities for participation (i.e. affordance) are provided and on the extent to which individuals choose to utilize these opportunities (i.e. agency) (Billett 2004). Eteläpelto, Vähäsanten, Hökkä and Paloniemi (2013) argue that both active participation and agency at work are prerequisites for workers to become creative life-long learners who actively develop work practices with colleagues. Billet (2011) uses the term 'agentic learners' in this respect. Therefore students should develop a sense of responsibility for themselves and their environment as they gradually take more ownership. This was captured in the third principle: *'increasing ownership'*.

From the perspective of the knowledge-creation metaphor of learning (Paavola et al. 2004), the ability of the knowledge worker to solve problems in an interdisciplinary context should also be reflected in the learning configuration. Gibbons, Limoges and Nowotny (1997) refer to this as 'Mode 2 knowledge production', which is context-driven, problem-focused and interdisciplinary. Guile and Griffiths (2001) argue that workers are increasingly expected to be competent 'boundary crossers'. Walker and Nocon (2007, p. 181) describe 'boundary-crossing competence' as the "ability to manage and integrate multiple, divergent discourses and practices across social boundaries." According to Akkerman and Bakker (2011b) boundary crossing requires not only the ability to understand and learn from each other's perspectives, but also the capability to effectively transform practices and perspectives. This transformation involves a creative process of building new knowledge, referred to by Sawyer (2004) as 'collaborative emergence'. The importance of making optimal use of different practices and perspectives was expressed in the fourth design principle: '*utilizing diversity'*.

According to Kessels (2001), an authentic working environment for knowledge workers should enhance and support learning processes. Along these lines, Tynjälä (2008) proposes that learning environments should be created in which conceptual, practical and self-regulative knowledge are present and become interconnected. However, as Griffiths and Guile (2003) argue, learners should be assisted in the process of connecting knowledge, skills and experience. Billett (2002, p. 29) confirms this by suggesting that "the use of intentional guided learning strategies has demonstrated a

capacity to augment the contributions of everyday experiences by making accessible and developing understanding and procedures that are unlikely to be learned alone". The corresponding fifth principle is *'inter-linking of working and learning"*.

A relevant theory within the cognitive dimension of learning (Illeris 2002) is the concept of learning by both participating in authentic activities and reflecting on them. This is captured in Kolb's reflective cycle (Kolb 1984) and Schön's notion of the 'reflective practitioner' (Schön 1987). In more recent models for improving connectivity between school-based and work-based learning reflection is linked to the integration of practical and theoretical knowledge (e.g. Tynjälä 2008, Guile and Griffiths 2001). Given the situated nature of work-based learning, learners should be supported in the process of analysing their own experiences and arriving at a critical understanding of their reality (Guile and Griffiths 2001). On the basis of these notions, the sixth principle was formulated as '*facilitating reflection'*.

The incentive dimension of learning (Illeris 2002) can be related to Damasio's research into the role of emotions in social cognition and decision-making (Damasio 1994). It can be assumed that positive emotions foster self-regulation (Pekrun and Linnenbrink-Garcia 2012) and enhance the development of a vocational identity by the learner (Meijers and Wardekker 2001). Strauser, Lustig and Çiftçi (2008) found a positive effect of psychological well-being on the development of a vocational identity which they described as the process through which individuals become aware of their career interests, goals, skills and talents. This supports the notion that the individual talents, interests and motivations of each student are important for their professional development and would have to be addressed explicitly within the learning configuration. This notion was expressed in the seventh principle: '*enhancing individual talents*'.

The eighth principle relates to assessment considered as an important part of the learning process. Many researchers state that assessment methods should support and enhance students' learning (Gibbs and Simpson 2004; Tynjälä et al. 2003). They argue that students should receive formative assessments at regular times during the learning period, instead of receiving only a summative assessment at the end of the learning period. Van Merriënboer and Sluijsmans (2009) propose that regular provision of feedback and 'feed forward', or reflection and 'preflection' can enhance self-directed learning. Boud (2007, p. 21) claims that assessment should be focused on "monitoring one's own performance, to see one's own learning in the context in which it is deployed and to respond with awareness of the exigencies of the tasks in which one is engaged". This idea was captured in the eighth principle: '*assessing for learning*' (this term was inspired by Mentkowski et al. (2000)).

A final, more overarching principle emerged after considering the other eight. In order for all of the other principles to apply, the learning configuration must have an organizational structure that supports the inter-linked working and learning processes. Concepts of the learning organization (Senge 1990) or the 'hybrid organization'

(Nonaka and Takeuchi 1995) inspired the ninth design principle, which is called '*enabling organization*'.

Initial design principles

In table 2.1 the initial design principles are described and examples of their manifestations in practice are given.

Table 2.1 Initial design principles, descriptions and manifestations

Design principle – key concept	Design principle – Description	Examples of manifestations within the learning configuration	Conceptual grounding
1. Fostering authenticity	Participants work and learn in an environment (context, tasks, activities, roles and communication) that reflects working practice, a professional working culture and organization.	Working for real clients from industry and other organizations. Students, educators, consultants and experts from working practice are seen as employees and relate to each other as (junior and senior) colleagues.	Billett (2011); Brown et al. (1989); Lave and Wenger (1991).
2. Creating a learning community	Community: every member should experience a sense of belonging to the community. Learner equity: every member of the community is a learner, each at their own level.	A culture of respect, equality and curiosity that stimulates learning is fostered. Learning trajectories for junior and senior participants are similar and run parallel. Members participate in communities that include experts and professionals.	Brown and Campione (1996); Illeris (2002); Lave and Wenger (1991); Rogoff et al. (1996); Scardamalia and Bereiter (1993).
3. Increasing ownership	Participants are increasingly responsible for their own learning, functioning, personal well-being and give-and-take. Reciprocity in information exchange and effort obtains.	Learners work on assignments of increasing complexity. Senior and junior participants share the responsibility for the physical and social working environment.	Billett (2004, 2011); Eteläpelto et al. (2013).
4. Utilizing diversity	Diversity is built-in, valued and utilized both at team and organizational levels and in internal and external networks.	Multidisciplinary teams collaborate with peers and are informed by internal and external experts. Senior participants from different companies, study programmes and educational levels collaborate in the design, implementation and evaluation of the learning configuration. Assignments from clients require an interdisciplinary approach that matches the disciplines of the team members.	Akkerman and Bakker (2011b); Gibbons et al. (1997); Guile and Griffiths (2001); Sawyer (2004); Walker and Nocon (2007); Paavola et al. (2004).

Design principle – key concept	Design principle – Description	Examples of manifestations within the learning configuration	Conceptual grounding
5. Inter-linking of working and learning	Participants learn by performing real tasks from practice. They are supported by educational interventions that are attuned to the task and to the individual learner, inter-linking working and learning.	Assignments are authentic, in most cases ill-structured and non-routine. Supportive information is to-the-point and timely. Coaching is provided at critical times, to groups or individuals.	Billett (2002); Griffiths and Guile (2003); Kessels (2001); Tynjälä (2008).
6. Facilitating reflection	Participants learn by reflection on tasks and experiences as a person, as a team and as an organization. Critical events in the working activities are the starting point for reflection and learning.	Development of reflective skills is facilitated. 'Lessons learned' are formulated at critical times. Peer feedback and/or group counselling sessions are facilitated.	Guile and Griffiths (2001); Illeris (2002); Kolb (1984); Schön (1987); Tynjälä (2008).
7. Enhancing individual talents	Explicit attention is given to participants' personality, characteristics, interests, motivation and talents. The development of a professional identity is a goal.	Assignments align with personal interest and the learners' motivation. Participants' characteristics and personality are made explicit.	Damasio (1994); Illeris (2002); Meijers and Wardekker (2001); Pekrun and Linnenbrink-Garcia (2012); Strauser, Lustig and Çiftçy (2008).
8. Assessing for learning	Feedback and formative assessment of individual personal and professional development are provided at regular times during the learning period.	Learning goals and learning results emerge from reflection on experiences and comparing oneself to the professional profile of an expert. Regular individual coaching on the progression of learning is offered.	Boud (2007); Gibbs and Simpson (2004); Mentkowski et al. (2000); Tynjälä et al. (2003); Van Merriënboer and Sluijsmans (2009).
9. Enabling organization	The organizational structure and culture supports the working process, knowledge creation and sharing at every level (individual, team, organisation, society).	Junior and senior participants share the physical working space. Knowledge products are saved, documented and utilized in further projects or activities. Activities and procedures allow for sharing of knowledge and experiences.	Nonaka and Takeuchi (1995); Senge (1990).

STAGE III: DESIGN, IMPLEMENTATION AND EVALUATION

The goal of this stage was to test both the pragmatic justification for the design principles and the completeness of the set of principles (McKenney and Reeves 2012). In line with Van den Akker's (2003) categorization of curricula, the design principles and the corresponding design of the learning configuration can be seen as the *intended curriculum,* which is understood as the vision or basic philosophy underlying a curriculum. When evaluating the principles in practice, we can only work with the *implemented curriculum* - the way the curriculum is actually used in practice - and the *attained curriculum*, which is the curriculum as perceived or experienced by the participants.

Therefore we took the perspective of the participants and explored the questions of how and to what extent the initial design principles manifested themselves in practice. In addition, we were interested in effects of these manifestations on the participants and conditions under which these effects appeared. We also looked for possible new design principles that were perceived but not made explicit in the design framework. This resulted in a set of refined design principles.

In summary, the relevant questions in this stage were:

- How and to what extent do the design principles manifest themselves in practice, as perceived by the participants of the learning configuration (students and faculty)?
- What are perceived features of the design principles, which effects of these features are reported and which conditions are mentioned under which these effects appeared?
- To what extent do new principles emerge?

Data were collected from iterations 4, 5 and 6 during this stage.

Method

As we were interested in participants' experiences we chose a qualitative research method. Semi-structured interviews with students and staff were carried out in iterations 4, 5 and 6. The interviews were aimed at eliciting the experience of the participants, or the '*attained curriculum'*. In order to avoid any bias towards the *'implemented curriculum'*, the design principles and features that were explicitly implemented by the designers were not presented to the interviewees. This gave the interviews a very open character.

In the fourth iteration four students (out of 22) and five faculty (out of 12) were interviewed about how they experienced participating in the learning configuration and what they had learned. In iteration 5, four students (of 17) were interviewed in a similar way. The duration of the interviews was between 45 minutes and an hour. At the end of iteration 6, nine students (out of 10) were interviewed as a group, because student interaction might result in increased elaboration and discussion (Frey and Fontana 1991). Topics included: differences between this learning configuration and 'school', different ways of teaching and learning, the physical setting, and what was gained by

participating in the HLC. Two researchers, one of which was external to the HLC, carried out this interview. The duration was approximately two hours including a short break.

All eleven faculty members were interviewed individually. They were expected (based on observations by the researcher) to speak more freely in an individual interview setting than in a group setting. They were asked to prepare for the interview by creating an image of the learning environment with themselves in it. This was the starting point for the interview. The focus was on how participants experienced working within this learning configuration and what they considered its strengths and weaknesses. At the end of these interviews, the faculty were asked to reflect on the nine initial design principles. The duration of these interviews varied from one hour to 90 minutes.

In order to maximize the range of information uncovered, interviewees were selected that represented the diversity of the group (Guba 1981). Students interviewed in iterations 4 and 5 came from both educational levels (MBO and HBO) and from both technical and agricultural study programmes. Business and education faculty were represented in iteration 4. Among the four interviewed lecturers were representatives from both MBO and HBO levels and both technical and agricultural study programmes.

In iteration 6, all students (save for one) and faculty were interviewed. This way all participants, faculty as well as students, were given a voice, from their own perspective. (Brooker and Macdonald 1999). The educational consultants, project manager and secretary were also interviewed. Table 2.2 provides an overview of the interviewees in iterations 4-6.

Table 2.2 Interviewees per iteration

Iteration	Interviewees	Characteristics
4	4 students (individual)	Students represented 4 different fields of study and two education levels (MBO and HBO)
	5 faculty (individual)	Faculty representing business (1) and education (4; 3 fields of study and two educational levels)
5	4 students (individual)	Students represented 4 different fields of study and two education levels (MBO and HBO)
6	9 students (group)	All students (save for one) were interviewed
	11 faculty (individual)	Every faculty member was interviewed

Data were analysed in three steps, as is shown in the overview of methods used in the four stages of EDR (figure 2.1). First, all the interviews were recorded and transcribed. Second, the interviews were all coded according to the initial design principles (concept-driven coding (Gibbs 2007)). Possible new principles were coded *in vivo* (open coding (Gibbs 2007)). At the same time (within the codes for each principle) the various manifestations of a principle were coded as a *feature* of that principle via the method of constant comparison (Gibbs 2007). For instance, a feature of the principle 'fostering authenticity' appeared to be: 'being seen as a company (and not as a school) by the

outside world'. If participants mentioned an effect of the feature or a condition under which this effect appeared, this was coded as well. This resulted in lists of quotes for each distinct feature of the design principles.

Third, we determined for each feature its effects, and conditions (as far as the data showed). Similar quotes were summarized into one description in order to reduce data. For instance, for the principle 'utilizing diversity', a feature was summarized as: 'explaining to others'. This was a summary of six similar quotes from students that concerned the need to explain their knowledge to others in their team, such as: "You have to make sure the whole group knows what it is about"; "I have to explain my expertise step by step"; "I could teach the others about building construction", and so on. Respondents sometimes mentioned an effect, such as "If you explain it, you understand it better yourself". The following condition was mentioned: "... because we knew well that everyone had to input their knowledge into the project".

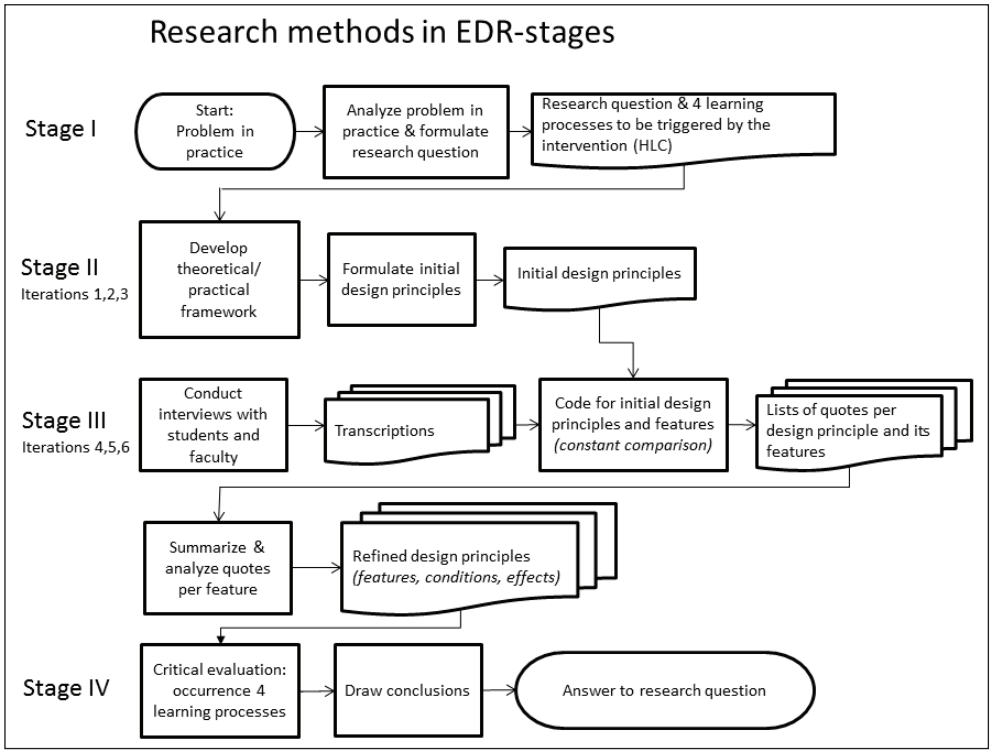

Figure 2.2 Overview of methods used in EDR stages

Several measures were taken in order to increase the trustworthiness of this study. The coding process was documented in ATLAS-ti. Memos were created for any decisions and dilemmas encountered during coding. A code book and research log was also created. The coding process and the analysis and summary of features were reviewed by another

researcher who was not involved in this research. This rigor in coding and the check by a peer researcher (intersubjectivity) should diminish the likelihood of researcher bias and enhance transparency or 'trackability' (Gravemeijer and Cobb 2006).

In order to paint as truthful a picture as possible (ecological validity), every participant's perspective was included in the data (Brooker and Macdonald 1999). In addition, every distinguished feature was included in the findings regardless of the number of respondents who brought it up. This was done because, in the words of Eisner (1991, p. 103): "... [e]very particular is also a sample of a larger class. In this sense, what has been learned about a particular can have relevance for the class to which it belongs. The theme embedded in the particular situation, extends beyond the situation itself". In a similar vein, Wals (1994, pp 231-232) says: "Hence, what one learns about one student's or a small group of students' thinking [...] can raise one's consciousness of features that might be found among other students". Thus, the data are not a general consensus among participants but rather a collection of experiences.

The researcher was part of the learning configuration's project team. An advantage of being involved in the practice that is being researched is that the researcher can develop an understanding of and familiarity with the participants, their language and culture (Herr and Anderson 2005). Being familiar to the interviewees, however, could also diminish the validity of the interview data. Having participated in the learning configuration's design and implementation, it is possible for the researcher and the faculty to become biased in a positive way toward the learning configuration (Herr and Anderson 2005).

The researcher attempted to avoid this bias by asking open, non-suggestive questions in the interviews (Rubin and Rubin 2006), by always trying to focus on both negative and positive experiences of the participants, and by reflecting from time to time on what was being said. This 'learning attitude' of the researcher should allow room for the educators' agency, which would undo or at least combat researcher bias (Savin-Baden and Howell Major 2010). Quotes from three of the interviewees indicated such agency in the sense that they obtained new insights by reflecting on the learning configuration during the interview. In addition, the raw interview data were anonymized and treated confidentially. The fact that the researcher was not involved in assessing the students' learning outcomes probably enabled students to be honest and feel free to speak their mind.

FINDINGS

In this section we will present the key findings. First, we describe the extent to which the design principles could be recognized in quotes by the students and faculty in the learning configuration. Next, we present the refined design principles as a set of tables that represent the features themselves, their effects and conditions. Last, we discuss new design principles and features that seem to emerge from the data.

Design principles in practice

The participants' quotes related to features of all nine design principles, though certain principles appeared more frequently than others. 'Creating a learning community' (19% of 596 total quotes), 'inter-linking working and learning' (19%) and 'fostering authenticity' (18%) appeared most often in the interviews, followed by 'utilizing diversity' and 'enabling organization' (each 14%). 'Assessing for learning' (7%), 'facilitating reflection' (5%), 'increasing ownership' (3%) and 'enhancing individual talents' (1%) were less prominent. Comments on 'enabling organization' were mentioned almost exclusively by faculty.

Design principles refined

During the coding process it became clear that the principles 'facilitating reflection', 'enhancing individual talents' and 'assessing for learning' seemed to overlap. Their features and the relevant quotes all seemed to relate to one another and to each of the three principles. After reconsidering the theoretical underpinnings of these initial design principles (Stage II, analysis and exploration) and the empirical findings we came to the conclusion that the common denominator in the three principles was the concept of reflexivity. Reflexivity, as Thompson and Pascal (2012) argue, is premised on self-analysis, which they view as a key factor in critically reflective practice. In light of this we merged these three principles into the new principle '*facilitating reflexivity*'. All quotes related to the new principle were pasted into one document and re-coded.

Almost all quotes relating to the design principle 'increasing ownership' referred to the culture of the learning configuration, fostering an increasing sense of responsibility or ownership in the students. Following Billett (2011) we concluded that learners who are participating in a community of professional workers need to be (or become) pro-active and agentic learners. Therefore 'increasing ownership' was regarded as a feature of the design principle 'creating a learning community'. The effect of these consolidations was a reduction from nine design principles to six.

The features of the six remaining design principles are presented in tables 2.3 to 2.8, one table per principle. The features of each principle are presented in a random order. Relationships between features and differences in importance are not indicated or suggested. For each feature, the effects on the participants (students (S) and/or faculty (F)) and the conditions under which the effects appeared (if apparent in the data) are indicated. Where it was obvious that the respondents did not agree with each other, this is indicated by: '*no consensus*'. If the participants mentioned that a certain feature needed improvement, this is indicated as well.

Table 2.3 Fostering authenticity. Features, effects and conditions mentioned by student (S) and faculty (F)

FOSTERING AUTHENTICITY		
Features	**Effects**	**Conditions**
Authentic assignment	Challenging, motivating (S)	Actively interested clients
Professional culture	Professional behaviour (S)	Respecting and living up to rules and values *(should be improved)*
Being seen as a company	Easy access to external experts (S) and (potential) clients (F)	-
Senior participants from education and business	Feedback from both enhances quality of work by students (F)	Balanced participation from education and business
Location in business environment	Professional behaviour, appreciation (S); taken seriously by external relations (F)	Finances for the rent
Seniors and juniors as colleagues	Taking each other more seriously (S,F)	-
Integrated school/work culture	Feels like a company (S,F); feels like school (S,F) – *no consensus*	-

Table 2.4 Creating a learning community. Features, effects and conditions mentioned by students (S) and faculty (F)

CREATING A LEARNING COMMUNITY		
Features	**Effects**	**Conditions**
Learning from and with each other	Useful tips and ideas (S,F)	Activities for information exchange between teams; working in Communities of Practice (S,F)
Ownership	Taking responsibility; showing initiative (S)	Making students responsible; clear expectations; professional environment; coaching (F)
Sense of community	Enjoying working and having fun at the same time; being willing to help each other; feeling at home (S); being yourself (F)	Culture of respect; openness; genuine interest in each other; equality; knowing each other personally
Learner equity	Improved coaching of juniors and learning by faculty (F)	Congruent learning activities by faculty and students, each at their own level *(could be improved)*

Table 2.5 Utilizing diversity. Features, effects and conditions mentioned by students (S) and faculty (F)

UTILIZING DIVERSITY		
Features	**Effects**	**Conditions**
Working with people from different disciplines and education levels	Learned a lot from other disciplines; for different education levels collaboration (S) and coaching (F) was sometimes difficult.	Good coaches

Learning from each other	Motivation to learn; getting new ideas (S)	-
Using different points of view	More people = more ideas = better results (S); better learning (F)	Balanced diversity in characteristics of team members
Collaboration	Combining knowledge requires collaboration; dividing tasks is not enough (S); collaboration reinforces learning by combining knowledge (F)	-
Feedback from different people	Stimulates reflection and learning about oneself (S,F)	Feedback from people with different backgrounds and views
Meeting new and interesting people	Inspiration by meeting new colleagues from other fields (F)	-
Using each other's strengths	Everyone is challenged to contribute and feels respected and valued for their input (S,F)	Everyone's input is needed for the task
Explaining to others	Understanding of task improves; becoming more helpful, more assertive (S)	Everyone's input is needed for the task

Table 2.6 Inter-linking of working and learning. Features, effects and conditions mentio by students (S) and faculty (F)

INTER-LINKING OF WORKING AND LEARNING		
Features	**Effects**	**Conditions**
New ways of learning	Learning by doing and discussing (S); learning by collaboration (F)	-
Learning by example	Learning by watching others work (S,F)	Working in the same room
Balance structure - letting go	Too much structure (S,F); not enough structure (S,F) – *no consensus*	-
Using a method for working in projects	Efficient learning by students (F)	Focus on problem first; reflect on milestones
Using external expertise	Verification of information; generating new ideas, inspiration (S)	Coaching and stimulating students 'to go outside'
Balanced focus of learning	Right balance between focus on task, process, person and knowledge (F) – *no consensus about the right balance*	-
Balance working/learning activities	Learning activities support working activities (should not disrupt each other) (S,F)	Supportive information is timely, to-the-point, tailored to participants
Adaptive interventions	Interventions when needed, not too ad hoc (S,F)	Underlying educational concepts and instruments
Increasingly complex tasks	First learning 'how it works here' during easier tasks works well (S)	Efficiency; saving enough time for the most complex assignment *(F not sure how to accomplish this)*
Guiding students' learning	Very helpful (S)	Different senior roles: coach, client's representative, expert

Table 2.7 Facilitating reflexivity. Features, effects and conditions mentioned by student (S) and faculty (F)

FACILITATING REFLEXIVITY		
Features	**Effects**	**Conditions**
Assessment *for* learning	Thinking about what is learned (S)	Setting goals and reflecting on learning with coach
Focus on person	Understanding behaviour of oneself and others; consciously making more future-oriented choices; growing as a whole person (S)	Facilitating individual personal and professional development
Reflection *on* action	Taking responsibility for learning; wanting to improve and live up to expectations (S)	Tools for and dialogue about feedback
Reflection *in* action	Continually thinking about what we do and why (S)	Feedback from practice; immediate adjustment and improvement
Connectivity school programme	Learning outcomes compatible with study programme (S)	Clear communication with school; relevant assignments from clients

Table 2.8 Enabling organization. Features, effects and conditions mentioned by student (S) and faculty (F)

ENABLING ORGANIZATION		
Features	**Effects**	**Conditions**
Facilitating working *and* learning	Being creative as well as organized (F)	Small community; 'face-to-face time', flexible organization structure
Sharing physical space	Easy contact students and faculty; knowing who has which expertise; learning by example (S, F)	Students and faculty working in the same room
Connectivity stakeholders	Participating institutions involved and committed (also financially) (F)	Shared vision and concepts; communication tailored to different stakeholders *(needs improvement)*
Learning organization	On-going development and innovation (F)	Research, reflection, monitoring and evaluation (not: routine, specialization, differentiation of tasks)
Explicit culture	Coaching on cultural aspects (F)	Making culture explicit when introducing new participants.

Emerging design principles

The goal of the evaluation stage in EDR is to underpin the set of initial design principles empirically by evaluating how they manifest themselves in practice. However, practice itself can reveal relevant aspects of the design that were not intended or made explicit by the designers. Some indications for new principles emerged from the data.

Many faculty members and some of the students discussed the relationships between the learning configuration and its surroundings. This relationship did not seem to be satisfactory. For instance, lecturers and managers within the participating education institutions were sometimes not sufficiently informed about or committed to the learning configuration. For example, a lecturer commented: "There is not a real connection with the partner-schools. They all say it is fantastic what we are doing, but they don't do anything with it; they merely watch it from the side-line." This suggests that the participants experienced a boundary between the HLC and its surroundings. This boundary may be related to the process of *hybridization* (Akkerman and Bakker 2011b), in the sense that ingredients of established practices (i.e. school and workplace) are combined, resulting in a new practice (the HLC) with its own boundary. Hence a possible new principle emerged which calls for the learning configuration to be in tune with its surroundings, bridging the boundary with its partner institutions and other stakeholders, such as (potential) clients. This design principle could be called *'enabling ecology'*.

Another issue mentioned by several faculty members concerned the participants in the learning configuration and their incentive to be involved. As to the students, it did not seem to matter how well they had been performing in their own study programme so far: some 'weak' students appeared to blossom in this learning environment. The performance requirements, however, did seem to be a motivating factor. Some of the students for whom no particular learning outcomes were required by their own study programme did not seem to be as motivated as either the students who did have requirements from their own programme or those who joined the HLC with their own set of learning outcomes. One faculty member from industry lost some of his motivation when he could not meet his own goal: "I notice a de-motivation because I am not going to reach my goal here, which is to apply the Value in the Valley concept to a business environment." This issue can be viewed as a *feature* of the new principle of 'enabling ecology': '*balanced performance requirements'*. The relevant balance would have to be struck both within and outside the learning configuration.

A third issue mentioned by several faculty members was the need to be creative and innovative and to remain that way. This was viewed as important because a knowledge worker requires a learning and working environment that is not stagnant. The following two threats to creativity and innovativeness were mentioned: task differentiation and the routine performance of tasks. Participants said: "After several iterations we know how to do the workshop on innovation." This call for innovativeness seems paradoxical in the following way. In order to develop and improve the learning configuration, one must keep what works well, but 'what works well' should not become either too routine or the task of a single person. In order to address these issues, an extra feature of 'enabling organization' might be introduced, namely '*on-going innovation.'*

Table 2.9 Initial and refined design principles

Initial design principles	Refined design principles	Description
1. Fostering authenticity	1. Fostering authenticity	Working/learning environment (context, tasks, activities, roles, and communication) reflects working practice, a professional working culture and organization.
2. Creating a learning community	2. Creating a learning community	Community: every member should experience a sense of belonging to the community. Learner equity: every member of the community is a learner, each at their own level.
3. Increasing ownership		
4. Utilizing diversity	3. Utilizing diversity	Diversity is built-in, valued and utilized both at team and organizational levels and in internal and external networks.
5. Inter-linking of working and learning	4. Inter-linking of working and learning	Participants learn by performing real life tasks supported by educational interventions that are attuned to the task and to the individual learner, inter-linking working and learning.
6. Facilitating reflection	5. Facilitating reflexivity	Participants learn by reflection on their tasks and experiences as a person, team and organization. Critical events in the working activities are the starting point for reflection and learning.
7. Enhancing individual talents		
8. Assessing for learning		
9. Enabling organization	6. Enabling organization	The organizational structure and culture supports the working process, knowledge creation and sharing at every level (individual, team, organisation, society).
	7. Enabling ecology	The learning configuration is attuned to its surroundings, which includes partner organizations and other stakeholders.

STAGE IV: DRAWING CONCLUSIONS

The findings presented in the previous section indicated how the initial design principles manifested themselves in practice as perceived by the participants. Three of the initial design principles ('facilitating reflection' 'enhancing individual talents' and 'assessing for learning') were merged into a new one: 'facilitating reflexivity'. The remaining set of six design principles was refined with features, effects and conditions. The new principle 'enabling ecology' was added to the initial set of principles. A feature of this principle is 'balanced performance requirements'. Also a new feature for the principle 'enabling organization' emerged: 'on-going innovation'.

With the knowledge of how the initial design principles were enacted in practice, we are now able to generate an answer to the main research question: *"Which set of principles can underpin the design of a hybrid learning configuration for educating the knowledge worker?"* We operationalized the research question (EDR stage I) by defining four learning processes that should be evoked by the HLC: self-directed learning,

authentic learning, the development of a professional identity, and creating knowledge collaboratively across boundaries. In doing so, we connect the empirical data with the intentions of the design.

In order to answer the research question, we will critically evaluate the features of the refined design principles (tables 2.3 to 2.8). We identify indications of occurrences of these learning processes, and we provide exemplary interview quotes from which these features were drawn. The relevant design principles will be referred to in italics. First we investigate to what extent 'self-directed learning' seemed to be realized. Second, we address 'authentic learning' and discuss 'the development of a professional identity'. Next, we discuss 'creating new knowledge collaboratively across boundaries'. Last, we draw conclusions with respect to the main research question.

Self–directed learning

Self-directed learning is defined here as pro-active or autonomous learning (Knowles 1975; Candy 1991). It can be described as a cyclical process consisting of five stages: diagnosing learning needs, goal setting, planning activities, monitoring progress and evaluating the extent to which a learning goal has been attained (Cremers, Wals, Wesselink, Nieveen and Mulder 2014).

Some of these stages were apparent from the data. The students set their learning goals, reflected on their progress and evaluated what they had learned. This was facilitated by coaching, feedback from faculty and peers and a procedure for personal professional development (*facilitating reflexivity*). A student's comment on coaching was: "If someone tells you that you are good at something you want to keep being good at it. And you want to work on things you're not good at."

In general, students were not pro-active learners when they started. Over the course of each iteration, the students gradually began to take more responsibility for their working and learning (*creating a learning community*). "If you want to achieve something here, you have to take action", was a relevant comment by one of the students. A lecturer stated: "Not everyone, but most of the students start taking initiative once they discover that it is up to them to make it work here."

The principle *creating a learning community* seemed to have the effect of the students feeling at home and "being themselves", which enhanced their motivation for working and learning pro-actively within the learning configuration. It is also plausible that reflection was enhanced by a safe atmosphere. Faculty mentioned "being genuinely interested in each other", "knowing each other" and "taking each other seriously" as important conditions.

The faculty did not agree about how much the students should be guided or left to their own devices (*inter-linking working and learning*). Some argued that most is learnt when things go wrong, whereas others were striving for a balance between guidance and self-direction in order to achieve an efficient learning process. They did agree that

providing clear expectations and being a coach rather than an instructor are important success factors for self-directed learning. Faculty stressed the importance of individual coaching and the need to make the procedure of personal professional development (*facilitating reflexivity*) more transparent and explicit.

It follows that the students' learning can be characterized as self-directed to a modest extent.

Authentic learning

The data suggest that authentic learning occurred in several ways. First, working on assignments from real clients motivated the students to work on the task (*fostering authenticity*). As a student put it: "It is really nice to know that someone will actually use the results." Students actively looked for information within and outside the learning configuration (*inter-linking working and learning*). One student said about this external focus: "You have to be more social here, you have to ask questions to people you don't know." According to one lecturer, this was facilitated "because the students are taken seriously by the client, by us and because Value in the Valley is seen as a company by the outside world" (*fostering authenticity*).

Students also learned from observing faculty at work (*inter-linking working and learning, enabling organization*). They mentioned the following in their interviews: watching faculty members guide the student teams, witnessing a presentation or a phone call, and attending a workshop from an expert. It follows that a certain kind of master-apprentice learning occurred. The faculty, however, did not work on the same projects as the students. They did not model the specific task for the students but were professional role models in a more general way. One student mentioned in the interview that he would have liked to collaborate with the faculty because "... that way, we would really have become colleagues". Another student was satisfied that faculty members from business supported students in their project (*fostering authenticity*): "Here people from practice think with us about our project; we get tips from business people."

The faculty did not agree on how best to balance the learning focus between knowledge, personal development, tasks and working procedures, and communication (*inter-linking working and learning*).

Developing a professional identity

Three aspects of students' development of a professional identity were apparent from the data. First, several students reported that they learned how a company works, even though most of them recognized that the learning configuration was not a real company in every way (*fostering authenticity*). They also started to behave in a more professional way by, for instance, "talking more decently" as one student put it, "dressing properly for meetings with clients", "answering the phone and receiving guests in a professional way", and "communicating about and keeping appointments".

Second, students mentioned that they got to know themselves and others better, and they indicated that this made them both understand others better and react to them differently (*facilitating reflexivity*). Reflecting on what they learned (or obviously had not learned yet), seemed to make the students think more consciously about their future. For instance they talked about what kind of role they would or would not like to play (project manager) in their future job, whether they would go on studying or start working after they finished their studies, and which field they would like to work in (many students found 'sustainable development' to be a very broad and interesting field, while others said that they were firmly committed to their choice for a career in their original field of study). These comments show that most students seemed to have developed, to some extent, their identity as a person in relation to their studies or future career.

Creating new knowledge collaboratively, across boundaries

An indication that new knowledge was created by collaborating in an interdisciplinary way (*utilizing diversity*) was found in students' comments such as "We needed each other's knowledge to achieve a result" and "Here the project is more together, not divided into separate parts that you throw together in the end; you have to discuss with each other constantly". The interdisciplinarity of the teams (provided that each discipline was needed for the task to be carried out) seemed to enhance or trigger the following processes as well: a motivation to learn ("if others in my team can make phone calls with clients, I should be able to do that as well"), getting to know oneself better ("I get feedback from people from different backgrounds who see things differently"), and becoming more assertive. One lecturer stated: "Students become more assertive, because each student has something to contribute from his own background, so they are challenged to bring forward their own point of view." Faculty reported that in some cases intensive coaching was required in order to get empowerment by each other going and to prevent a downward spiral of conflict resulting in negative behaviour in the student teams. Therefore, guiding students' learning (*inter-linking working and learning*) seems to be an important condition for creating knowledge by multidisciplinary and 'multi-level' collaboration.

Conclusions

In summary, the principles 'fostering authenticity', 'inter-linking working and learning' and 'facilitating reflexivity' seemed to enhance authentic, self-directed learning and the development of a professional identity. The collaborative creation of knowledge across the boundaries of disciplines was reflected strongly in the principle 'utilizing diversity'.

The data suggest a strong interconnection between the design principles. For instance, the principle of 'utilizing diversity' appeared to enhance reflection and the motivation to learn. This, in turn, seemed to enhance the inter-linked working and

learning that was needed in order to achieve knowledge creation, which occurred via interdisciplinary and multi-level collaboration. The principles 'creating a learning community' and 'enabling organization' and the new principle 'enabling ecology' can be viewed as providing the necessary context for the other principles to be effective.

Thus, it seems justified to conclude that this set of design principles can indeed be thought to underpin the design of a hybrid learning configuration for educating the knowledge worker.

DISCUSSION

Ideally, in EDR the practical goals and research questions are set at the beginning of the project by the researcher in collaboration with the practitioners. After this stage, a set of initial design principles is developed and implemented. These principles are then evaluated and refined after every iteration. In this case, however, the project began with general theoretical perspectives and the 'craft wisdom' of the designers. During the first iterations of design and implementation, the underlying assumptions and theories gradually became more explicit, which resulted in a set of initial design principles.

Iterations 4, 5 and 6 were based on these design principles and were evaluated. Since there was not much time between the iterations, the results of this evaluation were not directly put into practice in the next iteration. In addition, conclusions about the workings of the principles in practice were not drawn until after the end of the project. However, since the changes from one iteration to the next were minor and since every design principle was enacted in every iteration, we believe that we were justified in using the evaluation results of three consecutive iterations to reach our conclusions.

In this study we explored how participants in a learning configuration experienced the manifestations of educational design principles in practice. It is possible that participants did not recognize all manifestations of the underlying design. For instance, few students commented on the design principle 'enabling organization', possibly because they do not have a good idea of what an organization entails. Also, lecturers might have different conceptions of how a design principle is or should be put into operation within the learning configuration.

In addition to giving a voice to the perspectives of the different participants (students and faculty), a 'member check' (Guba 1981) could have increased ecological validity. A member check could demonstrate whether the conclusions drawn are credible or 'ring true' to those who provided the data.

Another issue to take into account is the interdependence and coherence of the design principles. As indicated in our conclusion, the data revealed relations between the design principles. This implies that conclusions drawn about individual design principles always need to be considered in relation to the other principles. This interdependence also became apparent because certain features seemed to be related to more than one design principle. For instance, a feature of 'enabling organization' was 'sharing physical

space'. Although this feature can be seen as an organizational issue, it can also be viewed from the perspective of 'creating a learning community' since working together in one room could be expected to enhance a sense of community. Thus we conclude, in line with Sandoval (2014), that features of a learning environment can be inspired by multiple design principles. For the sake of reducing complexity we chose to attribute those features to the design principle that seemed to be most directly linked to it.

Two kinds of overall outcomes often measured in EDR are learning results and the usability of the intervention as a whole. Although these overall outcomes were not measured systematically in this study, other studies (e.g. Cremers, Hekman and Bomhoff 2010) suggest that the students' learning results were in line with the intended learning outcomes and that both students and faculty enjoyed working and learning at the HLC. Interview data from this study seem to confirm this. Students seem to value the combination of "working seriously" within an informal atmosphere. Faculty often commented that the HLC offered a pleasant working environment and many opportunities for learning and developing themselves further as educators.

PRACTICAL IMPLICATIONS AND FURTHER RESEARCH

This study provides a set of design principles that, in this particular setting, appear to enhance authentic, self-directed learning as well as the development of a professional identity and the collaborative creation of knowledge across boundaries of disciplines, professions and perspectives. The set of design principles has been presented here with related features, effects and conditions. The features exemplify how the design principles can be applied, which enables other designers to utilize the principles in accordance with their own situation. In this way the set of design principles can facilitate collaborative knowledge building for a wide range of communities that design and explore hybrid learning configurations.

It follows that a logical direction for further research would be to monitor and test the utilization of the design principles in other contexts with different features (Andriessen 2007; Kali 2006). In addition, further research could be aimed at revealing the underlying mechanisms that explain why a certain feature or intervention produces a certain effect or outcome (Denyer, Tranfield and Van Aken 2008). This additional design knowledge would extend and deepen our understanding of how to design hybrid learning configurations for the knowledge worker.

Chapter 3

Self–directed lifelong learning in hybrid learning configurations[2]

Present-day students are expected to be lifelong learners throughout their working life. Higher education must therefore prepare students to self-direct their learning beyond formal education, in real-life working settings.

In this chapter we study an intervention that would strengthen students' capacity for self-directed lifelong learning within a hybrid learning configuration (HLC), a one-semester elective course at a university of applied sciences in the Netherlands. The research approach is educational design research (EDR). An intervention was designed, implemented and evaluated during two iterations of the course. Evaluation methods included interviews with students and the course facilitator, questionnaires, and students' logs and reports.

We developed five intervention design guidelines that will promote self-directed learning. We conclude that the intervention was usable and effective. At a basic level, the students did develop their capacity for self-directed lifelong learning.

2 This chapter is based on Cremers, P.H.M., Wals, A.E.J., Wesselink, R., Nieveen, N. & Mulder, M. (2014). Self-directed lifelong learning in hybrid learning configurations. *International Journal of Lifelong Education*, 33(2), 207-232.

INTRODUCTION

Increasingly, students currently pursuing higher vocational education will have professions that do not yet exist (Voogt and Roblin 2010; Hopkins 2010). For example, the shift to a low-carbon economy will create many completely novel employment opportunities (Baumann 2011). Hence, students must prepare themselves for a future that is to a significant extent unknown, both to themselves and to those who design and conduct higher education programmes (Barnett 2000). These changing demands in the labour market will require current students to become lifelong learners who are able to direct, monitor and evaluate their own learning during their working life. Therefore, higher education must aid students in developing the capacity to learn beyond the academy, where the infrastructure of teachers, courses and formal assessment is no longer available (Boud and Falchikov 2006).

Lifelong learning cannot be achieved merely by offering lifelong schooling (Billett 2010; Kirby, Knapper, Lamon and Egnatoff 2010). Learning in work and everyday life settings takes place mostly through ordinary, practical activities. It is always socially constructed, highly situated, and embedded in a particular context. In order to prepare students for lifelong learning that will occur in work settings, educational institutions should give students the experience of learning through practice. Learning should be related to the kind of on-going, practical challenges and problems that students typically experience (Boud and Falchikov 2006).

As we explained in chapter 2, the so-called 'hybrid learning configuration' (HLC) is a type of learning environment that offers students the experience of learning through practice. In such an interdisciplinary learning configuration students participate who are enrolled in different study programmes at different levels. They therefore vary in prior knowledge, interests and ambitions. Although they all aim to master similar professional tasks, individual students encounter their own, unique challenges and must learn from them in the process. By reflecting on their practical experiences, they will be able to relate their experience to theoretical concepts or models and their learning will deepen (Tynjälä 2014).

Accordingly, one of the seven design principles for HLC in chapter 2 was 'facilitating reflexivity'. This principle was described as: 'Participants learn by reflection on their tasks and experiences as a person, team and organization. Critical events in the working activities are the starting point for reflection and learning'. The capacity for self-directed lifelong learning can be seen as one of the desired learning outcomes of a HCL that is designed according to this principle.

We know from experience (e.g. Cremers et al. 2010), however, that the capacity for self-directed lifelong learning does not develop automatically as students work on authentic professional tasks. Individual learning that occurs as students work through such tasks often remains largely implicit or invisible. Evidence indicates that is difficult for students to make explicit both what they learned and (even more so) how they

actively direct their learning during their work. Therefore, additional educational support is required in order to foster self-directed lifelong learning (Jossberger 2011). Importantly, self-directed learning implies a move away from pre-determined and fixed assessment goals and criteria that are set by the programme or the lecturer, and towards more emergent and dynamic assessment goals and criteria that are set by the students in dialogue with the teachers (Bolhuis 2003; Boud and Falchikov 2007). Unfortunately, the fact that such a shift is necessary might act as a barrier for any attempt to integrate self-directed learning into existing education programmes.

Several recent studies have focused on facilitating students' self-directed learning in authentic learning environments (e.g. Blokhuis 2006; Poortman 2007; De Bruijn and Leeman 2010; Jossberger 2011). Most of these learning environments, however, are situated in senior secondary vocational education, where the available learning tasks and learning goals are usually more clearly defined and structured. Thus, less is known about how to facilitate the development of self-directed learning within an HLC, when students are working on ill-structured, authentic professional tasks.

This study aims to shed light on the nature of the capacity for self-directed lifelong learning in real-life situations and ways in which the development of this capacity might be facilitated within an HLC. To this end, an educational design research project was carried out in the context of an existing HLC that is embedded in an elective one-semester course at a university of applied sciences (UAS) in the Netherlands. An intervention for developing the capacity for self-directed learning within the HLC was designed, implemented and evaluated in order to develop a set of guidelines underpinning such an intervention.

First we introduce the educational design research approach used in this study. Next we describe the study context and the main research question. Then we present the theoretical underpinnings for the design of an intervention the aim of which is to develop the capacity for self-directed lifelong learning. After evaluating this intervention, we draw several conclusions about design guidelines for such interventions, and we discuss the intervention's effectiveness and usability.

EDUCATIONAL DESIGN RESEARCH

As we explained in chapter 2, educational design research (EDR) is the systematic study of educational intervention design, development and evaluation with the goals of solving complex educational problems for which no ready-made solutions are available, and gaining insights about key design principles (Nieveen 2009). As in the previous chapter, we used a model for EDR (figure 2.1) which contains four main stages. In this study the stages were carried out as follows:

I. *Diagnosing and agenda setting*. The researcher and practitioners analysed the problem in practice and formulated the research question(s).

II. *Analysis and exploration*. The researcher developed the conceptual framework that underlies the design of the intervention by conducting a literature search and eliciting craft knowledge from experienced practitioners. This was translated into a set of initial design guidelines.
III. *Design, implementation and evaluation*. The actual design and implementation in practice was a creative act undertaken by the researcher and the practitioners (in this case the course facilitator) in close collaboration. The researcher collected and analysed data during two iterations of the intervention. These analyses yielded findings about participants' responses to the initial design guidelines as they were implemented in practice, and they assisted in the evaluation of the effectiveness and usability of the intervention (Nieveen 2009). Finally, these findings were discussed with the practitioners (course facilitator and student coaches) and decisions were made about what adjustments to make in the next iteration.
IV. *Developing knowledge and consolidation*. In the knowledge stream, the researcher drew conclusions and provided a set of refined (or empirically tested) design guidelines that addresses the target problem in practice. In the practice stream, the new educational practice was consolidated in the specific context for which it was designed.

The research project will be described in more detail according to these four stages.

STAGE I: DIAGNOSING AND AGENDA SETTING

For this study an intervention for fostering self-directed lifelong learning was developed within an existing hybrid learning configuration at Hanze UAS in Groningen, the Netherlands. The HLC was embedded in a one-semester course, called 'Da Vinci'. First we will describe this course and then we will present the practical problem and research questions.

Context for the intervention: the Da Vinci course

Da Vinci is an elective course (which is called a 'minor') for third and fourth year students enrolled in different study programmes (e.g. technical studies, economics, sports or social studies). The course was conducted four times before this study started. The overall learning objective in the Da Vinci course is the acquisition of the professional task called 'effectuation' (Sarasvathy 2008). Effectuation is the development and realization of a new concept or product which includes the involvement of relevant stakeholders and commissioners. The focus is on entrepreneurial thinking through which a set of evolving means is used to achieve new goals (Society for Effectual Action 2010). An expert in the field of effectuation is referred to in the Da Vinci course as an '*innovation professional*'.

The students' central assignment is an ill-structured, authentic professional task. They are expected to conceptualize and develop their own project, and this allows them

to develop the complex skill of effectuation. The students are required to develop their projects in cooperation with relevant stakeholders in the community, which ensures the hybrid character of the course, i.e. the integration of the worlds of school and workplace. Two examples of student projects are a city bike rental system for the city of Amsterdam and a website like 'i-Tunes' for Hindu music, called 'Hindi Tunes'.

Approximately 20 students participate in the Da Vinci course each semester. They are allowed to form their own project teams, or they can work on their own, though this alternative is discouraged. Students are expected to work full-time in their own office space. A course facilitator, a lecturer, an entrepreneur, and two student-coaches are available for coaching and instruction. The total number of hours for coaching, instruction, assessment and course coordination is approximately 275 hours for a group of 20 students. There is little guidance for the project work in terms of assignments or scheduled activities. Assessment of the overall learning goal of 'effectuation' consists of three parts: an essay on a subject relevant to effectuation, a report about the new concept or product developed by the students and an oral presentation.

Problem in practice and research questions

Up until the design research study commenced, the lecturers of the Da Vinci course observed that students seemed to learn a lot individually, but they were not able to make explicit either what they had learned or how they had gone about acquiring their learning results. This is problematic since students are expected to become lifelong learners who are capable of directing, monitoring and evaluating their learning throughout their working life. In response, the lecturers felt the need to design and implement an intervention within the Da Vinci Course that would foster these capacities. Along with this practical goal, our central research question was formulated as follows: *"Which design guidelines underpin an intervention that would foster students' capacity for self-directed lifelong learning while working on ill-structured, authentic professional tasks?"*

STAGE II: ANALYSIS AND EXPLORATION

In order to design an intervention that would foster self-directed lifelong learning, a set of initial guidelines was developed. Here we will describe how the guidelines were derived from theory and professional experience. First we characterize the capacity for self-directed learning in real-life situations. Second, we investigate the ways in which one might facilitate the development of this capacity. Third, we address possible obstacles to integrating self-directed learning in an existing learning configuration. We conclude by discussing initial design guidelines for the intervention as it was implemented in the Da Vinci course.

The capacity for self-directed lifelong learning

What is the nature of the capacity for self-directed lifelong learning in real-life situations? There is a body of literature that shows that self-directed learning can be described as a cyclical process (e.g. Bolhuis 2003; Zimmerman 2002). Different authors use different terms for the stages within the cycle, but the following five stages or sub skills are generally recognized: diagnosing, setting goals, planning, monitoring and evaluating.

1. *Diagnosing*. Identifying what it is to be learned. This occurs by noticing a gap in one's knowledge or expertise (Sadler 1989), often brought about by 'life events' (Bolhuis 2003), which in the context of professional work could be called 'work events'.
2. *Setting goals*. Translating perceived learning needs into concrete learning goals (Knowles 1975; Bolhuis 2003). Defining the gap in knowledge (Boud and Falchikov 2006) and possible ways of closing it. Choosing a strategy underpinned by argumentation. Defining criteria for success.
3. *Planning*. Investigating possible ways of achieving the goal (Bolhuis 2003). Translating the strategy into subsequent concrete actions.
4. *Monitoring*. Engaging in practice and monitoring one's performance. Seeking and responding to feedback from different sources (Sadler 1989; Boud and Falchikov 2006; Hounsell 2007; Cremers et al. 2010).
5. *Evaluating*. Judging on the basis of evidence the extent to which the learning goal has been attained according to appropriate standards and criteria (Boud and Falchikov 2006).

Bolhuis (2003) states that these stages are not always followed in a particular order and that learners may jump back and forth between the stages. In addition, the evaluation stage often leads to renewed goal setting, which, in turn, leads to the initiation of a new cycle. For these reasons, it may be more accurate to describe a series of consecutive cycles as progressive or incremental, spiral development rather than as a cyclical process.

Developing the capacity for self-directed lifelong learning

How can the development of self-directed lifelong learning be facilitated? According to Combs (1971), while human beings are naturally inclined to self-fulfilment, this inclination has to be developed through practice. Responsibility and self-direction are learned when students have opportunities to experiment and are allowed to make mistakes. In line with this statement, several authors (e.g. Sadler 1989) recommend providing direct authentic experience with self-directed learning. Others note that training, instructional support and feedback by the teacher are also needed (Jossberger 2011).

Cremers et al. (2010) conclude that students should not start the cycle of self-directed learning at the very beginning of a course. For the most part, students' own learning goals emerge by working in practice on real issues. Only then will situations occur in which they experience a gap in their competence (Bolhuis 2003; Sadler 1989). In order to capture these critical incidents and provide the students with the opportunity

for reflection (looking back) as well as 'preflection' (looking forward) (Van Merriënboer and Sluijsmans 2009), students should be prompted to complete more than one cycle of self-directed learning during the course (Cremers et al. 2010).

Teachers should assist and empower students to observe their own effectiveness (Zimmerman, Bonner and Kovach 1996). This can be achieved by providing students with a clear description both of the professional task and of the competences that are central to the course. This helps students create a mental model of good professional practice. Such a 'professional profile' can guide the students while they define their own learning goals (Cremers et al. 2010). Several authors also emphasize the importance of providing feedback on the students' work (Sadler 1989; Nicol and McFarlane-Dick 2006; Hounsell 2007; Jossberger 2011). Sadler (1989) also stresses the importance of peer feedback. Feedback from working experts is also highly valued by students (Cremers et al. 2010). Well-crafted feedback can enhance learning in three significant ways according to Hounsell (2007): by accelerating learning, by optimising the quality of what is learned and by raising individual and collective attainment.

The foregoing implies that one way to facilitate self-directed lifelong learning is to offer students the opportunity to engage in two or more cycles of self-directed learning. Furthermore, educational support should consist of instruction, a professional profile and feedback from different sources.

Obstacles to self–directed learning

As we mentioned in the introduction, for most students self-directed learning requires a shift in mindset. This also holds true for many of the lecturers. It implies a change in learning strategy and may be conceived of as a case of conceptual change (Bolhuis 2003). Assessment goals, requirements and criteria are usually set by the teacher or the programme. If students are subjected to the assessments of others, they construct themselves as passive subjects (Boud and Falchikov 2007). However, "when people face learning demands outside the context of formal study – that is, in the contexts for which higher education is intended to prepare them – they necessarily have to construct themselves as active subjects" (Boud and Falchikov 2007, p. 18). For these reasons, Bolhuis (2003) claims that it may take time for students and teachers to let go of the old strategy and fully embrace the new one, even when the new strategy has been learned cognitively.

In addition to this shift in mindset, students may have negative experiences with assessment or reflection on personal development. Kinkhorst (2010) notes that many students in higher education in the Netherlands have become 'allergic' to words such as 'reflection' and 'personal development plan' because in many cases students are asked to reflect on their own weak and strong points without also being offered the choice or the control to direct their learning activities, since these are already planned and structured for them. This is coincides with Boud and Falchikov's (2007) statement that students may not always see themselves as active learners. Moreover, Taylor (1986) points out

that self-direction is often a struggle that involves periods of discomfort and anxiety as students move from one stage to the other in the cycle of self-directed learning. Thus, we conclude that special attention should be given to motivational and emotional aspects when facilitating the development of the capacity for self-directed lifelong learning.

Initial design guidelines

It follows from our theoretical exploration that self-directed learning is comprised of a cyclic process that consists of five stages: diagnosing, goal setting, planning, monitoring and evaluating. We also found that developing the capacity for self-directed lifelong learning should be embedded in authentic experience, that it should occur over two or more cycles and should be complemented by instructional support, a professional profile and feedback from different sources. Finally we found that motivation and emotional aspects should be considered when designing the relevant learning interventions. These features can be captured by the following three initial design guidelines:

1. *Provide opportunities to engage in two or more cycles of self-directed learning*, which consist of five stages: diagnosing, setting goals, planning, monitoring, evaluating.
2. *Provide educational support* consisting of instruction, a professional profile and feedback from different sources.
3. *Pay attention to the emotional and motivational aspects* that are evoked either by a shift in mindset or by resistance to and struggle with the process of self-direction.

STAGE III: DESIGN, IMPLEMENTATION AND EVALUATION

The first steps of phase III consisted of design and implementation. The researcher and the course facilitator translated the design guidelines into a set of intervention features that would be implemented in practice (table 3.1). The specific teaching and learning activities for self-directed lifelong learning in the Da Vinci course were called 'procedure for personal professional development'.

These guidelines and their features were implemented and evaluated in two consecutive iterations of the Da Vinci course. 23 third- and fourth-year students from 10 different study programmes (7 female and 16 male) participated in the first iteration of the course. In the second iteration 18 students (3 female and 15 male) representing eleven different study programmes participated. The researcher played an intervening role as an instructor of 'personal professional development' in cooperation with the course facilitator.

After the initial design and implementation, the two iterations of the intervention within the Da Vinci course were evaluated. First, the features of the initial design guidelines in practice were investigated, and then the overall effectiveness and usability of the intervention was assessed.

Table 3.1 Design guidelines and features of the intervention

	DESIGN GUIDELINE	FEATURES OF THE INTERVENTION
1	**Provide opportunities to engage in two or more cycles of self-directed learning**	**Iterations 1 and 2 (*additions in iteration 2 in italics)*** Students determine their learning progress twice during the course. Assignments for each stage (1.1 – 1.5) of the process are described below.
1.1	Diagnosing	Create a mind map of the innovation professional (characteristics, knowledge, skills) using the professional profile and presentations from experts. Analyse critical situations, problems, and events described in your blogs.
1.2	Setting goals	Describe your learning goals, a strategy to achieve them, an argumentation informed by existing theory or expert knowledge, and criteria for success.
1.3	Planning	Plan activities for each learning goal, specifying what, where, when, and with whom.
1.4	Monitoring	Alongside your project work, keep regular (e.g. daily or weekly) logs of events and describe critical situations and problems in detail. Give and receive (peer) feedback.
1.5	Evaluating	Evaluate your learning and translate successful work on learning goals into learning results.
2	**Provide educational support**	Two instructional workshops are provided. *A third workshop is added at the beginning of the course: the 'kick-off workshop'.* *Examples of learning goals and learning results are provided.* *The procedure for personal professional development is integrated in the handbook (study guide) of the course.* A professional profile (a profile of the 'innovation professional' including the task, characteristics of professional practice, required competencies) is provided. Expert innovation professionals are invited as guest speakers.
3	**Pay attention to emotional and motivational aspects**	'Personal professional development' is presented as a competence of the innovation professional and as a valuable complex skill that students need in working life. The importance of lifelong learning is stressed. Possible aversion against 'personal professional development' is acknowledged, but it is pointed out that learning goals in this course can actually be put into practice. Lecturers (coaches) are open to suggestions for improving the facilitation process, and they evaluate the process during and at the end of each course along with the students. At the end of the course study credits are awarded for the 'final report on personal professional development'. *Study credits are awarded twice: for the progress report and for the final report.*

Questions to be answered with respect to the *design guidelines* were:

- How did the participants (students and course facilitator) respond to and experience the manifestations of the guidelines in practice?
- What suggestions for improvement were made?
- Did possible new design guidelines emerge from the data?

Relevant questions regarding the *effectiveness* of the intervention were:

- To what extent did students develop the capacity for self-directed lifelong learning?
- To what extent was the students' learning during the project work actually made explicit?
- To what extent was the students' learning aligned with the intended outcomes of the course (i.e., the competencies of the innovation professional)?
- Were the students satisfied with their learning results?

For assessing the *usability* of the intervention we asked:

- How did participants experience the intervention (the 'procedure for personal professional development') as a whole?

Data sources and methods

Different types of data were collected in order to ensure that at least two data sources provided information on each of the design guidelines, the effectiveness and the usability of the intervention (triangulation) (Miles and Huberman 1994). Table 3.2 shows which data sources provided information about design guidelines, usability or effectiveness. If the data source provided information, this is indicated with a '+'. If not, this is indicated with a '-'.

Table 3.2. Data sources in relation to design guidelines, usability and effectiveness

DATA SOURCES	**DESIGN GUIDELINES**							**USA-BILITY**	**EFFECT-IVENESS**
	1. Provide opportunities to engage in two or more cycles of self-directed learning					**2. Provide educational support**	**3. Pay attention to emotional and motivational aspects**		
	1.1 Diagnosing	1.2 Setting goals	1.3 Planning	1.4 Monitoring	1.5 Evaluating				
Retrospective interview	+	+	-	+	+	+	+	+	+
Questionnaire	-	+	-	+	+	+	+	+	-
Progress reports	-	+	+	-	+	-	-	-	+
Student blogs	+	-	-	+	-	-	-	-	+
Course log and notes	-	+	+	+	+	+	+	+	-

The following data sources were used in iterations 1 and 2: Interviews with students and the course facilitator, student questionnaires, students' progress reports on their personal professional development and student blogs. As formal learning activities were carried out, a researcher observed, took notes and kept a course log. The data analysis

process was checked by a second researcher who was not involved in the Da Vinci course. Methods for data collection and analysis for each data source are as follows.

Eight students and the course facilitator were interviewed at the end of iteration 1. The students were selected in such a way that they differed in the degree to which they had been engaged in the procedure for professional development. They also differed in the degree to which they were enthusiastic about it. The interview consisted of two parts. Part one concerned general questions about the entire procedure. The students' answers provided information about guidelines 1.1, 1.2, 1.4 and 1.5 (diagnosing, setting goals, monitoring and evaluating) and the usability and the effectiveness of the intervention. In addition, students were asked to comment on their satisfaction with their learning results and the degree to which all their learning had been made explicit.

The second part consisted of questions concerning each formal learning activity or related product. The goal of each activity was explained, and students were asked if this goal had been accomplished. These questions also concerned the usability of the activity, which shed further light on guidelines 1.2, 1.4, 1.5 (monitoring, evaluating), 2 (educational support) and usability. The course facilitator was asked to answer the same questions both from his own point of view and from what he imagined the students' point of view to be.

The interviews were recorded, transcribed and coded according to design guidelines, usability and effectiveness. Suggestions for improvement were coded as well. For each code, a list of corresponding quotes was generated, and this list was summarized by the researcher. The coding process was documented by writing memos for any decisions and dilemmas encountered during coding and by maintaining a research log.

At the end of iteration 2 a questionnaire was filled out by twelve students. The content of the questionnaire corresponded to the second part of student interviews in iteration 1. Students were asked to comment on the accomplishment of the goal and on the usability of each activity. Students were also asked two open questions. The first was about how and from whom the student received feedback during the course, and the second asked for remarks about or suggestions for the 'procedure for personal professional development'. Questionnaire answers were coded using the same coding scheme utilized for the interviews. The progress reports from iterations 1 and 2, which included a report of learning results, learning goals and an action plan, were used to analyse the extent to which students actually engaged in goal-setting, planning and evaluation (guidelines 1.2, 1.3 and 1.5). The blogs were studied to find out more about guideline 1.4 (monitoring), especially where it concerned students' capacity to keep a record of their work and recognize critical events.

Three aspects of the effectiveness of the intervention were also derived from the reports and blogs. First, the extent to which students developed the capacity for self-directed lifelong learning was assessed via scoring rubrics. The rubrics addressed stages 1.1 through 1.5 of the cycle of self-directed lifelong learning. In this study we focused on

the development of skills associated with the stages of self-directed lifelong learning in order to limit complexity. Therefore, other competencies for self-directed learning, such as those concerning personal characteristics or self-conceptions (e.g. Knowles, 1975; Candy, 1991) were not taken into consideration. For each stage in the cycle, several criteria were formulated and rated on three levels: weak, moderate and satisfactory. The intervention aimed at 'satisfactory'. An example of criteria and levels is given in table 3.3.

Second, an indication of the extent to which students' learning was made explicit was derived from students' comments in the interviews on this issue combined with the content and amounts of learning results found in their progress reports.

Third, for each student learning results were categorized according to the competencies of the innovation professional. This was done in order to find out the extent to which student learning was aligned with the intended outcomes of the course. During both iterations the researcher recorded student questions, discussions that occurred during workshops and other observations. This information was used to support and supplement findings from the other sources. The course log and notes provided extra information on motivation (guideline 3) and usability.

Table 3.3 Examples of criteria for assessing the mastery of self–directed lifelong learning

Stage in the cycle of self-directed learning	Weak	Moderate	Satisfactory
Monitoring	Less than 4 blog entries. Blog entries not specific (according to STAR-method criteria: situation, task, actions and results). Blog entries not reflective.	4-7 blog entries. Blog entries not very specific (STAR method partly used). Blog entries partly reflective: jumping to conclusions without analysing the situation.	8-12 blog entries. Blog entries are specific using STAR method. Blog entries reflective: situations are analysed before drawing conclusions.
Evaluating	Learning results are not documented with literature or references to experts. No evaluation criteria.	Learning results are poorly documented (sources not specific enough). Evaluation criteria not measurable or to-the-point.	Learning results are well documented (sources specifically referenced). Evaluation criteria measurable and to-the-point.

FINDINGS

For each guideline (table 3.1) we will describe how the participants responded in both iterations. Suggestions for improvement that emerged from these findings are translated into refinements for each guideline, which will be summarized in table 3.4 in the conclusions section. We conclude this section by detailing our results regarding effectiveness and usability of the intervention.

Design guideline 1: Provide opportunities to engage in two or more cycles of self–directed learning, which consist of five stages: diagnosing, setting goals, planning, monitoring, evaluating.

For this guideline each stage of the cycle was evaluated.

Diagnosing (guideline 1.1)

The tools that best helped students get a mental image of the 'innovation professional' were different for each student. Some mentioned the professional profile and others stated that the mind maps and expert's presentations were most helpful. Some students indicated that they made decisions about their learning needs based on the requirements in the professional profile. A refinement for design guideline 1.1 would therefore be: 'Provide different representations of the professional and competencies central to the course (e.g. professional profile, mind maps and presentations by experts).'

Most students, however, based their decisions about learning needs on what happened in practice. For example, one student said: "Many things just happen to you while working on the project and that is what you learn". Those critical situations were sometimes derived from checking their own blogs, but most often they were directly derived from an event that "didn't feel right" or from feedback they received. Thus, a second refinement emerged: 'Be aware that learning needs tend to emerge mostly from working in practice.' Nevertheless, some students mentioned that they had formulated learning needs before they started the course.

Setting goals (guideline 1.2)

Several students admitted that they did not elaborate on their learning goals until the first progress report was due. Their learning goals often were not very specific and therefore not feasible. The refinement derived here is: 'Assist students in making their goals specific and feasible.'

The concepts 'strategy', 'argumentation' and 'criteria for success' for a learning goal appeared to be new for most students. The course facilitator often provided directions for locating existing theory or expertise that could help students attain a learning goal by setting a strategy and formulating measurable or observable criteria for success. This observation led to the following refinements: 'Assist students in underpinning their strategy with an argumentation based on theory or expertise', 'Make students aware of the existence of relevant theory or expertise' and 'Ensure that criteria are measurable or observable.'

Students indicated that the instructional workshops and coaching were important for helping them understand the concepts related to goal setting. Students appreciated being exposed to examples of good and poor goal setting, which was done more in the second iteration. This led to the refinement: 'Provide examples of goals, strategies, argumentation, and criteria for success.'

Planning (guideline 1.3)

Students tended to plan only the first action needed to engage in activities for the learning goal. Most of them did not update their plan of action nor did they check their progress on their own (they only did this when urged during a workshop or another structured activity). Students needed help in making their plan concrete and explicit. They also needed suggestions for involving others to help them achieve their goals. This resulted in two refinements: 'Help students make the plan of actions concrete and specific' and 'Make suggestions about how students can involve others for support.'

Monitoring (guideline 1.4)

Students differed very much in the degree to which they engaged in regular blogging for monitoring their work. A few did it every week, some almost never, and others had periods of active blogging followed by inactive stretches. Most students mentioned that they found working on the blogs useful. In some cases blogs were useful for deriving learning needs, and in others the blogs aided in reflection. As one student put it: "It makes you think about what you are doing, why you are doing it and if it is the right thing to do". Students had to learn when an event apparently was 'critical' to them, how to describe this event as concretely as possible, and how to reflect on it. Several students indicated that interrogating each other about details of the event worked well because it helped them get to the core of the matter. Two refinements relating to blogging were derived: 'Encourage students to be specific and reflective in blogging' and 'For their blogs, have students interrogate each other about critical incidents.'

All students were very positive about the feedback they received from coaches during project work, especially when setbacks occurred. Almost every student project team engaged in peer feedback. This feedback was sometimes very structured and other times more ad hoc. "We gave each other feedback when it was needed, we were very open to each other" was a comment often heard. One of the students who engaged in structured peer feedback activities recommended making this a compulsory part of the course for every project team. Therefore two refinements regarding feedback were: 'Provide feedback at critical times during project work' and 'Have students offer each other feedback.'

Evaluating (guideline 1.5)

On average, students had described approximately four learning results by the end of the course. By analogy with 'setting goals', they needed help in specifying what they had learned and what they took to be the strategy, argumentation and criteria for success. The corresponding refinement would be: 'Assist students in defining what exactly was learned and give feedback on strategy, argumentation and criteria.'

Design guideline 2: Provide educational support

In general students were satisfied with the instruction and feedback provided to them. Most students indicated that they eventually realized what was expected from them, if they did not do so right away. Students appeared to have different conceptions of 'learning' and 'knowledge'. They seemed to think that theory is "what we learn from books", and did not easily relate that to their learning during their project work. A refinement for this guideline would be: 'Pay attention to the students' conceptions of 'learning', 'knowledge' and 'theory'.'

The students also remarked that the workshops and written guidelines complemented each other. All students very much appreciated the individual coaching session they received after the first few weeks of the course. Their reasons were not only because it made much clearer what the 'procedure for personal professional development' entailed, but also because their learning goals became more explicit and because they were given personal attention. Indeed, one student indicated that he would have liked to have more than one individual coaching session. Two refinements regarding teaching activities resulted from this: 'Provide workshops as well as written guidelines' and 'Provide individual coaching that helps students specify individual learning goals.'

Almost all respondents in the interviews and questionnaire indicated that they very much appreciated the final presentation of their learning results in small groups: "you hear about each other's learning results in a pleasant atmosphere". The feedback from peers and from the course facilitator during this meeting was thought to be very informative and also reassuring: "I always thought that being a very ambitious student was mostly regarded as negative or annoying by peers, but it appeared to have good sides as well". This resulted in the following refinement: 'Have students present their learning results to each other.'

One student suggested making the procedure 'more social': "We always talk about our projects with each other, but never about our learning goals". This suggestion could become a **new design guideline**: 'Treat self-directed lifelong learning as a social learning process'. A suggestion made by another student was to make sure that students were aware of each other's learning goals and results from earlier on in the course. This would be a refinement to this new guideline: 'Have students share each other's learning goals and results from early on in the course.'

Design guideline 3: Pay attention to emotional and motivational aspects

When asked to estimate how many students seriously engaged in the procedure for personal professional development at the end of iteration 1, estimates offered by students were as follows: approximately five students were very seriously engaged and enthusiastic; six were 'followers', doing it because it was asked from them; and about six were not really serious, but they engaged in it to some extent for the study credits.

Most students found it difficult to actually carry through on their blogs and progress reports. Many students reported that initially the most important reason for this was the allergy they had to 'personal development', 'reflection' and related terms: "Here we go again; we have to state our strong and weak points again". It was a chicken-and-egg situation, which one student expressed well in the interview: "If a student sees the benefit, he will do it". And, further on he mentioned: "You have to experience it, then you see the use of it". So in hindsight, most students thought that working on their personal professional development was useful because (summarizing the students' comments in the interviews): "If you stop to think about what you do, you get more conscious of what you are good at (or not), what you learn, how you are developing and what you actually want to do or learn".

Another aspect was the different dynamics between project and personal development: one is doing, the other is pausing and reflecting. The project is often regarded as more important and certainly more urgent than pausing and reflecting. Students offered several suggestions about how to motivate them to do the necessary work. This included: making students work on it as a group every week at the same time, and having students from earlier iterations visit and share their experiences. The corresponding refinements for this design guideline were: 'Organize regular working sessions on self-directed lifelong learning.' and 'Have alumni of the course give presentations about their experiences with self-directed lifelong learning.'

Some remarks were made about the learning environment itself as a motivating factor. One student commented: "Here you can put your own learning goals into practice. Because of this freedom you start to think more about: what am I doing and what do I want?" Another refinement related to motivation would therefore be: 'Point out that the students can put their own learning goals into practice.' The same student also said: "Because you work with people from other fields of study you learn automatically because you are taken out of your usual way of thinking. You start to look at things differently; you see that there is another way as well". Thus a refinement on diversity was added: 'Ensure diversity: enrol students from many different study programmes.'

Another suggestion was to make the personal professional development tasks a more natural and integrated part of the course, and involving all coaches and assistant-coaches in the procedure. This suggestion could become a **new design guideline**. A **r**efinement for this guideline would be: 'Involve all lecturers and assistant-coaches in the process of self-directed lifelong learning.' When asked whether the fact that their reports were also data for research provided any extra motivation, most students answered that that it did not. Two students said that initially they just wanted to help the researcher, but soon saw that it was useful for them as well.

Effectiveness of the intervention

Relevant questions regarding the effectiveness of the intervention were:

- To what extent did students develop the capacity for self-directed lifelong learning?
- To what extent was learning during the project work actually made explicit?
- To what extent was learning aligned with the intended outcomes of the course (i.e. developing the competencies of the innovation professional)?
- Were the students satisfied with their learning results?

In general, the students did develop their capacity for self-directed lifelong learning but only at a weak to moderate level. The progress reports showed that they could describe learning goals and strategies for pursuing them, although this was not always expressed in concrete actions. They attempted to link their learning goals and results to theory or expert knowledge but were often not very specific (e.g. by referencing a study course instead of a specific source). The evaluation criteria for their learning results were often not directly measurable or observable. Most blog entries did describe critical situations, although they were not always very specific; students tended to jump to conclusions before really reflecting on the event. For instance, one student stated that another student 'got upset' with him but did not describe the incident in any detail.

From students' blogs and also from comments in the interviews, it appeared that they learned more than what was captured in learning results. This suggests that part of their learning remained implicit. One student captured this nicely: "Some things are in your head but you cannot get them on paper; something has changed, but you don't know what". Several students said that when they became better at a competence they already possessed, they did not include it as a learning result. This suggests that their conceptualization of what learning is, or what it is not, also determined what they included in their learning results.

Most of the learning results were aligned with the intended outcomes of the course. When the learning results (89 in total) from students' reports that received a 'satisfactory' in iteration 1 and 2 were clustered according to the competencies of the innovation professional, it appeared that most of the learning results related to the field of personal development (43%). A considerable amount of these learning results had to do with self-discipline, possibly because this learning environment offered little structure for the students' project work. Other learning results concerned collaboration (21%), networking (15%), innovation (10%) and communication (8%). 3% of the learning results were not directly related to the competencies of the course such as 'setting up a business plan'. Some students commented that they had not enrolled in the course to become an innovation professional but to pursue their own goals such as "discovering if I am an entrepreneur", "to develop my creativity" or "to find out if I can function in an unstructured environment".

Most students were very satisfied with what they learned. Several students made comments such as "I learned more about myself in this course than in the other three years of my study". The course facilitator toned this result down a bit. He stated that

most students were very proud of their projects and of what they learned, but for some of the students he doubted if they really had stretched their limits: "Some students come into the course already very capable and competent. For a few of them I wonder how much they actually have grown in this course". Most students said that what they learned differed from their expectations going into the course and that they were satisfied with this because they valued these learning results. Students mentioned for instance learning to cope with freedom and getting to know their own strengths and weaknesses.

Usability of the intervention

In order to assess the usability of the intervention we investigated how the participants experienced the intervention as a whole. As mentioned above, most students found working on their personal professional development useful but only after they made a serious effort. According to the students, the usability of the procedure could be improved if the 'rules of the game' were stricter. Students mentioned that there should have been consequences if they did not blog regularly or did not hand in their progress report in time to receive feedback. As one student said, "without consequences you don't put in a lot of effort, even if you intended to do it". As to what consequences would be appropriate, the students' comments were a bit vague. Most suggestions were in the direction of awarding study credits for blogs and progress reports and withholding feedback if work is turned in after the deadline. This could be translated into another **refinement** for guideline 2: Have strict rules and adhere to them (with consequences, such as no feedback or no study credits, if students fall short of the rules).

STAGE IV: DRAWING CONCLUSIONS

The findings seem to confirm that based on the initial design guidelines, the intervention actually supported the development of students' capacity for self-directed lifelong learning while working on ill-structured, authentic professional tasks. The findings resulted in refinements to each initial guideline and the possible addition of two new guidelines. These are summarized in table 3.4. Here, we discuss the suggested new guidelines and draw some additional conclusions from these findings.

The first new design guideline is: 'Position self-directed lifelong learning as a self-evident, integrated part of the course'. In hindsight, most students found working on their personal professional development useful as they felt it made them more aware of their actions and their own development. Being able to work on their own learning goals motivated them. Nevertheless, they found it hard to actually do the work during the course, probably because project work and self-directed learning are different in nature. The dynamic rush of the project work makes it difficult to slow down, pause and engage in the reflective activities involved in self-directed learning. Additional measures should be taken to urge or motivate the students to regularly work on self-directed lifelong

learning. At first sight, this seems paradoxical: urging students to self-direct. However, the notion of self-directed lifelong learning is new for most students. Moreover, it involves a change in mind-set. The student rather than the lecturer decides what is to be learned. Evidence from controlled studies suggests that strong instructional guidance is needed for novice to intermediate learners (Kirschner, Sweller and Clark 2006).

The second new design guideline is that self-directed lifelong learning should be treated as a social learning process. This coincides with Bolhuis' (2003, p. 341) recommendation: "Treat learning process and results as social phenomena". It should be noted, however, that working on one's personal development can be perceived as 'private', and it can sometimes be experienced as threatening. One student stated: "I don't need everyone to know what I am learning" and "I will not accept feedback easily from students who don't take this as seriously as I do". Giving and receiving peer feedback requires an atmosphere of safety and trust among students, and for this reason, a social learning approach must be implemented carefully (Sol, Beers and Wals 2012).

As expected, individual students achieved different learning results, most of which appeared to be in line with the course's target competencies. Since most of the learning goals and results emerged from project working, the learning results often differed markedly from the learning goals that students focused on going into the course. Part of their learning remained implicit, however. Students were aware that "something had changed" but were not able to express what exactly.

The quality of the blogs and progress reports was below expectation. More training, instruction and coaching is probably needed, especially with respect to the task of educating students about the concepts of strategy, argumentation and the criteria for success for a given learning goal or result. The finding that students often needed help in locating existing knowledge or expertise seems to confirm the notion that the capacity for self-directed learning is domain-specific. Learners tend to be more self-directing in familiar domains of activity than in domains less familiar to them (Candy 1991). For most students the domain of effectuation was new. For instance, many of the students had never before been required to involve external stakeholders for their projects. However, in domains in which students could be expected to have some prior knowledge, such as communication, they also needed help finding appropriate resources. This may be a problem of transfer of knowledge: students tend to have difficulty with linking the theory learned in class to their practical work (see e.g. Eraut 2004).

Students reported that individual coaching and feedback was very effective. The time available for this course is restricted, however, by established institutional regulations that cannot easily be changed. Therefore, we also conclude, in accordance with several studies conducted elsewhere, that the capacity for self-directed lifelong learning should probably be developed during the whole study programme, and not only as part of one individual course (Boud and Falchikov 2006; Bolhuis 2003; Jossberger 2011). It is plausible to assume that if students were offered more opportunities to work on self-directed

Table 3.4 Refined design guidelines for self-directed lifelong learning

	DESIGN GUIDELINE	REFINEMENTS
1	**Provide opportunities to engage in two or more cycles of self-directed learning**	Implement two cycles of self-directed lifelong learning into the course.
1.1	Diagnosing	Provide different representations of the professional and competencies central to the course (e.g. professional profile, mind maps, presentations by experts). Be aware that learning needs tend to emerge mostly from working in practice.
1.2	Setting goals	Assist students in making their goals specific and feasible. Assist students in underpinning their strategy with an argumentation based on theory or expertise; make students aware of the existence of relevant theory or expertise. Ensure that criteria are measurable or observable. Provide examples of goals, strategies, argumentation and criteria for success.
1.3	Planning	Assist students in making their plans of action concrete and specific. Make suggestions about how the students can involve others for support.
1.4	Monitoring	Encourage students to be specific and reflective in blogging. For their blogs, have students interrogate each other about critical incidents. Provide feedback at critical times during project work. Have students offer each other feedback.
1.5	Evaluating	Assist students in defining what exactly was learned and give feedback on strategy, argumentation and criteria.
2	**Provide educational support**	Pay attention to the students' conceptions of 'learning', 'knowledge' and 'theory'. Provide workshops as well as written guidelines. Provide individual coaching that helps students specify individual learning goals. Have students present their learning results to each other.
3	**Pay attention to emotional and motivational aspects**	Organize regular working sessions on self-directed lifelong learning. Have alumni of the course give presentations about their experiences with self-directed lifelong learning. Point out that the students can put their own learning goals into practice. Ensure diversity: enrol students from many different study programmes. Have strict rules and adhere to them (with consequences such as no feedback or no study credits if students fall short of the rules).
4	**Treat self-directed lifelong learning as a social learning process.**	Have students share each other's learning goals and results from early on in the course. Provide an atmosphere of safety and trust among students.
5	**Position self-directed lifelong learning as a self-evident, integrated part of the course.**	Involve all lecturers and assistant-coaches in the process of self-directed lifelong learning.

learning in different courses throughout their curriculum, they would reach a higher level of proficiency. Indeed, this conclusion seems to be supported by other research. Posner (1991) shows that students' competence in self-directed learning increased significantly after they had completed two or more different self-directed learning projects.

In summary, five refined guidelines were found to underpin the design of the intervention that would foster students' capacity for self-directed lifelong learning while working on ill-structured, authentic professional tasks. Table 3.4 shows the guidelines and the suggested refinements for this particular context. These guidelines are not intended as recipes for success, but can help others select and apply the most appropriate substantive and procedural knowledge for specific design and development tasks in their own settings (McKenney et al. 2006).

DISCUSSION

Self-directed learning while working on ill-structured professional tasks implies a shift in world-view both for students and course facilitators. The professional development of course facilitators is often a third aim of EDR, in addition to the aims of developing curricular products and formulating design guidelines. In this research project gradual involvement appeared to be a good strategy for the professional development of course facilitator and coaches. The design and development of educational activities such as workshops and a study guide was a collaborative effort by the researcher and the course facilitator. During the first iteration the researcher carried out most of the instructional activities, and then the course facilitator and the other coaches were gradually involved for successive iterations. The course facilitator appreciated the fact that the researcher actually worked in practice and therefore could ascertain whether the new design was feasible. He also stated that he felt confident "we are doing the right thing" because of the theoretical underpinning of the design.

For the coaches of the Da Vinci course one of the reasons for facilitating the students to self-direct and make explicit their learning was their wish to assess (and communicate to others) what the individual students had actually learned. In this study only the 'how to' or the technical execution of self-directed lifelong learning was facilitated and assessed. Its main goal was to enhance the students' capacity for self-directed lifelong learning, rather than evaluating the content and level of their individual learning outcomes (which were, in part, assessed by the project report, presentation and the essay). From an assessment point of view, it can be helpful to discern the different goals that assessment can serve. Boud and Falchikov (2006) use the term 'assessment for future learning' in relation to preparing students for lifelong learning. Tan (2007, p. 125) emphasizes that 'future-driven self-assessment' is different from 'teacher driven' or 'programme-driven' assessment in that "there is no emphasis on students being able to match the teacher's or the programme's requirements exactly. [...] When self-assessment is future-driven, it focuses on utilizing the programme of study to prepare students to develop sustainable

self-assessment ability". This development will extend beyond formal education and improve with practice and everyday (working) life experience.

If the students' self-reported learning results in the Da Vinci course were to be used for certification, a higher level of mastery of their capacity for self-directed lifelong learning would be required. In this experiment we were unable to judge exactly what was learned and to which extent because there were too many flaws in the strategy, the argumentation and the use of relevant criteria. As mentioned before, more instruction and practice would be needed throughout the curriculum. Further research is needed to investigate conditions for realizing higher levels of proficiency in self-directed lifelong learning throughout the curriculum and beyond.

Moreover, the system for higher education would have to find ways to accredit learning achievements claimed by the students that do not exactly match the (often nationally) defined standards and criteria for a specific study programme. This would imply a shift away from the current educational trends towards more detailed specification and assessment of learning outcomes in higher education.

Design research is in theory never finished. The 'procedure for personal professional development' was continued in further iterations of the course, and new guidelines and suggestions for improvement were implemented. Even though this study showed that some student learning was not captured and that the capacity for self-directed lifelong learning could not be developed at a very high level during a one semester course, the coaches felt that the 'procedure for personal professional development' added value to their educational practice. Students appreciated the fact that they were able to articulate their learning results and the coaches felt that they had a better grasp of what was actually learned.

Two issues should be considered regarding the transferability of the design guidelines to other contexts. First, the guidelines are interdependent and coherent. This means that conclusions drawn about an individual design guideline always need to be considered in relation to the others. Second, in order to study the effects of the guidelines in practice, one must observe their specific features in a particular context. For this reason, the context of this particular case should be known to those who wish to apply the guidelines to their own context. The description of the context and the features of the intervention in practice can be considered a 'thick description' of the learning configuration that was studied here. Field testing in other contexts (Andriessen 2007) would increase the transferability of the results, provided that the similarities and differences between these contexts are well documented. It is recommended that, as more and more educational design research is done, case-to-case comparisons should yield more insight into the working of design guidelines that might foster self-directed lifelong learning in hybrid learning configurations.

Chapter 4

Utilizing design principles for hybrid learning configurations[3]

Educational design research yields design knowledge that often takes the form of design principles or guidelines and provides the rationale or 'know-why' for the design of an educational intervention. As such, design principles can be utilized by designers in contexts other than the research context in which they were generated.

Although research has shown that quality support is important for design success, not much is known yet about ways to support inter-professional teams in their efforts to creatively utilize design principles when designing novel learning environments. In this chapter we explore an intervention for supporting the creative utilization of a set of research-based design principles by design teams in various contexts.

For this study, we used the set of design principles as described in chapter 2, which underpins the design of a hybrid learning configuration (HLC) at the interface between school and workplace. Analysis of responses to a questionnaire by four different HLC design teams shows that they perceived this intervention as being relevant, consistent, practical and effective. This intervention appeared to provide a conceptual framework for understanding and designing features of a hybrid learning configuration and a vocabulary to communicate design ideas. It thereby supported the creative utilization of the design principles.

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3 This chapter is based on Cremers, P.H.M., Wals, A.E.J., Wesselink, R. & Mulder M. (2015). Utlizing design principles for hybrid learning configurations. *Manuscript submitted for publication.*

INTRODUCTION

Educational design research (EDR) is a research approach that combines scientific investigation with the construction of solutions to problems that arise in educational practice (McKenney and Reeves 2012). EDR typically yields design principles that can be used as heuristic guidelines for educational improvements (Lakkala et al. 2012). These design principles are intended to be utilized in contexts other than the one in which they were generated. As such, design principles can promote collaborative knowledge building in a range of communities that are involved in designing and exploring educational interventions. They can also assist novice designers in creating effective interventions (Kali et al. 2009). To this end, the Design Principles Database (Kali et al. 2009) makes design principles that emerge from EDR available for others.

The designers of educational interventions can be individual teachers, teacher teams or interprofessional design teams (Kali, McKenney and Sagy 2015). In design teams a shared vision and goal is essential (De Koster, Kuiper and Volman 2012). Design principles can provide this vision or rationale or 'know-why' for the design (McKenney et al. 2015; Könings et al. 2013; Kali 2006). They do not prescribe how an intervention should be designed, because each intervention should be geared towards the characteristics of its specific context. Therefore, utilizing design principles for designing an intervention can be viewed as an analytical, but also as a creative process (McKenney and Reeves 2012). Although research has demonstrated that high-quality support is crucial for design success (Kali and Ronen-Fuhrman 2011), its focus has been mainly on the process of curriculum design and pedagogical expertise (Huizinga et al. 2014). Less is known about design processes that promote both creative and analytical thinking, although an interest in these processes is gaining momentum in the field of education (McKenney et al. 2015).

In this study we therefore explore an intervention for supporting the creative utilization of a set of research-based design principles by design teams of hybrid learning configurations (HLC) in various contexts. We will do so from the perspective of boundary crossing theory because it provides concepts and distinctions that aid in understanding design processes that utilize design principles. In light of this theory the set of design principles can be perceived as a 'boundary object' (Star and Griesemer 1989) that crosses the boundary from the research context in which they were generated to new design contexts in which they are utilized.

First we present the theoretical framework in which we elaborate on design principles as boundary objects. Next we present the set of design principles that we use in this study. We then describe the research method and findings. Finally, we draw conclusions, reflect on this study and offer suggestions for further research.

THEORETICAL FRAMEWORK

The theoretical output of EDR often takes the form of an empirically tested set of design principles or heuristics that can be used to guide endeavours that have similar goals and aligned tenets (McKenney and Reeves 2012). The utilization of these heuristics in new contexts could be framed as a process of transfer. Although there is no full agreement among theorists on the definition of transfer (Greeno 2006; Volet 2013), transfer can generally be characterized as the application of what is learned in one context in some other context (e.g. applying what is learned at school in a working context). Evans, Guile, Harris and Allan (2010) extend this definition when they describe transfer as a process of recontextualizing knowledge in a new context, which may spur innovation in that context.

However, creativity and innovation are not so much effects that may or may not occur when design principles are utilized in a new context, but are at the very core of the design process. McKenney et al. (2015, p. 195) argue that "powerful design heuristics contain guidance to facilitate ideation and nourish the creative spirit" when they refer to the design of educational interventions. Therefore, instead of transfer, we choose the perspective of boundary crossing theory. As mentioned before, in light of this theory a set of design principles can be perceived as a 'boundary object' (Star and Griesemer 1989). Given that boundary objects are defined as entities that are to be used and adapted flexibly in several different contexts, the boundary perspective supports our notion of design principles that promote the creative design of interventions in various educational contexts.

In the following sections we discuss the nature of design principles and their utilization. Then we present the concept of boundary objects and elaborate on the conceptualization of design principles as boundary objects. Next we discuss practical implications of this perspective on design principles and we conclude this section with the research question.

Design principles

Most EDR projects strive to develop educational interventions as well as design propositions or principles that can inform the development of such interventions by others outside the original field-testing context (McKenney and Reeves 2012). The interventions can be seen as the practical output of design research, whereas the design principles can be considered the theoretical output. Sandoval (2014) refers to design principles as 'high-level conjectures' which are manifested in features of the designed learning environment. Features may include artifacts, tools, activities or social and organizational aspects. For instance a feature of the design principle 'fostering authenticity' could be that everyone in a community relates to one another as colleagues (rather than as students and lecturers).

According to Lakkala et al. (2012) design principles can be used as heuristic guidelines for improving educational practice rather than for falsifying scientific laws. They can be used to design new educational interventions by educational researchers or practitioners but also to assess or evaluate current educational practices (Lakkala et al. 2012). "Design principles are not intended as recipes for success, but to help others select and apply the most appropriate substantive and procedural knowledge for specific design and development tasks in their own settings" (McKenney et al. 2006, p. 73).

This specific design in new settings usually implies the development of new features in accordance with the characteristics of that particular context, a process which, according to McKenney and Reeves (2012), requires creative thinking alongside analytical thinking. Kali (2006, p. 198) describes the design process as follows. When researchers articulate a design principle as a result of a study in a certain area, Kali argues, "they provide theoretical background and connect the pragmatic principles with one or more features. [...] This provides field-based evidence and illustrates how the principle was applied in its specific context. [...] Then, another research group uses the information provided in the design principle to design new features and explore them in new contexts". Over time, this can result in design principles being refined, altered, supplemented or even discarded.

Design principles as boundary objects

Boundary objects can be defined as "objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. They may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation. The creation and management of boundary objects is key in developing and maintaining coherence across intersecting social worlds" (Star and Griesemer 1989, p. 393). Examples of boundary objects are electronic patient records, which can be used by diverse medical actors or institutions, and a student's portfolio that can be used both by assessors in their educational programme and by potential employers.

In this study the 'intersecting social worlds' are the original research context in which the set of design principles was generated (the HLC 'Value in the Valley') and the new context or HLC in which the design principles are utilized. Differences between HLC contexts can be manifested in, for example, the type and number of collaborating partners (educational institutions, business, governmental or research institutions), their objectives or central issues (e.g. energy transition, healthy ageing), or in organizational and financial structures.

The set of design principles can be considered a type of boundary object that Star and Griesemer (1989) call the 'ideal type'. It is an abstraction that can be adapted to

different contexts or perspectives because it does not contain local contingencies from the common object: "All perspectives are served at once by deletion of features that are specific to each perspective" (Star and Griesemer 1989, p. 410). Therefore, the process of boundary crossing by a set of design principles can be seen as a process of first decontextualizing (i.e. viewing the design principles as abstract concepts, independently from their features in the context or perspective in which they were generated), and then recontextualizing (i.e. creatively redesigning or designing new features in another educational context). The context of an educational intervention is interpreted broadly here so as to include the actors (the practitioners who implement the intervention, e.g. Könings et al. 2007) as well as the cultural aspects, normative rules and regulations and political factors, all of which may influence the way an intervention is designed and implemented.

When a boundary object 'travels' or crosses the boundary from one practice to another, additional information (e.g. its inception, history, or surrounding negotiations) is often needed in order to enhance understanding by others. Star and Griesemer (1989, p. 146) observed that "the potential of boundary objects often goes unrecognized and untapped because underlying cultural models remain implicit." This additional information can also be viewed as a 'thick description' (Geertz 1975) that provides information on the research context in which the design principles were generated. The understanding of a set of design principles can be enhanced by giving concrete examples of their application in educational practice. Kali (2006) contends that design principles become more useful for designers when they are connected with various features that exemplify how they can be applied in different contexts.

Wenger (1998, p. 111) adds that people must also accompany the boundary objects: "Without mutual engagement, one must carefully consider the potentials and limits of boundary objects. If unaccompanied by people there is the risk of divergent interpretations." When people constitute the connection between two sides of a boundary, this is referred to as 'brokering', a situation in which people introduce elements of one practice into another (Wenger 1998). "A broker translates knowledge created in one group into the language of another so that the new group can integrate it into its cognitive portfolio. To do this, brokers must be able to manage the relations between individuals as well as act as translators" (Kimble, Grenier and Goglio-Primard 2010, p. 438).

Practical implications of design principles as boundary objects

From the foregoing we conclude that a set of design principles possesses characteristics of a boundary object. We also noted that a boundary object is preferably accompanied by additional information about its original context and that examples of features or manifestations of each design principle in practice could enhance understanding in new contexts.

A practical implication of this is that the set of design principles should somehow be 'reified' (Wenger 1998) or materialized as a product or object that can carry the concept from one practice to another. This also holds true for the additional information, such as the original features and context. For this research project we chose to describe the design principles, features and context in the form of a written document, which we called a 'guidebook'. We also concluded that a person or 'broker' should facilitate the process of introducing the design principles to a new educational practice (in this case an HLC) and thereby support their utilization as a source of inspiration for designing or redesigning features of an HLC.

In this study we chose to provide this facilitation and support in the form of a workshop. Our rationale was that workshops involve some degree of active participant action and interaction and they are therefore considered useful tools for promoting changes in the participants' practice (Rust 2006). Since the (re)design process requires creativity and innovative thinking (McKenney et al. 2015), 'prototyping' (Brown 2009) is considered an appropriate working method. Prototyping, or 'thinking with your hands', entails the use of physical props as a springboard for one's imagination. "This shift from physical to abstract and back again is one of the most fundamental processes by which we explore the universe, unlock our imaginations, and open our minds to new possibilities" (Brown 2009, p.87).

Prototyping is used not only for designing tangible artifacts (e.g. Brereton and McGarry 2000), but also for designing concepts or new ideas. Holloway (2009, p. 51) suggests that "when using artefacts to express ideas, the final deliverable in the design thinking approach is a prototype that can be used for communication, alignment, and living requirement specifications to provide clarity and transparency during the production of the solution." In other words, when the 'solution' is a set of ideas or concepts, such as the design of an HLC, prototyping could support and enhance the collaborative design and implementation process.

In this study, we refer to the workshop, including the guidebook and workshop facilitator, as an *intervention* (McKenney and Reeves 2012), which aims it is to support the creative utilization of a set of design principles in new contexts. Hence the research question is: "*What is the perceived effectiveness of a boundary-crossing intervention (based on a set of research-based educational design principles) for (re)designing hybrid learning configurations?"*

METHOD

In this study we focus on the set of design principles underpinning the design of HLCs that was generated by the EDR project described in chapter 2. Table 4.1 shows the design principles and their descriptions.

Table 4.1 Design principles for a hybrid learning configuration

Design principle – key concept	Design principle – Description
Fostering authenticity	Working/learning environment (context, tasks, activities, roles, and communication) reflects working practice, a professional working culture and organization.
Inter-linking of working and learning	Participants learn by performing real life tasks supported by educational interventions that are attuned to the task and to the individual learner, inter-linking working and learning.
Utilizing diversity	Diversity is built-in, valued and utilized both at team and organizational levels and in internal and external networks.
Facilitating reflexivity	Participants learn by reflection on tasks and experiences as a person, team and organization. Critical events in the working activities are the starting point for reflection and learning.
Creating a learning community	Community: every member should experience a sense of belonging to the community. Learner equity: every member of the community is a learner, each at their own level.
Enabling organization	The organizational structure and culture supports the working process, knowledge creation and sharing at every level (individual, team, organization, society).
Enabling ecology	The learning configuration is attuned to its surroundings, which includes partner organizations and other stakeholders.

Because we were interested in how a relevant phenomenon (the intervention) would work in different real-life contexts, we chose a case study research approach as the method for exploring whether an intervention consisting of a boundary object (the guidebook) and a broker who introduces the boundary object into a new context (the workshop), would support the creative utilization of a set of design principles.

First, the boundary object (the description of the set of design principles and the original context and features) was constructed and tested. Second, the intervention was created. Third, the intervention was conducted with four HLC design teams in different contexts. Finally, each intervention was evaluated. We describe these steps in detail below.

Step 1. Constructing and testing the boundary object

In order to 'reify' or materialize the set of design principles as a boundary object a 'guidebook' was constructed that listed the design principles and their description (as in table 4.1) and offered a description of the original research context (the HLC 'Value

in the Valley'). For each principle, examples were given of the features of the design principles as they were manifested in the HLC.

The first version of the guidebook was evaluated by the following four staff members of Hanze University of Applied Sciences (UAS): a lecturer/educational advisor (who offered a lecturer's point of view), an educational consultant involved in the development of an HLC (who offered a practical point of view), an educational consultant who writes educational strategic advice (to assess the reasoning in the guidebook) and an educational/research grant writer (who checked for completeness and clarity). This resulted in a final version that contained 3 chapters:

1. An introduction that explained the guidebook's goals, defined the HLC and gave the rationale for the development of HLCs;
2. The design principles and a short description of the HLC 'Value in the Valley';
3. The context description and the design principles with their features in 'Value in the Valley', along with effects of the features and conditions for these effects to occur.

For example, a feature of the design principle 'fostering authenticity' is working on an authentic assignment. The reported effect is that it motivates and challenges the students. A condition for this effect to occur is that a client or stakeholder is actively interested in the results (Cremers et al. in-press). Tables 2.3 to 2.8 provide further examples of features, effects and conditions. The following items were contained in the context description: activities, participants, goals and objectives, learning outcomes, vision on education and learning, and the position of the HLC.

Step 2. Creating the intervention

In order to facilitate 'Guidebook' utilization, a three-hour workshop was constructed for (re)design teams of HLCs. The workshop consisted of a short introduction of the set of principles and a short presentation about design thinking and prototyping. Depending on the participants' needs, the guidebook was made available to the participants before the workshop. Participants were also provided a form that they could use to take notes for each design principle.

The participants were asked to build a prototype of their current or future HLC with handicraft materials (figure 4.1). The participants worked individually or in groups of two or three. Each group was assigned three design principles as a starting point for their prototype. The number of design principles was limited to three in order to reduce cognitive load (Sweller 1994). Together the groups covered all seven design principles.

After having built the prototype, each group was given 'diamonds', which were shiny refrigerator magnets, and band-aids. They were instructed to place diamonds on the strong points represented by the prototype and the band-aids on the challenges or aspects that they believed needed to be developed further. Next, the groups interviewed each other about their prototypes. The diamonds and the band-aids were translated into 'strong points' and 'challenges', and these were written down on 'sticky notes'. The

sticky notes were placed on large sheets of paper and were clustered loosely around the design principles. The workshop was concluded with a short evaluation of the workshop and a discussion of the next steps that should be taken by the design team.

Figure 4.1 Building prototypes of an HLC

Step 3. Conducting the intervention in four cases

In this step, we studied four educational contexts within Hanze UAS that either were or intended to become an HLC and had asked for support during the design process. For each case the intervention was carried out in a similar way. The same version of the guidebook was used, and each workshop was facilitated by the researcher who could act as a broker given that she had also been involved in the Value in the Valley HLC as an educational consultant and researcher.

In order to be able to assess the utilization of the set of design principles for both the design and the evaluation and redesign of HLCs, cases were chosen that were at different stages of development. The 'Bureau NoorderRuimte' (BNR) case had already been functioning as an HLC for several years, 'Project Office Hanze Honours College' (POHHC) only had a few characteristics of an HCL and wanted to develop further, and two HLCs

were just starting to develop, namely the bachelor programme 'Communication and International Communication' (CO/IC), and the master programme 'Healthy Ageing' (MHA).

All four cases met our definition of HLC in the sense that they either were or intended to be built around more or less ill-defined tasks for or with stakeholders in the community. Further, the resolution of these tasks required a multidisciplinary approach, save for CO/IC, which started with monodisciplinary assignments in the first year of the bachelor programme. All four cases aimed to transcend traditional structures and sectors by making efforts to integrate aspects of education and work in one setting and by collaborating with stakeholders from different organizations and sectors. They also aimed to promote and integrate different forms of learning that depend on and are attuned to the type of assignments and the participants' requirements. The HLCs can be characterized as follows.

Bureau NoorderRuimte (BNR), in English 'Office of the Northern Region', is part of the Centre of Applied Research on Area Development NoorderRuimte. It is a hybrid practice in which graduate students from various study programmes, lecturers, researchers, professors and professionals work and learn together in order to solve spatial issues in the Northern region of the Netherlands and Germany. These projects are initiated by NoorderRuimte or its external environment. Four departments of Hanze UAS, namely Facility Management, Engineering, Built Environment and Business Administration are responsible for staffing Bureau NoorderRuimte with students, lecturers and researchers. Students are assisted in their personal and professional development by senior staff members of BNR.

The *Project Office Hanze Honours College* (POHHC) acquires projects from external clients for all students of Hanze UAS who follow an honours programme. POHHC assigns students to clients and provides a coach (a lecturer) for each group of students. The coach awards study credits at the end of a project (which can vary in length) based on several criteria: the product delivered by the students, client satisfaction and the extent to which students have been engaged and have realized their individual learning outcomes. The next step for POHHC would be to design organizational, cultural and educational aspects more explicitly and to further attune them in ways that better facilitate the students' learning and assessment.

The bachelor programme 'Communication and International Communication' (CO/IC) is a regular study programme that is being redesigned as an HLC. The new curriculum is intended to function as a hybrid working and learning environment in which the students work on assignments from clients starting on the first day of their study. The physical, organizational and cultural environment is intended to reflect an authentic working context that is interwoven with 'regular' courses or educational activities.

The Master Healthy Ageing (MHA) is a completely new master programme. It aims to educate working health professionals from different sectors with a bachelor degree to

become 'healthy ageing professionals'. This new type of professional conducts transition processes within the health sector that require multi-stakeholder collaboration and learning. The master programme wishes to provide a suitable working and learning environment by designing it as an HLC.

Step 4. Evaluating the intervention

The aim of the intervention was to support the creative utilization of the set of design principles for the design or redesign of an HLC. The effectiveness of the intervention was evaluated both as a direct outcome (does the set of design principles support creative (re)design of the HLC) and as a more indirect outcome (is utilization of the set of design principles expected to lead to an improved HLC). This ultimate goal can be seen as the 'bottom line effect' (Van Aken 2004) of the intervention, which is beyond the scope of this study.

Besides effectiveness, relevance, consistency and practicality of the intervention were evaluated because these quality criteria can be considered prerequisites for an effective intervention (Nieveen and Folmer 2013). The four quality criteria are defined as follows:

- Relevance: there is a need for the intervention, and its design is based on state-of-the-art (scientific) knowledge – also called content validity.
- Consistency: the intervention is 'logically' designed – also called construct validity.
- Practicality: the intervention is usable in the setting for which it has been designed.
- Effectiveness: the intervention results in the desired outcomes.

Table 4.2 shows how each criterion was made operational for both the content (the design principles) and form (the guidebook, the workshop) of the intervention. The criterion 'effectiveness' applies to the intervention as a whole.

Data were collected in three ways (table 4.2):

1. Feedback from experts was solicited regarding the *consistency* of guidebook and workshop. As described earlier, four staff members evaluated the guidebook. The set-up of the workshop was constructed by the researcher with the assistance of an expert in the field of design thinking and prototyping at Hanze UAS.
2. Questions regarding *practicality* of the workshop were asked during the workshop. The workshops were audio-recorded for this purpose.
3. A digital questionnaire contained questions concerning the *relevance*, *consistency,* and *practicality* of the set of design principles, the *relevance* of the guidebook and the *effectiveness* of the intervention as a whole. For each question, respondents could answer "Yes" or "No"), and they were provided with boxes for elaboration on their answer. The questions were the same for each HLC but the term HLC was 'personalized' in each case.

The questionnaire was emailed to the workshop participants the day after the workshop.

Table 4.2 Evaluation criteria for educational interventions

CRITERIA	METHOD OF DATA COLLECTION	OPERATIONALIZATION
Relevance *Content*	Questionnaire	The set of design principles is relevant for the HLC. The set is considered complete; none of the principles is redundant.
Form	Questionnaire	Guidebook and workshop are both needed by and relevant for the users.
Consistency *Content*	Questionnaire	The set is logical and it is clear what each design principle represents. A description of the context (thick description) and examples of features of an existing HLC clarify the meaning of the design principles.
Form	Feedback from experts	Guidebook and workshop are structured in a logical way.
Practicality *Content*	Questionnaire	The set is useful (i.e. it helps to get an overview of and structure one's knowledge about HLC).
Form	Questionnaire/Feedback in workshop	Guidelines and workshop are user-friendly.
Effectiveness *Content and form*	Questionnaire	Utilization of the set of design principles supports the creative (re)design of the HLC and is expected to lead to an (improved) HLC.

A total of 32 participants (out of 44) responded to the questionnaire. Table 4.3 shows for each HLC how many of the workshop participants responded to the questionnaire. All of the six workshop participants of BNR (five lecturers and one coordinator) filled out the questionnaire. For POHHC the response was six out of eight participants (two lecturers, one coordinator, one manager, and two external clients). Eight out of fifteen participants of CO/IC (one manager, six lecturers, one educational consultant) and twelve out of the fifteen MHA workshop participants responded (six lecturers, two professors, two educational consultants).

Table 4.3 Workshop participants and responses to the questionnaire

HLC	Workshop participants	Responses to questionnaire
BNR	6	6
POHHC	8	6
CO/IC	15	8
MHA	15	12

FINDINGS

First, we will present the findings relating to relevance, consistency and practicality of the content of the intervention (the set of principles), followed by findings regarding the form (the guidebook and workshop). We conclude this section with results relating to the effectiveness of the intervention as a whole.

Relevance, consistency and practicality of the design principles (content)

The respondents of the four cases (32) almost unanimously found the set of design principles *relevant* for their HLC. They also thought that the set was complete. No principles were considered either redundant or missing, except for the following two suggestions that were made in the MHA case: "Add a principle concerning the coherence between educational units within the programme", and also a principle that would facilitate "making it fun, interesting and useful to learn from each other".

Regarding *consistency*, which concerned clarity and reasonability, some participants of POHHC and MHA indicated that the principles were "a bit too theoretical and abstract" and did not provide enough guidance for actually developing the HLC: "The principles are quite broad; you have to colour them by yourself". According to most respondents, the examples of how design principles were manifested in the HLC 'Value in the Valley' helped them to get a better understanding of the design principles. In turn, this helped them relate the principles to their own HLC. One participant from the CO/IC group wrote the following about a feature of the design principle 'fostering authenticity': "The role of students as junior employees and lecturers as senior employees was an eye-opener for me." Also, some participants indicated that they would have liked to read or hear more about this HLC. Others in the BNR and POHHC groups said they would have preferred to elaborate more on manifestations of the design principles in their own HLC.

28 out of 32 participants from three different cases confirmed that the set of design principles helped them structure their knowledge of HLC and get an overview of what is involved when designing an HLC. One participant from the POHHC group commented that there seemed to be some overlap in the principles.

Relevance, consistency and practicality of the guidebook (form)

Almost all respondents (29 out of 32) indicated that they had read the guidebook. The guidebook was considered *relevant* as a preparation for the workshop by most participants because it informed them about what the workshop would be about (BNR) and what could be expected of the workshop (MHA). It also provided common prior knowledge by defining the concepts in a way that ruled out confusion about them during the workshop (POHHC).

The respondents also mentioned other merits of the guidebook: "It provides a clear framework, the vision on this type of learning environment is described clearly and it

provides focus on the subject" (MHA), "the guidebook gives a good overview of the design principles" (PBHHC, BNR), and "the design principles seem feasible" (MHA). The guidebook makes you aware of aspects that have to be considered seriously, and it gives background information and justification of the principles" (BNR).

Respondents commented on the *consistency* of the guidebook as being informative (PBHHC), concise, comprehensive, clear, insightful and usable (MHA). It also provided "examples of how something abstract can be applied in practice" (MHA). A respondent suggested expanding it by adding examples other than the Value in the Valley HLC (BNR).

Regarding *practicality,* the guidebook was found useful as a reference book when developing the HLC: "I can use it as a guideline, it gives a good idea of how an HLC can be developed" (POHHC). Some participants had expected it to be more like an instruction guide: "I miss the working method of developing an HLC; how do you proceed?" (POHHC) and "Practical application remains vague" (MHA). Other comments were that the guidebook "stimulates you to think about the HLC" (CO/IC) and that providing the guidebook before the workshop "gives you the opportunity to read it in your own time and pace" (MHA).

Relevance, consistency and practicality of the workshop (form)

In all four cases the workshop was found *relevant* because it provided an opportunity to exchange ideas about the development of the HLC. The prototyping exercise lead to lively conversations in which many metaphors were used for aspects of the HLC. For instance: a butterfly was used to symbolize playing, flittering and discovering, which all stand for the idea that students are activated and not merely taught. In addition, the prototyping exercise itself was used as a metaphor for designing the HLC: "We don't have the perfect tools and facilities, but we work with what we have and make the best of it!" (CO/IC). The metaphors of the diamonds and the band-aids were used during all the presentations and also after the workshop: "When we encounter a problem that we don't know how to solve right away, we say: 'let's put a band-aid on that issue'" (MHA).

Participants had no comments regarding *consistency*. The participants from BNR suggested that there should be an increased focus in the introduction on BNR instead of Value in the Valley given that the guidebook containing information on that case had been read beforehand. POHHC members requested a follow-up workshop that focused specifically on their assignments.

As to *practicality,* most of the participants indicated that the workshop provided an opportunity to engage in conversation about the HLC. During this conversation, ideas were generated for the practical development of the HLC. BNR intended to use the outcomes of the workshop (namely, the strong points and challenges for the HLC) in a strategic meeting about the future of the HLC, which was already planned.

The workshop seemed to enhance a shared image of the HLC among the team members. For CO/IC, creating a common image of the new curriculum and identifying the most urgent challenges were important steps. The relevant challenges for them were the acquisition of enough assignments from clients and the definition and implementation of new roles of the lecturers.

The MHA team valued the workshop for the opportunity to exchange ideas about the direction of development. Many practical questions, however, remained unanswered for them. For example, they still wondered which assessment methods are appropriate in a given learning community. Some of the participants (POHHC and MHA) expected to obtain more concrete ideas for developing their HLC at the end of the workshop.

The POHHC team discovered that their context or frame of reference was not sufficiently well-defined. Issues they discussed were: what do we expect from students and clients, in which directions should students develop competencies, and what are desired learning outcomes given the variety of different projects. They felt that more time was needed to elaborate on the design principles, and for this purpose a follow-up meeting was arranged. In general, the workshop was considered to be fun, pleasurable, creative, useful and meaningful. Some participants indicated a preference for doing the workshop earlier in the process (MHA, CO/IC).

In every workshop the participants were very interested in each other's prototypes, and every prototype was discussed with the whole group. Participants appreciated each other's efforts. Though some participants were initially reluctant to start building a prototype, in the end every participant had participated in prototype building.

Effectiveness of the intervention

Effectiveness was made operational (table 4.2) as a direct outcome of the intervention (*utilization of the set of design principles supports the creative (re)design of the HLC)* and as an effect on the longer term (*utilization of the design principles is expected to lead to an improved HLC)*.

Direct outcomes

The set of design principles was considered a source of inspiration and new ideas by BNR and MHA participants. The set also helped determine "where we stand now, what we are already doing and what to develop further. By identifying strong points and issues for further development, the set is useful for evaluation and improvement" (BNR).

The set of principles was viewed as a kind of checklist by participants of CO/IC and MHA: "the set makes clear what you have to keep in mind when developing an HLC". MHA participants also said that it structured thinking about the design and enabled choices to be made more consciously. BNR and MHA participants saw more coherence and alignment between the features of the HLC: "I have become aware that each principle influences the result", "working with the design principles enhances uniformity and

continuity between elements of the HLC" and "the principles are relevant as a whole" (CO/IC).

The design principles were also seen as a shared frame of reference (MHA) that delimits the playing field (POHHC). MHA participants saw the design principles as "a way to clarify our criteria and get consensus about them". The workshop also was viewed as a way of "making the concept alive in the heads of the lecturers" (CO/IC).

Working with the design principles also made some participants reflect on their design team and on the design process. An MHA participant remarked: "We are a community of learners ourselves". One of the BNR participants realized that "it is clear that we can make improvements, this gives starting points for further development; dealing with it in an analytic way helps to identify parts and develop them further."

Expected long term results

When asked whether the respondents thought that their HLC would improve by applying the set of design principles and in which way, the following answers were given.

Participants of POHHC expected that working with the design principles would provide more clarity in communication between lecturers, students, clients and other stakeholders. A common language would also result in more structure and more uniformity in working methods.

CO/IC respondents valued the principles as way of justifying their approach as being in line with Hanze UAS' vision on education. The fact that the design principles were underpinned by research "would be a pro when the programme is audited". Participants in three cases expected that the educational quality of their HLC would improve by using the set of design principles: "The principles provide a frame of reference for how we can offer more structure to students for carrying out their projects and for facilitating their learning processes" (POHHC) and "elements of the HLC will be better attuned to each other" (BNR). MHA participants expected that the chances of designing 'traditional' education activities would decrease and that the programme would be sufficiently practice-oriented if the designers incorporated the principles

One lecturer of POHHC remarked that although the set of principles represented a framework that delimited the playing field, this would also give the designer the freedom to be flexible in their execution of the HLC: "The practical application can vary for each assignment since the role and requirements of each client can be different."

Some of the CO/IC participants did not yet know whether the set of design principles would be useful or not. One of them commented that the set was useful "as long as we don't apply everything at once" (CO/IC). An MHA lecturer thought that if a lecturer puts the students in charge of his or her own learning processes, the role of the lecturer changes automatically to being more like a colleague. Another response was: "We will know if the set was useful when the programme we execute has proven to be successful" (MHA).

CONCLUSIONS

Based on the results we can now answer the research question: "*What is the perceived effectiveness of a boundary-crossing intervention (based on a set of research-based educational design principles) for (re)designing hybrid learning configurations?"*

In order to support the creative utilization of the design principles, we developed an intervention by:

1. conceptualizing the design principles as boundary objects that fall into the category 'ideal type';
2. providing contextual information about the original research context (Value in the Valley);
3. providing features of the design principles in the original research context;
4. reifying principles, features and context (in the guidebook);
5. having a broker introduce the set of design principles as a boundary object in four new contexts (workshop) and
6. having the participants create a prototype of the HLC in their own context, which implied decontextualizing (i.e. letting go of features of Value in the Valley) and recontextualizing (i.e. designing features of their own HLC).

The results indicate that participants perceived this intervention as being relevant, consistent and practical. In the four cases studied almost all participants acknowledged the relevance of the *set of design principles (1)* for their own educational practice. They almost unanimously thought that the set was complete and none of the principles was redundant. Some participants remarked that there seemed to be some overlap among the principles. The set of design principles was considered helpful for structuring the participants' knowledge about HLCs and for getting an overview of aspects related to them.

The *contextual information (2)* about Value in the Valley helped participants to define their own context more clearly. In one case it revealed that the context (the goals, positioning, etc.) of the HLC had not yet been defined clearly, and this seemed to hinder the design process because the participants did not start the prototyping exercise until they had had a long discussion about certain aspects of the context. This suggests that decisions about the context should be made before or in early stages of the design process.

The *features (3)* of Value in the Valley enhanced understanding of the principles for most of the participants, although there was an observable difference between the existing HLCs and the new HLCs. The designers of the existing HLCs (BNR and POHHC) would have appreciated more examples of features of their own HLC, whereas some of the designers of new HLCs (CO/IC, MHA) would have preferred more information on Value in the Valley. This suggests that (re)contextualizing is easier if there already is

an existing context. Therefore, it seems advisable to attune the extent and content of exemplary features to the developmental stage of the HLC.

The guidebook (4) was characterized by different people as a reference book, as an incentive to think about HLC, and as a guideline when developing an HLC, whereas the *workshop (5)* was appreciated for the fact that it provided an opportunity for the design teams to have conversations about the principles.

The *prototyping (6)* activity facilitated the exchange of ideas about further development of the HLCs, but was not seen as providing instruction or resulting in instant solutions to or decisions about practical issues.

Effectiveness of the intervention

The intervention seemed to have three main outcomes: an enhanced understanding of the structure and coherence of elements of the respective HLCs, a shared image of the HLC with its strong points and challenges, and ideas and inspiration for how to (re) design the HLC. Therefore, we conclude that the design principles, conveyed by this intervention, appeared to provide a conceptual framework for understanding and designing features of an HLC and a vocabulary for communicating design ideas, and, thereby, supported creative utilization of the design principles.

Effectiveness on the longer term

As to the ultimate goal, or bottom line effect, most of the participants expected the HLC to improve by utilizing the design principles. They indicated that this could happen in several different ways. In the design process, the set was expected to be used as a checklist and frame of reference that would foster conscious choices. At the same time, some of the participants thought that the principles did not provide enough guidance for developing their HLC. Participants indicated that using the principles would lead to better communication and harmonization within the HLC and with external stakeholders. It would enable the team to base the design on an educational vision that is underpinned by research. Educational quality would be increased by better facilitating the learning process of the students and by better attuning the elements of the HLC to each other.

Although the actual development and possible improvement of the HLCs is beyond the scope of this study, we conclude that using the set of design principles can potentially benefit the design of HLC by facilitating more conscious choices by the design team and by fostering better internal and external communication about both the HLC itself and the harmonization of its elements.

DISCUSSION

In this study we used a set of design principles that were the result of a single case study. Even though the principles were underpinned by theoretical concepts and educational experience and tested in practice in three consecutive iterations (Cremers, Wals, Wesselink and Mulder in-press), transposing these principles to another context might be considered problematic. According to Yin (2003) researchers should strive to validate the results of a single case study by testing them in more cases and in various contexts. In this study we checked this in a modest way by asking the participants if they thought that the set of design principles was relevant and complete, and the responses were almost unanimously affirmative.

However, as Gravemeijer and Cobb (2006, p. 45) point out, "in EDR complete replicability is neither desirable nor, perhaps, possible". Design research aims for *ecological validity*, which is the idea that the (description of) the results should provide a basis for adaptation to other situations (Gravemeijer and Cobb 2006). Utilization of design principles in new contexts leads to adjustments that are geared towards the unique characteristics of that context (Kali 2006). In our study participants designed new features, suggested slightly different wording of the design principles and adjustments in the guidebook, and each design team had its own preferences for the type of features used as examples.

Local conditions justify the use of design principles for guidance and direction, but not for giving certainties (Plomp 2013). In our study some of the participants did expect more 'certainties' than the design principles were intended to offer. This suggests that expectations of those involved were not managed well enough. It could also indicate that these participants lacked design expertise (Huizinga et al. 2013). It also might indicate that these participants would be more comfortable adjusting an existing intervention or a 'curricular framework' to their own context rather than designing an entire intervention based on design principles.

Some of the respondents in this study indicated that the design principles seemed to overlap. Indeed, features of an HLC could be inspired by multiple principles. For example, when a feature of an HLC is 'all stakeholders work at fixed times in the same room', this can be inspired by the principles 'enabling organization' (the room being a physical facility) and 'fostering a learning community' (having people share a room is expected to enhance collaboration). This is in accordance with Sandoval's (2014) model according to which design principles and features are related in multiple ways.

These multiple relationships between design principles and features suggest that having designers think about features for each separate principle, and presenting examples of features in this way (Cremers et al. in-press) is not correct. However, we also found that participants appreciated this analytical or 'atomistic approach' (Van Merriënboer and Kirschner 2007) in order to understand each design principle. When they built the prototypes, the participants seemed to work from a more holistic conceptualization

of the set of design principles, and they did not seem to be constrained by the idea that each feature should be related to only one principle. Therefore, we conclude that it may be advisable initially to present the design principles and their related features as separate entities and to use them in a more holistic way in the actual design process.

In this study we framed the design principles as a boundary object. According to boundary crossing theory, we noted that a boundary object is preferably accompanied by information about its original context and by a 'broker' who constitutes the connection between different worlds, i.e. different HLCs. Indeed, the results suggest that utilization of the design principles was enhanced when participants were provided with information about the context and examples of features of the HLC in which the design principles were generated. The researcher, who conducted the intervention, acted as a broker because she explained the design principles and their original context further. She also connected different practices with each other by providing examples of how the principles are manifested in several different HLCs, including the participants' own HLC. Thus, we conclude that boundary crossing theory, indeed, provided a useful perspective on the utilization of a set of design principles in different settings.

CONCLUDING REMARKS

As mentioned in the introduction, it is important that design teams of educational interventions work from a shared vision or rationale and that high-quality support is available. Both of these are crucial for design success. We also noted that although research has been carried out on ways of supporting the design process, not much research has focused on the creative utilization of a set of design principles as the rationale for a complex educational intervention. Hence, this study was aimed at developing an intervention that supports hybrid learning configuration design teams. Further research could be directed towards other or complementary ways of support, such as technology-based methods. In addition, longitudinal case studies could reveal whether the potential long term benefits of utilizing the design principles that are suggested in this study can be fully realized.

Chapter 5

Learning across boundaries during the design and implementation of a hybrid learning configuration[4]

In chapter 1 we defined a hybrid learning configuration (HLC) as 'a social practice around ill-defined authentic tasks or issues whose solution requires transboundary learning'. Because of its transboundary nature, the design and implementation of HLCs is often a collaborative effort conducted by actors from different educational institutions and other organizations, such as companies or (non)governmental institutions.

Since the actors in this design process come from different practices and perspectives, they are likely to experience boundaries. Although these boundaries can hinder cooperation, they can also be vital sources for learning. In this chapter we explore the nature of boundaries and boundary crossing activities in order to enhance their learning potential. We pursue this aim by studying the interprofessional team that designed and implemented the hybrid learning configuration (HLC) that we described in chapter 2.

In this study, transcripts of interviews with members of the design team were coded using a theoretical framework. This framework provided a lens through which different ways of boundary crossing and learning mechanisms and processes became visible. We found that when boundaries are detected and the related practices are made explicit, this allows for further analysis of these boundaries, which in turn can provide possible strategies for enhancing cross-boundary learning.

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4 This chapter is based on Cremers, P.H.M., Wals, A.E.J., Wesselink R., & Mulder, M. (2015) Learning across boundaries during the design and implementation of a hybrid learning configuration. *Manuscript submitted for publication*.

INTRODUCTION

The design of learning environments in higher and vocational education is no longer exclusively the task of one or more lecturers within a certain study programme. The design is often performed by a team of educators and other professionals representing different fields of study and working contexts (e.g. Zitter and Hoeve 2012). The motivation for such an approach to design is that in our 'knowledge society' (Hargreaves 2003) professionals are expected to create knowledge collaboratively, across the boundaries of disciplines, professions and perspectives (Linden 2003; Black 2002). Learning environments that aim to prepare students to become such 'knowledge workers' should reflect this transboundary nature. Hence, they are best designed by teams that consist of professionals from different organizations or practices.

When these professionals bring their different perspectives into the collaboration, they are likely to experience boundaries (Akkerman and Bakker 2011a). These boundaries may either hinder or enhance cooperation. Although boundaries can be seen as barriers, they can also be 'spaces' with potential for learning. They can even be vital sources of change and development (Roth and Lee 2007) that provide "a chance to explore the edge of your competence, learn something entirely new, revisit your little truths, and perhaps expand your horizon" (Wenger 2003, p. 84).

Although several researchers have started to emphasize that boundary crossing can enable learning, they have not discussed explicitly how this is done (Akkerman 2011). Akkerman and Bakker (2011b) conducted a review of the emerging body of literature on boundary crossing and provide a theoretical framework that characterizes the nature of boundaries as well as the learning mechanisms and associated processes that occur when crossing boundaries. Based on this theoretical framework we aim to gain a better understanding of boundaries and explore how this understanding could enhance learning.

We pursue this aim by studying an interprofessional team that designed and implemented a hybrid learning configuration (HLC) at the interface of school and workplace in which learning is embedded in ill-defined, authentic tasks (Cremers et al. 2014; Zitter 2010; Zitter and Hoeve 2012). This 'HLC-team' consisted of lecturers from different educational institutions, educational consultants and business representatives.

First we present the theoretical framework. Next we describe the research approach and the team that was researched. Finally, we report the main findings and draw conclusions from our analysis.

THEORETICAL FRAMEWORK

Transboundary learning is seen as a process that involves multiple perspectives and multiple parties. Its emphasis is on overcoming discontinuities in actions or interactions that can emerge from social or cultural differences (Akkerman and Bakker 2011b). One could argue that all learning is believed to involve some form of cognitive discontinuity or dissonance (Festinger 1957; Berlyne 1960). The boundary perspective, however, adds to conventional learning theories the dimension of two-sided actions and interactions between learners from different contexts. In transboundary learning the main unit of analysis is not constituted by one community or context, but rather by different but related social practices. Whereas diversity is often perceived as problematic in conventional theories of learning, in transboundary learning this diversity is appreciated (Akkerman and Bakker 2011b).

In our theoretical exploration we address three issues that are central in the literature research on boundaries by Akkerman and Bakker (2011b). First, we discuss the nature of boundaries and how they can be detected. Second, we explore possible learning mechanisms and processes that can occur across boundaries. We conclude with a discussion about how boundaries can be bridged by persons, objects and language.

Boundaries can be defined as "socio-cultural differences leading to discontinuity in action or interaction. Boundaries simultaneously suggest a sameness and continuity in the sense that within discontinuity two or more sites are relevant to one another in a particular way" (Akkerman and Bakker 2011b, p. 133). For this study we view 'socio-cultural differences' broadly to include not only differences relating to physical locations or practices, but also more abstract distinctions, such as different perspectives or perceptions of unfamiliar domains (Engeström et al. 1995). These differences can be perceived explicitly by diverse actors or they can be more implicit but empirically detectable via so-called *verbal markers* (Kerosuo 2004). These markers can be references to synonyms of the word boundary (e.g. border, limit), metaphors (e.g. fences, walls), references to social relationships such as 'we versus them', or spatial references to different locations.

In their literature review of boundary crossing and boundary objects Akkerman and Bakker (2011b) employed the term 'learning' in a very broad sense such that it includes new understandings, identity development, change of practices, and institutional development. They found the following four types of dialogical mechanisms for learning that occurs at boundaries:

- *identification*: distinguishing boundaries and related different perspectives and identities;
- *coordination*: facilitating exchanges across boundaries;
- *reflection*: expanding or changing (developing new) perspectives and identities;
- *transformation*: co-developing new practices.

These four mechanisms are related in several different ways. Identification and reflection are oriented towards perspective and identity and, thus, are related to meaning-based learning. Coordination and transformation are more action-oriented and, thus, are related to practice-based learning. Identification and coordination can be considered ways of adaptation in that they require crossing and negotiating boundaries. Both distinct worlds coexist on each side of a boundary, and this allows for 'multi-voicedness' (Bakhtin 1981). By contrast, reflection and transformation tend to transcend boundaries. They require learners to create a new, hybrid entity (e.g. a new perspective, a new identity or a new practice) that contains ingredients from both practices that do not belong to and are unspecified in either world.

Akkerman and Bakker (2011b) also found different *processes* within the four boundary learning mechanisms. We present and describe these processes in table 5.1. For the worlds on each side of a boundary we use the general term (socio-cultural) 'practice'.

Table 5.1 Boundary learning processes and learning mechanisms (based on Akkerman and Bakker 2011b)

Learning mechanism	Characteristic Processes of boundary crossing	Description
Identification	Othering	Different practices distinguish their identities in light of the perceived boundary.
	Legitimating coexistence	Defining the complementarity of different practices.
Coordination	Communicative connection	Exchanging relevant information across boundaries.
	Efforts of translation	Giving and sharing meaning by using languages from different practices.
	Increasing boundary permeability	Minimizing discontinuities; making it easy to cross a boundary (lowering the threshold) by establishing connections between practices.
	Routinization	Developing procedures that make boundary crossing efficient; connecting actions in one practice to those in the other.
Reflection	Perspective making	Recognizing and making explicit the different perspectives of each practice.
	Perspective taking	Looking at things from the perspective of the other practice with the goal of changing one's perception or frame of reference.
Transformation	Confrontation	Making explicit significant discontinuities.
	Recognizing shared problem space	Addressing a problem that is significant for both practices.
	Hybridization	Combining ingredients from different practices into something new.
	Crystallization	Materializing or applying hybrid creations in practice(s).

The connection across boundaries can be enhanced by artefacts and language and can also be embodied by people. Artefacts or *boundary objects* can be defined as "objects that inhabit several intersecting practices and satisfy the informational requirements

of each of them [...]" (Star and Griesemer 1989, p. 393). Boundary objects can be concrete documents or instruments, but they can also be more abstract concepts taking the form of a common language that can represent shared concepts, symbols, routines, ways of doing things, etc. For example, in a particular HLC, the students, lecturers and other practitioners refer to each other as 'colleagues' and 'junior' and 'senior' employees, respectively. The latter form of boundary object is called the '*shared repertoire*' (Wenger 1998). When people, as opposed to objects, facilitate connections across boundaries they are essentially negotiating or 'brokering' across boundaries. They can do this by introducing elements of one practice to another. The broker is said to provide a 'participative connection' between different practices (Wenger 1998).

As stated in the introduction our main question is: *In which ways could a better understanding of boundaries enhance learning?* Inevitably related questions include:

- What is the nature of the boundaries experienced by the actors?
- Which boundary markers do they use?
- What (potential) learning mechanisms and processes are in play?
- What is the role of boundary objects and brokers?

METHODS

In this study we relate the espoused reflections on boundary (inter)actions by the members of an HLC team to the main elements of the theoretical framework. The research questions in this study are answered by mirroring the theoretical framework on boundaries with the verbatim reports of interviews conducted with 11 members of the team that designed the HLC we described in chapter 2 (the researcher, who was also a member of this team, excluded). The primary aim of the interviews was to derive design principles for an HLC by asking the interviewees about strong and weak features of their HLC (Cremers et al. in-press).

A frequent topic in the interviewee's responses was the ways in which the HLC-team had collaborated and learned across perceived differences among them during design, implementation and evaluation of the HLC. Therefore the data seemed to provide an opportunity for a secondary analysis in which we could apply the theoretical framework on boundaries and boundary learning to gain an understanding of transboundary learning processes.

The interview reports were coded using ATLAS-ti. Each quote that could be related to the theoretical framework was included in the findings. We indicate whether several participants made the same point (e.g. "we did not question each other enough"), and if many or most participants made the same point, we indicate that as well. This implies that the findings do not represent a consensus, but rather a collection of relevant experiences related to perceived boundaries.

Quotes relating to the HLC-team itself and its working practice (i.e. the HLC) were coded as 'team' and 'practice' respectively. From these quotes and other contextual

information from project documents a description was created, which was summarized in the section 'The design team in context'. In addition, we looked for references to boundaries. Through open coding the relevant quotes were coded according to the nature of the boundaries found. Three boundaries were selected that appeared most prominent in the data: 1) the boundary between business and education, 2) the boundary between the designers and the educators, and 3) the boundary between the HLC and its surroundings.

For each of these boundaries the related articulated reflections were summarized in memos and pasted in a separate document. The memos in each document were then coded according to the key elements of the theoretical framework:

- *Nature of the boundary* (origin, practices separated by it)
- *Boundary markers* (metaphors indicating separation that were used by the participants)
- *Learning mechanisms and processes* (table 5.1)
- *Boundary objects and brokers* (objects, people, language).

Descriptions of the three boundaries were created on the basis of these memos. For each boundary we indicated which team members commented on the boundary and the perspective from which they did so.

Validity and trustworthiness

When performing a secondary data analysis it is important to know who performed the primary study and in which context the primary data were collected (Heaton 2004; Bishop 2007). In this case those conditions were met because the secondary analysis was performed by the same researcher who conducted the interviews for the primary analysis. Contextual information was available through project documents and notes by the researcher who had also participated in the HLC as an educational consultant.

A potential pitfall of a secondary data analysis is a 'lack of fit' (Hammersley 2010) given that the data were collected with a different set of research questions in mind. On the one hand, certain issues relevant to boundaries may not have emerged in the data since interviewer did not have the boundary theory framework in mind while interviewing the participants. On the other hand, the risk of bias was reduced because the initial research did not explicitly focus on boundary issues.

In order to increase validity of the findings, a member check was performed (Guba 1981). For each of the boundary practices investigated (education – business, educators – designers, HLC-team in general) a representative participant was asked to comment on the findings and the conclusions. These five participants validated most of the findings and supported the conclusions. They added the following comments:

- Some of the participants had not experienced boundaries as strongly as others and felt that they had often acted as brokers between the practices separated by the boundaries.

- The time each of the team members had available for working at the HLC varied and may have influenced their learning capacity.
- Focusing on boundaries seems to highlight their negative or problematic aspects too much. Working and learning at the HLC for the most part was a very inspiring, pleasurable experience.
- One participant mentioned that many more actions and interactions had occurred around the boundaries that were not captured in the data and that dynamics within the HLC-team had changed over time. He also remarked that it probably would have been impossible to capture everything that goes on within a complex social practice such as the HLC.

The results of the member check have been included in the findings and the conclusion.

Finally, this study, being a single case study, aims for ecological validity (Brewer 2000). This implies that the results should provide a basis for adaptation to other situations. Therefore a more elaborate description is provided here to understand the team's motives and intentions (Gibbs 2008). Such an understanding can help others determine whether transfer from the reported situation to their own is possible (Van den Akker 2007).

THE DESIGN TEAM IN CONTEXT

The design team collaboratively designed, constructed, implemented and evaluated an HLC in six iterations of one semester each. The HLC, which is described in more detail in chapter 2, was initiated by two Dutch educational institutions for senior secondary vocational education (in Dutch MBO) and two universities of applied sciences (in Dutch HBO), in collaboration with two companies. The HLC aimed to address an increasing demand from industry and business for professionals who are able to contribute to multidisciplinary and multi-sector innovations in the field of sustainability (Antonides and Hoetink 2005).

The core design team consisted of twelve participants from four educational institutions and two companies (table 5.2). Five lecturers from five different study programmes participated: one lecturer from agricultural MBO, two lecturers from technical MBO, two lecturers from technical HBO; two educational consultants/ researchers from HBO (one of which was the researcher), one independent educational consultant; two participants from companies; a project manager and a secretary from an MBO school. The team members worked part time at the HLC and spent the rest of their time at their own educational institution or their company.

Table 5.2 Composition of the core HLC–team

The HLO-team members	
Lecturers MBO	↑ Livestock Farming ↑ Process Technology ↑ Dutch language and communication
Lecturers HBO	↑ Human Technology ↑ Chemical Technology
Educational consultants	↑ Advisor curriculum design & evaluation ↑ Independent educational consultant ↑ Advisor curriculum design & research (the researcher)
Project management	↑ Project manager MBO ↑ Secretary MBO
Business	↑ Client manager civil infrastructure and buildings ↑ Business unit manager Industry Services oil and gas industry

The HLC represented an authentic working context in the sense that it functioned as a consultancy firm. Students from different study programmes and levels were the 'junior employees' and the design team or 'HLC-team' acted as the senior employees. The students worked on assignments in the community and engaged in educational activities, whereas the HLC-team worked on the design and development of the HLC. They also instructed, coached and guided the students, and they recruited clients and students for each new iteration. Students and HLC team members worked in the same room at fixed times, which provided ample opportunity to meet and interact with one another.

During the successive iterations, the team developed the HLC further by combining elements from school and workplace into a new practice, which was different from 'regular' education and working life. For instance, the team intended to form a 'learning community' in which all participants - junior and senior - are learners, each at their own level. Elements from school and workplace were also combined in the procedure for acquiring assignments from clients and matching them with the learning needs of the multidisciplinary student teams.

The team members were eager to learn and experiment, and they appreciated the team's diversity. They learned a lot from each other and were genuinely interested in each other at a professional and personal level. Although it was apparent to them that they had different views of education, different expectations of the students and different prior knowledge, they did not tend to confront each other about these issues often. All team members enjoyed the working atmosphere at the HLC, which they characterized as cheerful, pleasurable, inspiring and dynamic. They particularly enjoyed witnessing the rapid professional and personal development of the students.

FINDINGS

The findings on the following three boundaries are presented here: 'Business and education', 'The designers and the educators' and 'The HLC and its surroundings'.

Boundary 1. Business and education

The boundary between business and education resulted from differences at a systemic level that stemmed from the fact that the HLC-team consisted of participants from schools and companies. The team had to collaboratively create a hybrid practice, which required interweaving ingredients from both work and school environments. This boundary was mentioned by one lecturer, the project manager and the secretary, all of whom represent the educational perspective. Both business participants also mentioned it.

Nature of the boundary and boundary markers

The team's common goal was to prepare students from different study programmes and levels for a future in the 'knowledge society' by having them carry out assignments for real clients in the community. From the start, the participants from education had very different motives for participating in the HLC. These included 'contributing to People, Planet, Profit' or 'coaching students in real-life projects'. The business participants' goals were to learn more about education and coaching and about implementing the concepts of the HLC into their own companies. No metaphorical boundary markers were used relating to this boundary, as the participants referred to each other simply as colleagues 'from education' and 'from business'.

Learning mechanisms and processes

Two learning mechanisms were apparent in the quotes about the boundary between business and education, namely *reflection* and *transformation*.

Reflection

The processes of perspective making and perspective taking seemed to arise from the participants' recognition of the uniqueness of each of the practices of school and of work.

Perspective making was expressed by a business participant who noticed that the way meetings were conducted and decisions were made seemed to be different in a school culture than in a working culture. "At the HLC we have long meetings, discussing lots of things, always using all the time planned for the meeting. At my company, meetings are as short as possible, sometimes no more than a short interaction at the coffee corner. Here meetings seem to be very inefficient and yet we achieve a lot, developing all these models, concepts, instruments. I guess the time taken to reach a certain consensus is

worthwhile. I also notice other school influences such as long holidays and the fixed time frame of iterations of one semester."

Perspective taking was demonstrated by a lecturer who took the business perspective within her educational practice: "I learn so much from my business colleagues, especially acting adroitly and quickly. My colleagues also notice that I have become a bit more business-like, which they think is good for the HLC."

Transformation

Interviewees discussed three processes related to transformation, namely recognizing a shared problem space, hybridization and maintaining uniqueness of intersecting practices.

A misbalance between educational and business influences within the HLC was perceived by both business participants and lecturers, which may have been due to the absence of the process of *Recognizing shared problem space*. A business participant and a lecturer commented that the HLC had become more like a school than a company. The business participant said: "Because the project is funded by education, and because we have ten participants from schools and two participants from business, everything is approached from an educational point of view. There is an emphasis on educational processes, design and instruments, although the HLC has become more business-like over time." The lecturer added: "At the HLC working and learning is really integrated, it is not like an internship, where the two practices of education and work are only weakly connected. Yet, I think the HLC is still a lot like a school, with all its rules and procedures for the students."

Lecturers as well as business participants seemed to agree that the HLC should have been more entrepreneurial. For instance, the secretary said: "The HLC should have become more like a real company in the sense that we should have made money somehow, so we would not be dependent on sponsors and limited in time. Being more entrepreneurial in that sense would have been an extra drive for the students as well."

The HLC was in part truly hybrid. It was called an 'innovation institute' and was not positioned exclusively as a school or a company. Also boundary objects reflected the process of *hybridization*. This included the 'Procedure for personal professional development', which combined elements of human resource management and assessment for school, and the 'Handbook', which integrated elements of a study guide and company guidelines.

At the same time the *uniqueness* of both practices of school and work was *maintained*. Work characteristics that were maintained included the students and the HLC-team relating to each other as junior and senior employees, the acquisition of assignments from clients, professional communication and presentation towards clients. School characteristics that were maintained included long holidays, the time frame of semesters, and an emphasis on learning processes in the design of the HLC.

Both *hybridization* and *maintaining uniqueness* were expressed by one of the business participants, "At first, I thought that this HLC would be an overlap between a company and a school organization. But now I see it as a new organisation between the two, to which each of them contributes. Education contributes methods of coaching, methods for integrating the students' learning outcomes from school into their work at the HLC, and provides assignments for the students. Business contributes by introducing a professional working culture where the HLC-team and students relate to each other as colleagues, a professional working behaviour, and professional communication with clients. Our goal is working as well as learning, and we make this explicit all the time, e.g. by having a handbook and a procedure for personal professional development for all the participants of the HLC."

Boundary objects and brokers

Several boundary objects (such as the handbook and the procedure for personal professional development) resulted from the process of hybridization. The culture and working procedures at the HLC became part of the shared repertoire of the participants. Participants from business as well as from education reported that they applied elements of the HLC in their own working practice. For instance, one of the business participants experimented with a Community of Practice (CoP), which is a concept learnt at the HLC. By linking his company to another one they were able to tackle problems that the companies would not be able to solve individually.

Boundary 2. The designers and the educators

At the beginning of the project the lecturers, educational consultants and experts from business were one entity (the 'HLC-team') without any organizational structure. After some time, however, four sub-teams were set up in order to accomplish goals more efficiently within the HLC. The 'Research & Development' (R&D) sub-team developed new educational and organizational concepts for the design of the HLC and offered coaching and support during implementation. The 'Implementation' sub-team developed instruments and procedures for the students' working and learning activities and they carried out educational activities such as coaching, instruction and assessment. The 'Knowledge Infrastructure' sub-team set up Communities of Practice, and the 'Project Management' sub-team handled financial management, knowledge dissemination, and acquisition of students and clients.

Every HLC-team member participated in one or more sub-teams. Over time the sub-teams of 'R&D' and 'Implementation' developed different social practices and a boundary between them emerged. The two social practices were those of the 'the designers' (R&D) and 'the educators' (Implementation). Two team members discussed this boundary from the perspective of the designers, and six team members commented on it from the perspective of the educators.

Nature of the boundary and boundary markers

Unlike the boundary between education and business, the boundary between designers and educators was not evident from the beginning. Rather, it emerged after a task division had been put into practice. As one of the participants indicated, this boundary was unintended: "It [the HLC-team] should be a whole, but somehow it has become two."

Markers of discontinuities that indicate this emergent boundary were mentioned in the interviews from both a designer's and educator's perspective. The educators mentioned separation, both in a physical and a metaphoric way (for example: working in different rooms, not sitting in on each other's activities, and the designers being in an ivory tower). The designers identified discontinuities in terms of differences in conceptions of objectives, tasks and procedures in the practices of design and education.

Learning mechanisms and processes

In the participants' comments relating to the boundary between the designers and the educators all four learning mechanisms occurred: *identification, coordination, reflection and transformation*.

Identification

Some participants reflected on the differences between the educators and the designers in the process of *othering*. They pointed at differences in objectives and commitment. Although both the designers and the educators aimed at educating the students as well as possible, the designers appeared to be very committed to the project plan, which called for the development of models, procedures and instruments based on educational theory, which were to be used within the HLC and in other contexts. The educators' foremost objective was to coach the students as well as possible and educational theory was viewed as a facilitating instrument for this. As one of the designers put it: "As a designer I am most interested in how to underpin our practice with theory, knowing why it works in a certain way. Educators want to be a good coach and in order to do so they want to be fed with theory." An educator commented: "The designers are more than 100% committed to the project plan, but some of us, the educators, are not always as committed, although we probably all should be. Maybe it has to do with the temporary and part-time character of our work here."

Coordination

Translation seems to be an important learning process at this boundary. It occurs via the creation of boundary objects in the shape of models, procedures and instruments. These objects bridge the design and implementation practices. In most cases the designers created the boundary objects and explained them to the educators, which did not always

lead to the intended use of the objects. In the words of a designer: "For the design or redesign of each iteration we had meetings with the educators, introducing new concepts or instruments. We made handouts, explained their contents and decided as a team that we were going to apply them. In some cases we noticed after some time that educators interpreted our design differently than intended because the ideas behind it or the context were not clear. For instance, the instrument called the 'digi-coach' was to be used by the educators to monitor and adjust their way of coaching the students. The designers intended to use it for evaluating the coaching process during each iteration. But at first, some of the educators did not fill it out correctly and its use was not clear to them. We probably should have followed up more by checking if everything was understood well and was used in practice as intended."

The educators appreciated it when the theories behind models or instruments were explained. One educator suggested that the designers, when presenting a new model or procedure, should start with examples of implementation in practice: "It is difficult to learn new concepts or procedures from paper. Maybe the practical implications should be presented first, and then the theoretical background. It is nice to discuss what an instrument is about and how it can lead you to act in a certain way with the students. If you know the background, you can play with it more, make variations, know how it relates to other items." However, the educators differed both in the extent to which they wanted to be 'taught' by the designers and in the shape of their learning curves.

Another instance of translation occurred when one of the educators translated procedures that were proposed by the designers into concrete guidelines for students and coaches. In so doing, she acted as a broker between the practices of design and implementation.

Reflection

Perspective making via role-changing was suggested in hindsight and, thus, not carried out. An educator: "We have built an ivory tower in which the designers do the thinking, often in a separate room, whereas the educators want to act. Sometimes it goes well together and sometimes it clashes. Maybe we could have changed roles every once in a while, the designers coaching the students and the educators participating in the design meetings. That way we could have exchanged more and become more one."

Transformation

Two learning processes that seemed to be lacking at times were *confrontation* and *recognizing shared problem space*. The absence of these processes was reported in comments that suggested that a lack of shared problem space should be detected and confronted. Participants reported that though differences emerged (e.g. in vision on education, in working methods, or in objectives) they were not always recognized or questioned. A designer: "The HLC-team does not have a shared vision of the learning

outcomes or the assessment criteria. For instance, some colleagues apply their own weighing system when assessing the students' progress." Two comments by educators: "We never clearly stated what our focus is in educating the students. It shifted towards coaching and personal development, whereas knowledge and project work received less attention. We do not all agree on this focus. As a team, we don't have a shared mental space; we don't discuss what we as a team think is important." And: "We already know so much, but everyone has created their own image of the HLC. Maybe a team meeting, presenting all the concepts, asking what everyone's ideas are and discussing them would be a good way to get a team image of all the concepts behind the HLC."

On some occasions a boundary object, such as a concept or model, was discussed with the whole team. The team members investigated each other's interpretations of the object and adjusted it if necessary. This joint adaptation can be viewed as a process of *hybridization*. Meetings in which this occurred were useful according to the educators, although the designers experienced a dilemma. On the one hand, hybridization seemed preferable to translation, because the latter might be too directive and might hinder self-organization by the team. On the other hand hybridization was much more time-consuming. A designer: "Sometimes we had meetings discussing a model with the whole team. This took a lot of time, but the educators found the meetings useful. It is a challenge for us, the designers, to balance direction with self-organization. We have high ambitions with the design of the HLC and have lots of ideas for how things could be improved, and at the same time we want to collaborate and not to impose things, use the creativity of the educators. But time is limited; there is no time between iterations to evaluate everything in great detail. It is hard to decide when to spend time on discussing the design with the team, and when to move on and put new ideas into practice."

This dilemma between translation and hybridization was also felt among the educators. One lecturer liked "being fed" by the designers (translation), and another would have liked to "get the ingredients from the designers and cook together."

Boundary objects and brokers

Some of the boundary objects, such as the 'procedure for personal professional development', were created by one of the lecturers acting as a '*broker*' (Wenger 1998) between the two practices by literally translating the 'design language' into 'lecturer or student language'. The broker noticed that she was often asked by a designer "to help reformulate this complex text for the educators".

Several educators indicated that they did not have an overview or comprehensive mental model or *shared repertoire* of all the concepts, theories, models and instruments used in the HLC. They also reported that, nevertheless, they had learned a lot about educational theory. An educator commented: "The educational models are the foundation of the HLC. There are a lot of them; it is hard to get an overview. Most of us can mention the elements but cannot describe the whole. It probably takes at least two

iterations to really get a new procedure down." One of the educators who joined the HLC during the second year found it especially difficult to grasp the working methods: "It felt like having to keep up with very skilled skiers: every time when you catch up, they speed away again."

Almost all educators reported that they had implemented elements of what they learned at the HLC about educational design into their own working context. Examples of learning results are: "I learnt about the interrelationship between the personal, team and organizational level, and that a design always starts from your goals for the students"; "In the HLC we have looked at many different concepts and theories (Damasio, big five, Leary, Covey, etc.). You learn things here that you use very much in daily life, unconsciously"; "I have become more assertive as a lecturer because I learnt about the principles behind education"; "I learnt that multidisciplinary and multilevel groups of students can work together with the right way of coaching."

Boundary 3: The HLC and its surroundings

Over the course of three years of iterative design and implementation, the HLC developed into a novel practice, different from existing study programmes at schools and companies. This created a boundary between the HLC and other educational institutions, especially the home institutions of the HLC team members. The participants would like to continue the HLC beyond the three years of project funding and also apply the concept of the HLC to other contexts, in accordance with the project plan. As one of the participants put it: "I really hope we can continue this HLC somehow [...]. Otherwise it is just a 3-year project. We would like to make the concept of this HLC, the 'golden formula', work in other contexts, within schools, preferably in different study programmes, or companies." This boundary is commented on from the perspective of ten HLC-team members.

Nature of the boundary and boundary markers

Although it was clear from the beginning that the HLC would become a new kind of practice with characteristics of education and business, the boundary around it became visible and stronger during the development of the HLC. It was marked by e.g. the distinction made between the HLC and 'regular education'. The emerging character of this boundary is illustrated in the following quote by a participant from education: "The HLC is changing into a company more and more. But not like the companies of our experts from industry. And we are also becoming more and more different from regular education."

Learning mechanisms and processes

Three mechanisms appeared around this boundary: *identification, coordination and reflection*.

Identification

It took a lot of effort for the participants to identify what exactly made the HLC so distinctive. One participant described one of the differences as follows: "At the HLC we have a choice of what to read and examine, the underlying theories are an enrichment compared to what you normally learn as an employee of a school or a company."

Importantly, the identification process of *othering* was not always successful. For instance, lecturers from participating schools did not always see the difference between the HLC and existing study programmes. A participant: "Sometimes it is hard to capture what exactly is different at the HLC as compared to 'regular' education. Some people from my institution compare the HLC to the study programme of Human Technology. Most of us don't know that programme very well, but I think we should be able to point out the differences."

However, the process of *othering*, did seem to work well when a representative of one practice (the HLC) embodied this practice in another context (his home institution): "At my school colleagues notice that I work differently (talking to clients, coaching the students). They see that our students have 'blossomed' at the HLC and that it really functions as a business environment. This changes their perspective of the HLC."

Coordination

The following processes of coordination can be recognized in the data: communicative connection, efforts of translation, increasing boundary permeability and routinization. HLC participants were always looking for avenues of *communicative connection* with educational institutions and companies. Examples of such connections include issuing a paper, publishing two articles about the HLC and a holding a conference in the third and last year of the project. Although the audience at the conference was interested, this interest evidently did not lead to the actual adoption of concepts of the HLC in other contexts, at least not in collaboration with participants from the HLC.

The participants envisioned this transfer as a process of *hybridization* (transformation), in which representatives from both practices of the HLC and another organization create something new using the concepts and instruments of the HLC as boundary objects. Participants were always disappointed if lecturers from another context were not interested in collaboration: "And yet, we get no requests for collaboration. We are always in a state of giving, but no one will come and get it. Maybe that is the consequence of being at a location away from school. Our conference was a success, we have many 'prospects' for future collaboration, but the flower does not bloom yet, schools remain at a distance." Another lecturer commented: "Some schools did contact us, but then they just picked some instruments and used them in their own context without taking the underlying concepts into account. We want to collaborate, not to be picked from without any dialogue."

One HLC-team member brought up the issue of *translation*, which also seems to be related to the process of *identification*. She stated that communication between practices should use language from both practices, e.g. "If lecturers call the HLC a kind of internship for students, we should use that term when communicating with them."

The process of *Increasing permeability*, which would make it easy to cross the HLC's boundary, was attempted by giving presentations at the partner institutions for recruiting students. Attempts were also made to *routinize* the process of recruiting students, but this succeeded only when the participants of the HLC put in a lot of effort. The secretary commented: "Communication with partner institutions for recruiting new students each semester is laborious; I have the impression that it is a one-sided effort by the HLC."

Reflection

One of the business participants mentioned a lack of *perspective taking:* "For us, participants from business, it is not profitable to be engaged in the HLC on the longer term if nothing comes out of it for the company such as applying this kind of learning to a business environment. There is definitely a need for integrated learning, such as the HLC, in teams within companies, as a kind of lifelong learning. We have to be entrepreneurial and start with the output, what a company would like to achieve. "

Boundary objects and brokers

Although it was difficult to adequately inform other institutions about the HLC by creating boundary objects or having meetings, when participants from the HLC actually enacted the new practice in their own working context, colleagues seemed to notice and appreciate this.

The shared repertoire that developed from this boundary seemed to be a change of the participants' mind-set, rather than concrete concepts or terminology. A lecturer commented on this: "I notice that the HLC in these three years has moved away from regular education more and more. Going back to regular education will feel like going back into my cage, a cold shower, being from another planet. I will miss the theory, the vision, and the professional working environment."

One of the business participants reflected: "I look at my own company's buildings differently now. I used to be interested in floor size and use, but now I look for charm, cheerfulness, and large windows. Also my approach to employees changed: I used to start a conversation asking 'how is your work going?' Now I always start asking 'how are you doing?' because I have learned here how important it is that employees feel at home at the workplace and that this will increase productivity and loyal ability towards their own company."

CONCLUSION

Based on the findings about the three boundaries studied, we will now explore in which ways a better understanding of boundaries could enhance learning.

The nature of boundaries

The findings suggest that boundaries, such as the business-education boundary, can be expected given certain systemic differences. They also emerge during collaboration, which was the case with the educator-designer boundary and the boundary around the HLC. Together with Akkerman (2011) we conclude that boundaries are revealed and experienced as discontinuities during interaction and not as systemic or observable differences per se. When there are differences on a system level, boundaries may be expected but they are not always perceived as such. And at the same time, as this study revealed, boundaries may be unintended and yet they are experienced as such.

We also found that boundaries can be highly personal, subjective constructs. This feature should be taken into account when choosing means of bridging them or utilizing their learning potential. The member check showed that participants varied in the degree to which they experienced any recognized boundaries as discontinuities, and they varied in the boundaries that they mentioned.

Boundary markers

Although boundary markers were present in the language of the HLC-team members, they were not recognized or labelled as being indicators of perceived discontinuities. In addition, the associated boundaries were not made explicit or discussed as such, which means that boundaries could have gone undetected. Interactions and reflections by participants that indicated separation or cognitive dissonance included "*we are not in 'Ba'*" (referring to being in the same cognitive space), "they work in separate rooms", "we created an ivory tower", and "I don't want to go back into my cage."

In accordance with Akkerman (2011), we conclude that the nature of a boundary would be clarified by making the sociocultural practices on both sides of the boundaries explicit. This would provide the opportunity to discuss, negotiate and possibly enhance boundary learning processes. Our findings suggest that there are several ways to make boundaries and their related practices explicit:

- Be sensitive to and look for markers in conversations and reflections. Boundaries are often not expressed directly in interaction, but there are words and expressions that hint implicitly to the existence of boundaries (Kerosuo 2004).
- Question and discuss discontinuities in actions and interactions (*Confrontation,* boundary 2). Explicating boundaries and their associated practices may trigger dialogical engagement and collective reflection. If mutual perspectives are not recognized, people's concerns can be easily neglected (Akkerman 2011).

- Make explicit and discuss each other's motives, expectations, language, etc. (the process of *Othering* in boundary 2 and 3). Cultural-historical Activity Theory (CHAT) (Engeström 2009) is often referred to as an enabler for this (Kerosuo 2004; Yamazumi 2008; Sannino and Nocon 2008; Akkerman 2011).
- Have participants of one practice experience the other's practice (*Perspective making*, boundary 2). This is related to what Wenger (1998) calls 'peripheral access' to a certain community of practice. Depending on the skills needed to participate in another practice, this 'casual but legitimate access' to a practice could range from visiting or observing to actually engaging in activities (Wenger 1998).
- Be sensitive to each other's language and terminology and be aware of similarities and differences (e*fforts of translation*, boundary 3). When connecting practices across boundaries, the language used by participants includes boundary elements (Wenger 1998). Establishing such connections requires searching actively for words that make sense in both practices, making translations between synonyms, and being aware of homonyms and other potentially confusing expressions used in either practice.

Another conclusion suggested by the findings is that the team should have balanced representation of practices that are related to the relevant boundaries. With respect to the boundary between education and business, the HLC was thought to share more features with an educational environment than with a business environment. There were more participants from education (ten) than from business (two) mainly due to the fact that the main sponsor of the project was the Dutch Ministry of Education. Both lecturers and business participants considered this a misbalance.

Learning mechanisms and processes

Boundary 2 and 3 showed that emerging boundaries seem to foster new identities, goals, motives, expectations and language among participants on each side of the boundary. At the designer-educator boundary individual participants sometimes recognized these new characteristics, but they were not always made explicit or confronted, and this led, to some extent, to unfulfilled expectations on both sides of the boundary.

Regarding boundary 3, it was difficult to identify the HLC as a new practice. Notably, collaboration with other institutions did not get started. Therefore we conclude that the boundary learning mechanisms of identification (*othering*, *legitimating co-existence*) and reflection (*perspective taking, perspective making*) seem to be a prerequisite for successful coordination or transformation. This is in line with Akkerman and Bakker's (2011b) hypothesis about how the mechanisms relate to one another.

It follows that the learning potential of boundaries might be better utilized if explicit attention is first paid to identification and reflection before moving into coordination and transformation. The fact that each mechanism and almost every learning process was represented in the data suggests that there is no hierarchy between mechanisms in the

sense that one is 'better' than the other or that transformation should always be strived for. Each mechanism seems to have its own merit.

It also seemed advisable to get to know the participants' learning preferences and to make use of learning mechanisms and associated processes accordingly. In this case study the participants differed in their learning preferences and learning curves. Some preferred to get explanations (coordination: *translation*) whereas others liked to co-create and experiment (transformation: *hybridization*). Some were ready for something new in every iteration and others needed or preferred to have at least two iterations in order to really grasp a concept or procedure. This difference may be related to the time spent at the HLC, which was different for each participant.

Boundary objects and brokers

Boundary objects seemed to play an important role within the boundary learning mechanisms of coordination and transformation. Boundary objects can be more effective when they are accompanied by information (explanations by people, e.g. inception, history, surrounding negotiations). This information can be very helpful in rendering boundary objects intelligible to other parties or for future use (Star and Griesemer 1989). This is illustrated by educators who indicated that they preferred to know the ideas behind new concepts (boundary 2). Moreover, brokers can play an important role in enhancing understanding of boundary objects (Wenger 1989). The HLC-team seemed to be aware of this in relation to boundary 3, though not in an explicit way. They wished to collaborate with other practices in order to transfer concepts of the HLC to different contexts, but they did not want others to 'pick and choose' elements from it in the absence of explanation or advice from an HLC-team member.

Successful brokering is illustrated by the educator (boundary 2), who translated abstract educational concepts into concrete guidelines for students and coaches. The other participants explicitly acknowledged her as a broker (indeed, she called herself a 'translator'), which seemed to enhance her functioning as such. A process of brokering that occurred around all three boundaries was the transfer of what was learned or developed at the HLC to another context, often the participants' own working context.

Brokers not only appeared to bridge boundaries using objects, theoretical concepts, or jointly created constructs or language, but also with intangible assets such as behaviour, attitude or mind-set. This is illustrated in boundary 2, when colleagues at the home institution saw a participant of the HLC work in a different way and in boundary 3, when participants said that their mind-set changed and that they saw things differently because of participating in the HLC.

Concluding remarks

In this study we aimed to gain a better understanding of boundaries and explored how this understanding could enhance learning. We performed a secondary data analysis

on transcriptions of interviews with members of a diverse team that designed and implemented a hybrid learning configuration. Since the data were not collected with the research questions of this study in mind, it is possible that some boundaries or associated processes were not captured. However, despite the fact that the data did not represent a complete picture of the boundaries and their related learning processes, many aspects of the learning potential of boundaries could be highlighted in this study.

As we mentioned in the introduction, the design of a hybrid learning configuration in higher and vocational education is often performed by a team of educators and other professionals who represent different fields of study and working contexts. Thus, the design team in this study, which consisted of lecturers from different study programmes and levels, educational consultants and participants from business, can be viewed as representative of other HLC teams. Therefore we expect that our results are transferable to other design teams of HLC and it seems plausible that other types of interprofessional teams in or outside the field of educational design could benefit as well.

We found that when boundaries are detected through boundary markers and the associated practices are made explicit, this allows for further analysis and understanding of these boundaries. The results suggest that the intentional introduction and utilization of the concept of boundaries can enhance learning. As transboundary collaboration becomes increasingly important in our knowledge society, it is vital that we learn more about boundaries and possible strategies for enhancing cross-boundary learning.

Chapter 6

Conclusion and discussion

"In times of change learners inherit the earth; while the learned find themselves beautifully equipped to deal with a world that no longer exists."
Eric Hoffer

In this chapter we summarize the conclusions of the four studies that were presented in the previous chapters. Next, we frame these conclusions in a broader perspective in two ways. First, we elaborate on the relationship between a set of design principles, the features of an intervention and the desired outcomes. Second, we position the support of HLC design teams in a broader framework for design knowledge.

This is followed by a discussion of rigor and relevance within the educational design research (EDR) approach. Then we discuss the scope of the findings and present directions for further research. This chapter concludes with reflections on how the findings of this PhD research can be utilized and developed further by researchers and practitioners who are committed to educating future professionals in an ever-changing world.

HLCs ARE HAPPENING

The number of hybrid learning configurations (HLCs) in which Dutch institutions for higher and vocational education take part is increasing rapidly. These institutions are partnering with, for example, companies, governmental institutions, societal organizations, and research institutions. These partnerships are sometimes initiated by educational institutions, and sometimes by companies or other parties. For instance, a former World War II concentration camp that is now a museum and education centre, initiated collaboration with regional educational institutions, companies and governmental institutions in order to develop the centre further. 'Innovation labs' on different themes related to 'healthy ageing' have been started by an academic hospital, two universities, many companies and governmental institutions. Another HLC is the Energy Transition Centre at Hanze UAS, a site with technical facilities where different partners develop innovative products and services related to renewable energy and energy transition. In some of these HLCs student learning is foregrounded, while in others product innovation or applied research is the primary concern. In all cases, however, solving complex problems and learning during the process is central.

Our research has shown that participants such as students, lecturers, researchers and other stakeholders are often enthusiastic and appreciate being part of activities that are relevant and important for society. They often enjoy their own personal and professional development and they take joy in seeing the other participants develop. But, they also face the challenges and insecurities that come with being pioneers and crossing boundaries between different worlds and perspectives. Questions are, for example: How do we establish lasting relationships between all stakeholders? How can we organize the processes of innovation, research, and learning, each with their own dynamics and characteristics? What is a good business model? How can the students' learning be supported and assessed and how does the work in the HLC relate to the learning outcomes required by the study programmes? How do the different participants relate to one another? Which roles are relevant and which competencies are required to fulfil them?

The aim of our research was to help researchers and practitioners address the challenges that come with the design and implementation of HLCs by providing design heuristics and different ways of support during the design process.

FINDINGS AND CONCLUSIONS OF THE FOUR STUDIES

We will summarize the results of each of the four studies before framing these findings in a broader perspective. The first study (chapter 2) provided a set of principles and related features that can underpin the design of an HLC (table 6.1).

Table 6.1 Design principles for hybrid learning configurations

Design principles	Description
1. Fostering authenticity	Working/learning environment (context, tasks, activities, roles, and communication) reflects working practice, a professional working culture and organization.
2. Creating a learning community	Community: every member should experience a sense of belonging to the community. Learner equity: every member of the community is a learner, each at their own level.
3. Utilizing diversity	Diversity is built-in, valued and utilized both at team and organizational levels and in internal and external networks.
4. Inter-linking of working and learning	Participants learn by performing real life tasks supported by educational interventions that are attuned to the task and to the individual learner, inter-linking working and learning.
5. Facilitating reflexivity	Participants learn by reflection on their tasks and experiences as a person, team and organization. Critical events in the working activities are the starting point for reflection and learning.
6. Enabling organization	The organizational structure and culture supports the working process, knowledge creation and sharing at every level (individual, team, organisation, society).
7. Enabling ecology	The learning configuration is attuned to its surroundings, which includes partner organizations and other stakeholders.

The intention was that four learning processes would be enabled by the HLC: self-directed learning, authentic learning, the development of a professional identity and collaborative creation of knowledge across the boundaries of disciplines, professions and perspectives. We concluded that all four processes were enabled to a certain extent. Self-directed learning was realized only to a modest extent. The data suggest a strong interconnection between the design principles which implies that they should be applied in a holistic way.

In the second study (chapter 3) an intervention and design guidelines were developed for fostering students' capacity for self-directed lifelong learning. In this study we use the term 'guidelines' rather than 'principles' because these guidelines are formulated in a less abstract and more directive way than the principles that underpin an HLC. Elements of the intervention that was called 'procedure for personal and professional development' are described in chapter 3. The guidelines and the refinements that resulted from evaluating them in practice are presented in table 6.2.

Guidelines 1-3 of the intervention were implemented in two iterations and were subsequently refined. Two extra guidelines were added as a result of the evaluation that foregrounded the interrelationship between project work and self-directed learning, and self-directed learning as a social learning process. We also concluded that developing the complex skill of self-directed lifelong learning takes more time than a one-semester period. It should probably already be nourished and practiced starting on the first day of study, and perhaps even earlier.

Table 6.2 Refined design guidelines for self–directed lifelong learning

	DESIGN GUIDELINE	REFINEMENTS
1	**Provide opportunities to engage in two or more cycles of self-directed learning**	Implement two cycles of self-directed lifelong learning into the course.
1.1	Diagnosing	Provide different representations of the professional and competencies central to the course (e.g. professional profile, mind maps, presentations by experts). Be aware that learning needs tend to emerge mostly from working in practice.
1.2	Setting goals	Assist students in making their goals specific and feasible. Assist students in underpinning their strategy with an argumentation based on theory or expertise; make students aware of the existence of relevant theory or expertise. Ensure that criteria are measurable or observable. Provide examples of goals, strategies, argumentation and criteria for success.
1.3	Planning	Assist students in making their plans of action concrete and specific. Make suggestions about how the students can involve others for support.
1.4	Monitoring	Encourage students to be specific and reflective in blogging. For their blogs, have students interrogate each other about critical incidents. Provide feedback at critical times during project work. Have students offer each other feedback.
1.5	Evaluating	Assist students in defining what exactly was learned and give feedback on strategy, argumentation and criteria.
2	**Provide educational support**	Pay attention to the students' conceptions of 'learning', 'knowledge' and 'theory'. Provide workshops as well as written guidelines. Provide individual coaching that helps students specify individual learning goals. Have students present their learning results to each other.
3	**Pay attention to emotional and motivational aspects**	Organize regular working sessions on self-directed lifelong learning. Have alumni of the course give presentations about their experiences with self-directed lifelong learning. Point out that the students can put their own learning goals into practice. Ensure diversity: enrol students from many different study programmes. Have strict rules and adhere to them (with consequences such as no feedback or no study credits if students fall short of the rules).
4	**Treat self-directed lifelong learning as a social learning process.**	Have students share each other's learning goals and results from early on in the course. Provide an atmosphere of safety and trust among students.
5	**Position self-directed lifelong learning as a self-evident, integrated part of the course.**	Involve all lecturers and assistant-coaches in the process of self-directed lifelong learning.

The third study (chapter 4) aimed to support design teams in the creative utilization of design principles for HLC. The results show that an intervention consisting of a guidebook and a workshop was considered relevant, consistent and practical by four HLC design teams. The team members reported that the intervention had been effective for them in three main ways. It yielded an enhanced understanding of the structure and coherence of their respective HLCs, a shared image of their HLC with its strong points and challenges, and ideas and inspiration for how to (re)design their HCL. The design principles seemed to provide a conceptual framework for understanding and designing features of the HLC and a vocabulary for communicating design ideas, thus supporting creative utilization of the design principles. Examples of the features of the HLC in which the set of design principles was generated appeared to enhance understanding of the principles and contextual information about this HLC helped the participants understand and define their own context more clearly.

The fourth study (chapter 5) explored the way in which an interprofessional HLC design team collaborated and learned across the boundaries that occurred as a result of differences in perspectives. We found that if boundaries are detected through 'boundary markers' in the participants' language, and if the practices or perspectives associated with the boundaries are made explicit, this allows for further analysis and understanding of these boundaries. Our analysis of boundary crossing actions and interactions suggests, in line with Akkerman and Bakker (2011b), that the learning mechanisms of identification and reflection are prerequisites for successful coordination and transformation. Moreover, 'boundary objects', artefacts or more abstract concepts that are used simultaneously in several practices, played an important role in the coordination of processes across boundaries, provided that they were accompanied by an explanation about their usage. Also 'brokers', understood as participants who work in different practices, provided bridges between different practices or perspectives. Finally, the degree to which a boundary was perceived differed greatly among the team members, thereby confirming that boundaries are highly personal and subjective constructs.

FINDINGS AND CONCLUSIONS IN A BROADER PERSPECTIVE

In this section we will consider the insights of the four studies in a broader perspective, taking the two main research questions as a starting point.

Design heuristics for HLC

The first question was: "*Which heuristics can underpin the design of a hybrid learning configuration?*"

In the first two studies (chapters 2 and 3) we developed sets of design heuristics taking the form of design principles for an HLC and a set of design guidelines for an intervention within an HLC that would enhance self-directed lifelong learning. In the

third study (chapter 4) we investigated an intervention with the goal of supporting design teams in order to enhance utilization of the set of design principles for HLC. As described above, the design principles provided a shared frame of reference about the HLC and a language to communicate about the design. They did not prescribe the features that should be developed. Rather, the set of principles provided the rationale for guiding design decisions (McKenney et al. 2015; Kali et al. 2009).

In our study of the utilization of design principles (chapter 4) some of the participants indicated that they would have preferred to get more direction as to how to design their HLC. This raises the question of how specific and directive design knowledge, or design heuristics, should be. According to McKenney and Reeves (2012, p.34) the term 'design principles' is most often used to characterize "the prescriptive theoretical understanding developed through educational design research". Herrington and Oliver (2000) speak of 'design guidelines'. Most authors agree that design principles are more or less abstract conjectures that guide the design of interventions and connect the features of an intervention to some form of rationale (e.g. Kali et al. 2009; Sandoval 2014; McKenney et al. 2015).

In the literature on educational design research, however, there is no consensus on the degree of abstraction or direction, nor on the nature of the link between design heuristics, features and outcomes of an intervention. The Design Principles Database (Kali and Linn 2015) states: "Principles can link to one feature, to several features, and can link several principles together. Design principles emanate from and connect to theories of learning and instruction." Denyer et al. (2008) discuss what they call 'design propositions' that are described by 'CIMO-logic'. The CIMO logic is phrased as: "In this class of problematic Contexts, use this Intervention type to invoke these generative Mechanisms to deliver these Outcomes" (Denyer et al. 2008, p. 395). In the case of the design of an HLC this logic could be stated as: 'In our complex knowledge society (C) where educational and societal institutions form coalitions, develop hybrid learning configurations (I) to invoke the learning processes (M) authentic learning, self-directed lifelong learning, cross-boundary knowledge creation and development of a professional identity, to achieve the development of knowledge professionals and innovation of professional practice (O), with the ultimate aim of successfully addressing complex problems in society'.

However, as we concluded in chapter 4, the link between design principles and designed features of an intervention is not a singular one-to-one relationship. Rather, our findings suggest that it is a multiple relationship. After all, a feature can be inspired by more than one design principle, and a design principle can inform multiple features. Moreover, the relationships between heuristics and features, and between features and desired processes or outcomes are not a collection of linear causal relationships. This leads us to the assumption that an HLC has characteristics of a complex (social) system (Snowden and Boone 2007). This implies, among other things, that HLCs consist of

many interacting elements, people among them. Moreover, the interactions are non-linear and systemic, the sum is greater than the parts and there is more than one right answer.

Sandoval (2014) acknowledges this challenge of multiple relationships between design heuristics and the actual design of a complex educational intervention. His model, the so-called 'conjecture map', portrays the relationships between design knowledge, features or elements of an intervention, desired learning processes, and outcomes. Sandoval proposes two kinds of 'conjectures'. The first is a 'high-level conjecture' that informs the design of elements or features of a learning environment. The second is a 'design conjecture' that takes a form similar to the CIMO-logic and specifies the link between the designed features and the 'mediating processes', through which certain 'outcomes' (learning outcomes, motivation, etc.) are achieved. A third kind of conjecture is the 'theoretical conjecture' that explains how the mediating processes lead to the desired outcomes.

The conjecture map could be used to frame our research of the design of an HLC as a complex educational intervention (chapter 2), as is shown in figure 6.1. In our case the 'high level conjectures' would be represented by the set of design principles, which are connected with the 'embodiment' or features of the HLC in multiple ways. The embodiment would encompass the whole system of the HCL, including organizational structures and relationships with its environment. We defined the 'mediating processes' as four learning processes that the HLC is intended to enable. The 'outcomes' of the HCL are represented as the 'bottom line results' (Van Aken 2004) or 'overall outcomes' such as the professional development of the participants, and innovation of professional

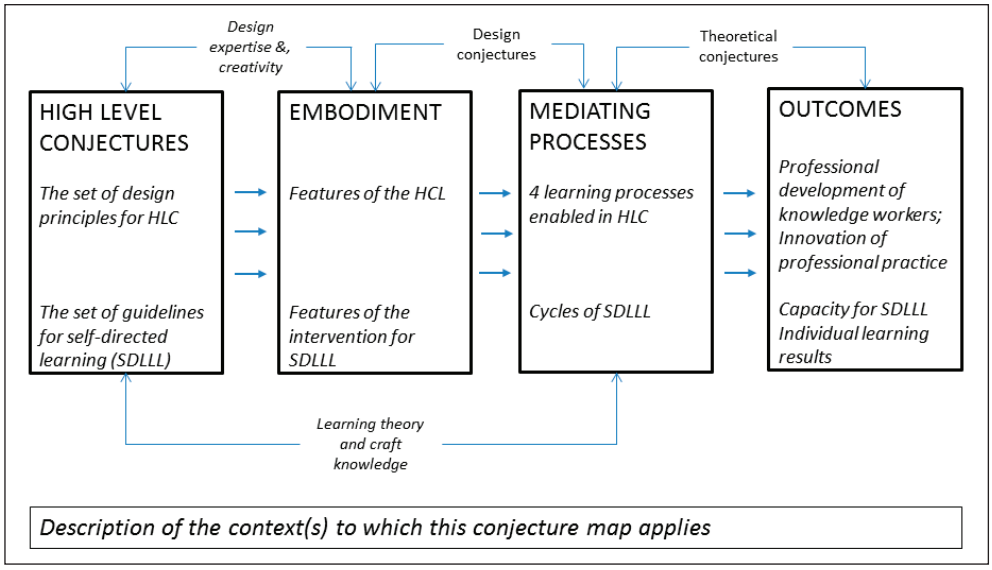

Figure 6.1 Model for the design of an HLC (after Sandoval, 2014)

practice. In our study the 'design conjectures' are approximated by the effects and conditions of the features of the HLC that were related to the four learning processes (chapter 2; tables 2.3-2.8).

For our study of design guidelines for self-directed lifelong learning (chapter 3), the high level conjectures would be the set of five guidelines. Their embodiment is described as features of the intervention. The main mediating process would be the cycle of self-directed lifelong learning that students should engage in. The main outcomes are the students' capacity for self-directed lifelong learning and their individual learning results. In our research the 'theoretical conjectures' between mediating processes and outcomes are represented by educational theory on the kinds of learning processes that would be effective for the professional development of knowledge workers. In our version of the conjecture map (figure 6.1) we added this connection between mediating processes and the high level conjectures because we used relevant learning theories (for instance the three metaphors for learning and stages in the process of self-directed lifelong learning) along with practical knowledge to develop the design heuristics, which were the 'high level conjectures'. We connected the 'high level conjectures' with 'embodiment' by way of 'design expertise and creativity'. Finally, we added the description of the context(s) for which this 'conjecture map' is relevant.

By underpinning the multiple relationships between design heuristics, features, intended learning processes and desired outcomes with theoretical concepts and conjectures, supplemented with a description of the relevant context, the conjecture map can be a basis or foundation for the design of HLCs in different contexts. In other contexts the design heuristics can be linked to different features, learning processes and desired outcomes, which would lead to multiple 'conjecture maps'. Over time, more general patterns could emerge and the design heuristics themselves could evolve as they are refined, altered, supplemented or discarded (Kali 2006). According to Boisot and McKelvey (2010), the logic or justification for the working of a complex system is *anticipation*, rather than *prediction*. Therefore, they argue, research on complex systems should be directed at exploring a wide range of possible solutions. This allows practitioners to select the most plausible of these possibilities, i.e. the one that resonates the most with their prior experience and context.

Following this line of reasoning, the answer to our first research question from a broader perspective is: framing the set of design principles or guidelines in multiple conjecture maps, rather than representing them as causal chains of design propositions, can provide guidance and support for designing and researching complex educational interventions such as HLCs.

Supporting design teams

In the third and fourth study we addressed the second research question: "*In which ways can interprofessional teams be supported when designing hybrid learning configurations?*"

Most of the research on design expertise for educational designers is focused on teachers as designers, working individually or in teams. A large part of this literature concerns computer-enhanced learning (e.g. Kali et al. 2009; Herrington and Herrington 2000; McKenney et al. 2015). In this literature teachers are characterized as either 'enactors', who make subtle adjustments to new curriculum materials, as 're-designers', who adapt ready-to-use activities and materials for their current curriculum, or as 'co-designers' who collaboratively create completely new learning activities and materials for their classes (McKenney et al. 2015).

The frequent usage of the terms 'teachers', 'curriculum' and 'classes' in the literature suggests that educational design is often conceptualized as the creation of curricular products within a particular school-based study programme by educators in a certain discipline. An HLC, however, is usually not designed by a team of lecturers within the same discipline or programme. The design teams often consist of co-designers from different backgrounds or perspectives, such as educational consultants, educational designers or researchers, lecturers of different study programmes and levels, and representatives of organizations in society. In addition, the HLC, as mentioned above, is a complex environment at the interface between school and work, rather than an intervention within an existing curriculum. In an HLC, the learners can be students, lecturers, researchers or other stakeholders. This raises the question of how these interprofessional teams who are challenged with the complex, ill-structured task of designing an HLC could be supported.

First and foremost, existing research on teacher design knowledge provides many useful tools and strategies for supporting teams designing educational interventions (e.g. Huizinga et al. 2013). However, according to McKenney et al. (2015) there is still a lot to be gained from capitalizing on what is already known and by drawing on the wealth of literature on designers and designing outside the field of education. The 'ecological framework for conceptualizing teacher knowledge for technology enhanced learning design' (McKenney et al. 2015) provides a comprehensive overview of types of knowledge needed for educational design work. The framework structures design knowledge into the categories of know what, why, how, when, who and where, and it does this from a technical, phenomenological, and realist perspective. Although the framework is positioned within the field of technology enhanced learning, it seems to be relevant for a much broader context, including the design of HLCs.

This study adds to this framework two aspects that are especially challenging when designing a complex educational intervention such as an HLC. The first aspect is the utilization of the design rationale (i.e. 'know why' in the ecological framework). As mentioned above, the design of an HLC is based on a set of design heuristics, rather than a single principle, guideline or proposition. This requires an understanding of each principle and the ability to creatively 'translate' the set of principles into features of a

learning environment in a coherent way. The intervention studied in chapter 4 seems to enhance this understanding and ability.

The second aspect relates to the team itself (an extension of 'know who' in the ecological framework) and concerns support for interprofessional teams who might encounter boundaries or 'discontinuities in their actions and interactions' (Akkerman and Bakker 2011b). In chapter 5 we explored ways of transcending these boundaries and utilizing their learning potential. We found that boundary crossing theory provides a framework that can enhance understanding of boundaries and related learning processes and we presented suggestions for enhancing their learning potential.

In summary, our overall response to the second research question is that design teams of HLCs can be supported by using an appropriate framework for design knowledge and by adjusting or expanding this framework for the design of complex interventions by interprofessional design teams.

STRENGTHS AND WEAKNESSES

In chapters 2-5 we discussed strengths and weaknesses of each of the four studies. Here we take a more general perspective and discuss both the benefits and risks of EDR as a form of practice-based research and the role of the practitioner as a researcher.

As mentioned before, EDR is a research approach that not only seeks to describe or explain social practice but explicitly aims to develop knowledge that can be used in designing solutions to real-world problems (Van Aken 2004). Such design research connects, in the words of Schön (1983), the 'high ground of theory' with the 'swamp of practice'. Educational theory and craft knowledge inform the design of an intervention to solve a real-world problem. Evaluating the intervention in turn can refine theory. Gravemeijer and Cobb (2006, p.46) describe this as follows: "In design research scientific knowledge is grounded in practical wisdom while simultaneously providing heuristics that can strengthen practical wisdom."

Thus, EDR is always situated in a particular educational context in practice. It is often a cyclic process of development and research in real-life situations. This means that reproducing the research cannot ensure reliability. Therefore, reliability in EDR is often expressed as 'trackability' or 'virtual replicability' (Gravemeijer and Cobb 2006), which implies that the research process is made explicit and that it includes descriptions of the researcher's procedures and choices. In our studies trackability is enhanced by keeping a research log, and by making the data collection and analysis process explicit. Moreover, each stage of the EDR process was discussed with researchers outside the research context and the HLC design team.

The results of EDR should be adaptable to other situations (Gravemeijer and Cobb 2006). For this reason, the term 'transferability' is used rather than 'generalizability' (Guba 1981). Design knowledge in the form of heuristics (i.e. principles, guidelines) that are the result of the study of an intervention (or several iterations of it) in one specific

context can be understood as 'local theory'. In our studies on design heuristics (chapters 2, 3 and 4) we sought to enhance transferability of this local theory by providing thick descriptions (Geertz 1973) of the context researched. Moreover, as our findings seem to confirm, one can enhance understanding and support the utilization of design principles in other contexts by providing examples of the features of the studied intervention.

In the four cases studied in chapter 4, participants reported that they perceived the set of design principles for HLC as complete without redundancies. However, the design principles and guidelines from our studies were not systematically evaluated and tested in multiple contexts. This would have, perhaps, increased the validity of the design heuristics, which would have resulted in a more 'middle range' theory (McKenney and Reeves 2012).

A possible cause of researcher bias could be embedded in the role of the researcher. In three of the four studies presented here, the researcher was a co-designer (chapter 2, 3 and 5), and in one study the researcher also acted as a lecturer and coach within the studied intervention (chapter 3). On the one hand, this co-design and active participation in the enacted intervention provided the opportunity to gain direct insights into the strengths and weaknesses of the intervention (see also McKenney et al. 2006). It also seemed to enhance trust in the design process. A lecturer commented that a researcher who actively participates in an intervention knows how it works in practice and will therefore ascertain that the design will be feasible.

On the other hand, a researcher who studies his or her 'own' practice could become biased, especially if he or she is a member of the population itself or has a strong affinity for the participants being studied (Chenail 2011). In our studies we attempted to avoid this bias by asking open, non-suggestive questions in the interviews (Rubin and Rubin 2006) and by reflecting on what was said from time to time. Because of this the interviews were more like critical dialogues among professionals than researcher-practitioner interrogations. Some of the respondents indicated that they obtained new insights by reflecting on the learning configuration during the interview. While it is true that conducting the interviews together with a researcher who was not involved in the practice researched could have diminished researcher bias, the interviewees might have been less at ease if they had been interviewed by two people rather than one. Additionally, there are clear advantages in gathering their reflections about the HLC during a one-on-one conversation with a team member who knows the HLC from the inside.

As EDR aims to contribute both to theory-building and to improvement of educational practice, its strengths and weaknesses can also be considered from the perspective of practical relevance. To this end, we will conclude this chapter with practical implications of our research. Many researchers (e.g. Edelson 2006; Reeves 2011) call attention to the balance between rigor and relevance in EDR. They claim that an increase in rigor often seems to result in the loss of relevance and vice versa. For instance, if scientific claims on rigor require testing design knowledge in many different contexts, this may

jeopardize practical relevance, given that educational practice may have changed before the conclusions of the research become available. If scientific rigor is insufficient, this poses the risk of developing unsuccessful innovations and, perhaps even worse, inadequate design knowledge. Therefore the design researcher always has to consider and the balance between rigor and relevance (Edelson 2006; Reeves 2011). In this study we hope to have struck an acceptable balance between the two.

SCOPE AND DIRECTIONS FOR FURTHER RESEARCH

As we mentioned before, the design principles and guidelines presented in chapters 2 and 3 were based on single case studies. Although they were grounded in theory, in practical wisdom and were tested in several iterations in practice, they should be systematically tested and evaluated in other contexts. Relating them to a variety of features would provide more examples of ways to 'embody' the principles in practice and could lead to refinement of the principles and guidelines.

All the cases studied here were HLCs that were initiated by one or more educational institutions. Hence, learning by the students was foregrounded. Increasingly, HLCs are initiated by societal groups or organizations. In these HLCs, learning by all the stakeholders is more prominent. Further research on multi-stakeholder learning (e.g. Wals et al. 2011; Sol et al. 2012) could shed more light on these learning processes and reveal ways in which student learning and assessment can be aligned with requirements by their respective study programmes. Moreover, the roles and competencies of the different stakeholders could be made clearer, which would allow explicit enhancement of these competencies. Current research by Wesselink, Gulikers, Oonk and Mulder (2015) is aimed at exploring roles and competencies of lecturers in hybrid learning configurations.

The learning outcomes for students and staff in an HCL were not systematically researched in the studies addressed in chapters 2 and 3. Although we had access to information about learning results in both cases and we made sure that the learning results were in line with the intended learning outcomes, our first concern was the learning processes that were supposed to be enabled by the HLC. Further research into learning outcomes (whether intended or unexpected) of participants in HCLs in various contexts could increase our understanding of the relationships between design heuristics, features, learning processes and outcomes. In addition, further research is needed to investigate conditions for realizing higher levels of proficiency in self-directed lifelong learning throughout the curriculum and beyond.

In our study the support of interprofessional design teams in the creative utilization of design principles (chapter 4) was limited to one intervention (consisting of a guidebook and a workshop) in the first stages of the design or redesign of an HLC. The four HLC design teams differed in the degree to which they needed support after the workshop. One design team that evaluated an existing HLC proceeded without further support and used the results of the workshop in a 'strategic meeting' about how to proceed

with redesigning the HLC. Another team working in a developing HLC requested several meetings with the researcher so that they could learn how to advance with the redesign process. The other two teams no longer worked with the design principles after the workshop. The team that designed the master programme intended to resume the design process as soon as additional funding for their project would be granted. The other team reported that their learning environment (a bachelor programme) had not developed as an HLC but more as a regular school-based curriculum.

Moreover, different design teams seemed to need different types of support. Several HLC design teams within and outside Hanze University that were not included in this study used the guidebook and some of them requested the workshop or some other type of intervention as a way of supporting their design efforts. Further research could be directed towards other ways of support, such as technology-enhanced methods. In addition, further research could be focused on the next stages of design and development of HLCs.

This study did not provide heuristics or clear-cut directions for overcoming boundaries and enhancing associated learning processes. Rather, the last study (chapter 5) was an exploration into the world of boundary crossing and trans-boundary learning theory. We established that this theory provides a useful framework for enhancing the learning potential of boundaries by connecting the theoretical concepts to actions and interactions in the practice of an interprofessional HLC design team. Further research could be directed towards ways of using this knowledge to formulate tools, interventions or guidelines for enhancing or improving learning processes across boundaries.

In our studies of HLC design, we were guided by three metaphors of learning: acquisition, participation and knowledge creation. The acquisition and participation metaphors have been dominant in educational theorizing in the last decades. Both have already proven to offer valuable and complementary perspectives on learning (Sfard 1998) and have been used to underpin the design of learning environments. The knowledge creation metaphor was introduced more recently (Paavola et al. 2004). One could argue that this third metaphor is already included in the acquisition and participation metaphors, since knowledge creation requires acquisition of new knowledge and collaboration by practitioners.

However, creating new knowledge across boundaries of disciplines, professions or perspectives, requires more than merely acquiring knowledge and applying it by participating in a particular practice. Transboundary knowledge creation calls for the formation of reflexive learning communities, which have their own dynamics, organization and working culture. By explicitly incorporating the knowledge creation metaphor in the development of the set of design principles for HLCs and our exploration of boundary learning processes we hope to have added a new perspective on the design of learning environments.

IMPLICATIONS FOR PRACTICE

This research project was triggered by a challenge that institutions for higher and vocational education face: to educate students to become knowledge workers who are able to solve complex problems across boundaries of disciplines, professions and perspectives in an ever-changing world. HLCs can enrich competence-based education in two ways. Firstly, HLCs enhance the development of 'horizontal expertise' or 'polycontextual skills' that are needed for knowledge creation and innovation. Secondly, HLCs address the problem of connectivity between school and workplace (e.g. Biemans, Wesselink, Gulikers, Schaafsma and Verstegen 2009) by integrating school-based and work-based learning.

The cases studied here were situated within the context of vocational education, but as traditional universities are facing the same challenges, the results are expected to be relevant and usable for these institutions as well. As society increasingly faces complex problems that need to be addressed from multiple perspectives, our higher education system should probably provide opportunities for 'hybrid learning' to all of its students, though the degree to which students should engage in these opportunities may vary. This will also have implications for the professional development of teachers, coaches and facilitators within these hybrid learning configurations, whose roles will be different from those in school-based education. Moreover, HLCs influence the way curricula are structured, physical and technology-based facilities, and organization and culture of educational institutions.

The set of design principles for HLC, along with the guidelines for self-directed lifelong learning, have appeared to be useful when combined with examples of features of an existing HLC and a context description. Also, features and descriptions of other contexts could enrich understanding and enhance usability by providing a broader repertoire of possible enactments of the heuristics in practice.

Our research highlighted an intervention for enhancing the utilization of design principles. Experience in practice has shown that design teams use the guidebook in different ways, for instance, as a checklist or as a tool for assessing strengths and weaknesses. In addition to the guidebook, a database modelled after the Design Principles Database for technology-enhanced education (Kali 2006) could be another way of disseminating design heuristics and further developing them, together with examples of features and contexts in which they are utilized.

The method of prototyping, which we used in our research as a means of enhancing creative thinking about the design of HLCs, seems to be an inspiring and effective way to generate ideas by the design team members. In addition, this exchange of ideas appeared to make explicit and align the team's conceptions of what an HLC encompasses and how to proceed with its development. Design methods and tools from fields outside education (e.g. product design) such as 'design thinking' (Brown 2009) or 'effectuation'

(Sarasvathy 2008) may very well provide valuable assets to those supporting and inspiring HLC design teams.

But no matter how well the ideas about the design of an HLC are conceived, its success depends the team that designs and implements it. Members of such a 'hybrid team' bring different perspectives into the process. These perspectives are needed and they can be sources of inspiration. But in cases where they are experienced as obstacles or boundaries, our findings suggest that the concepts of boundary crossing theory can be useful tools for overcoming them and using their learning potential.

This thesis aims to contribute to the knowledge base for designing hybrid learning configurations. This is done with the intention that this contribution will be utilized and developed further by researchers and practitioners who are committed to educating future professionals in an ever-changing world.

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Summary

In today's knowledge society there is a demand for professionals who are able to create knowledge across boundaries of disciplines, professions and perspectives. Increasingly, challenges have to be addressed by experts from different fields who collaborate across different contexts. In addition, given the fast pace with which society changes, experts must continually construct and reconstruct their expertise in a process of lifelong learning.

Institutions for higher and vocational education are challenged to educate these 'knowledge workers'. They are responding, among others, by developing novel hybrid practices at the interface between school and workplace, the so-called hybrid learning configurations. By connecting education, research and professional practice they aim to address complex problems in society by fostering interprofessional collaboration and learning. We define a hybrid learning configuration (HLC) as 'a social practice around ill-defined, authentic tasks or issues whose resolution requires transboundary learning by transcending disciplines, traditional structures and sectors, and forms of learning'.

While many educational institutions and other organizations are co-developing and experimenting with HLCs, the process followed is often one of trial and error. Practical expertise is becoming available but only in an ad hoc and fragmented way. Although research on situated and social learning offers relevant theories and concepts that are useful when designing an HLC, not much research has addressed the design of HLCs in a comprehensive way. This PhD research aims to address this lacuna.

We investigate HLCs from an educational design research (EDR) perspective, which involves framing the HLC as a complex intervention. We are interested not only in the features or designed elements of such interventions, but also in the underlying principles or conjectures that are embodied in those features. In addition, we intend to provide support for interprofessional HLC design teams, which consist of, for instance, educational consultants, researchers, lecturers and other practitioners.

In order to address these aims we studied six HLCs in the context of Dutch higher vocational education. One of the cases is a joint project of two Dutch institutions for senior secondary vocational educational (which are called 'MBO' in Dutch) and two universities of applied sciences ('HBO' in Dutch) in collaboration with two companies. The other cases are HLCs in different settings within the context of a university of applied sciences in the Netherlands.

The aims mentioned above led to the following general research questions:

1. *Which heuristics can underpin the design of a hybrid learning configuration?*
2. *In which ways can interprofessional teams be supported when designing hybrid learning configurations?*

Chapters 2 and 3 address the first research question and chapters 4 and 5 address the second question.

Design principles for HLCs

Chapter 2 focuses on the HLC as a whole. The central research question is: "*Which set of principles can underpin the design of a hybrid learning configuration for educating the knowledge worker?"* Based on a literature search and designers' craft knowledge, a set of initial design principles was developed for an HLC at the interface between school and workplace. The intention was that four learning processes would be enabled by the HLC: self-directed learning, authentic learning, the development of a professional identity and collaborative creation of knowledge across the boundaries of disciplines, professions and perspectives.

These initial design principles were evaluated from the perspective of the participants by analysing interview data from students, lecturers, educational consultants and business representatives. This resulted in the following set of seven refined principles that underpin the design of an HLC: fostering authenticity; creating a learning community; utilizing diversity; inter-linking of working and learning; facilitating reflexivity; enabling organization; enabling ecology. These principles can be used as heuristics for guiding the design and development of hybrid learning configurations in contexts that have similar goals and aligned tenets.

Fostering self–directed lifelong learning in HLCs

Chapter 3 elaborates further on the design principle 'facilitating reflexivity'. Since knowledge workers have to redefine and reconstruct their own expertise in an on-going fashion, they should be able to reflect on and pro-actively develop their professional competence. This capacity for self-directed lifelong learning is an essential asset for them and should therefore be developed or enhanced in an HLC. The main research question in this chapter is: *"Which design guidelines underpin an intervention that would foster students' capacity for self-directed lifelong learning while working on ill-structured, authentic professional tasks?"*

An intervention was designed, implemented and evaluated during two iterations of a hybrid learning configuration, which was embedded in a one-semester elective course at a university of applied sciences in the Netherlands. Evaluation methods included interviews with students and the course facilitator, questionnaires, and students' logs and reports. This resulted in the following five intervention design guidelines: provide opportunities to engage in two or more cycles of self-directed learning; provide educational support; pay attention to emotional and motivational aspects; treat self-directed lifelong learning as a social learning process; position self-directed lifelong learning as a self-evident and integrated part of the course.

The intervention appeared to be usable and effective. At a basic level, the students developed their capacity for self-directed lifelong learning. We concluded that further research is needed to investigate conditions for realizing higher levels of proficiency in self-directed lifelong learning throughout the curriculum and beyond.

Utilization of design principles for HLCs

The focus of chapter 4 is the utilization of the set of design principles that was generated in chapter 2. Research has shown that while knowledge of design heuristics can increase the efficiency and effectiveness of design work, design teams often have difficulty articulating the rationale for their design. In addition, it is important to facilitate ideation and nourish creative spirit while utilizing the design heuristics to create a novel learning environment.

In this study we explored an intervention for supporting the creative utilization of the set of design principles for HLC. The intervention was based on boundary-crossing theory and design thinking methods, with a particular focus on prototyping. It consisted of a 'guidebook' in which the design principles were explained, and a workshop. The corresponding research question was: *"What is the perceived effectiveness of a boundary-crossing intervention (based on a set of research-based design principles) for (re)designing hybrid learning configurations?"*

Four design teams of different HLCs in the context of a university of applied sciences used the guidebook and attended the workshop while (re)designing their HLC. The intervention was evaluated by way of questionnaires that were filled out by members of the design teams. The results show that the design teams perceived this intervention as being relevant, consistent, practical and effective. The intervention appeared to provide a conceptual framework for understanding and designing features of a hybrid learning configuration and a vocabulary to communicate design ideas. It, thereby, supported the creative utilization of the design principles. Further research could explore other, complementary ways of facilitating the design of hybrid learning configurations.

Cross–boundary learning during the design and implementation of an HLC

Chapter 5 concerns cross-boundary collaboration and learning processes within an interprofessional design team of an HLC. These teams often consist of actors from different educational institutions and other organizations, such as companies or (non) governmental institutions. When team members bring their different perspectives into the collaboration, they are likely to experience boundaries. Boundaries can be defined as 'discontinuities in action or interaction'. They can hinder cooperation, but they can also provide opportunities for learning. This led to the following research question: *"In which ways could a better understanding of boundaries enhance learning?"*

In this study, transcripts of interviews with members of an HLC-design team were analysed using concepts of boundary crossing theory. This theoretical framework provided a lens through which different ways of boundary crossing, learning mechanisms and processes became visible. We established that boundaries are highly personal and subjective constructs. We found that if boundaries are detected and if the related practices are made explicit, this allows for further analysis of these boundaries. Our analysis yielded a number of possible ways to enhance trans-boundary learning in

HLC design teams. We also concluded that boundary objects and brokers can play an important role in transboundary learning processes.

Conclusions in a broader perspective

In chapter 6 we frame our conclusions from the four studies in a broader perspective. The first aim of our research was the development of heuristics for the design of HLCs. Given this aim, we developed a set of design principles for an HLC and guidelines for an intervention that fosters the capacity for self-directed lifelong learning. We positioned these principles and guidelines in a 'conjecture map' (Sandoval 2014), which shows the relationships between design heuristics, their embodiment in features of an intervention, the intended mediating processes, and the desired outcomes. Our overall conclusion is that framing the set of design principles or guidelines in multiple conjecture maps, rather than representing them as causal chains of design propositions, can provide guidance and support for designing and researching complex educational interventions such as HLCs.

Our second aim was to provide support or 'design knowledge' for interprofessional HLC design teams. We addressed that aim by developing and testing an intervention that supported the creative utilization of a set of design principles for HLC. In addition, we provided guidance for enhancing learning across boundaries that could be experienced in an interprofessional design team. We positioned this design knowledge in a broader framework, the 'ecological framework for conceptualizing teacher knowledge for technology-enhanced learning design'. This framework seems to be useful in contexts beyond technology-enhanced learning, and, so, we consider it relevant to the design of HLCs. We conclude that design teams of HLCs can be supported by using an appropriate framework for design knowledge and by adjusting or expanding this framework for the design of complex interventions by interprofessional design teams.

Further research and practical implications

Our studies led us to the following recommendations. While we focused mainly on learning processes that should occur within HLCs, further research could be directed towards the students' learning outcomes. Moreover, our findings suggest that self-directed lifelong learning should be developed and practiced throughout an education programme. To achieve this, curricula in higher education should offer opportunities for students to experiment and follow their own path, alongside prescribed activities with fixed learning outcomes.

In the six HLCs that we studied, student learning was foregrounded. However, an HLC also involves other stakeholder types, such as lecturers, researchers, citizens, and entrepreneurs. Therefore, further research could shed light on supporting and evaluating multi-stakeholder learning processes and learning outcomes of all types of stakeholders.

Our research on supporting interprofessional design teams focused on the utilization of design knowledge in early stages of (re)design of an HLC. Further research and development could yield ways of support in further stages of the design. In light of this we recommend crossing the boundaries of areas of design science outside the educational context. This will allow us to learn from each other and capitalize on what is already known.

In our study, design principles for HLC were 'reified' and disseminated by way of a guidebook. Further investigations could reveal other ways of documenting and communicating design knowledge, for instance via the construction of a database containing principles or guidelines and their associated features in different contexts.

Boundary crossing theory appeared to provide a lens through which boundaries and related learning processes became visible. The elements of boundary crossing theory can be translated into guidelines or tools for enhancing cross-boundary learning in interprofessional HLC design teams and, perhaps, for other types of 'hybrid teams' as well.

This thesis intends to contribute to the knowledge base for designing hybrid learning configurations. This is done with the intention that this contribution will be utilized and developed further by researchers and practitioners who are committed to educating future professionals in an ever-changing world.

Samenvatting

De huidige kennismaatschappij vraagt om professionals die kennis kunnen creëren over de grenzen van disciplines, beroepen en perspectieven heen. Steeds vaker kunnen problemen alleen worden opgelost door experts die samenwerken vanuit verschillende achtergronden en contexten. Door de snelle veranderingen in de maatschappij moeten die experts ook continu hun expertise blijven onderhouden en uitbouwen.

Het hoger en middelbaar beroepsonderwijs staat voor de uitdaging om deze 'kenniswerkers' op te leiden. Dit gebeurt onder andere door het aangaan van nieuwe, hybride samenwerkingsverbanden of 'praktijken' die tussen school en beroepspraktijk in staan, de zogenaamde hybride leeromgevingen of -configuraties. Door onderwijs, onderzoek en beroepspraktijk met elkaar te verbinden kunnen studenten en professionals in deze omgevingen complexe problemen in de maatschappij gezamenlijk aanpakken en daarvan leren. We definiëren een hybride leeromgeving (*hybrid learning configuration*, HLC) als 'een sociale praktijk rondom niet-afgebakende, authentieke opdrachten of kwesties, waarvan de oplossing vraagt om leren over de grenzen heen van disciplines, traditionele structuren en sectoren, en vormen van leren'.

Veel onderwijsinstellingen zijn samen met andere organisaties, zoals bedrijven en overheden, aan het experimenteren met het vormgeven van HLC's, maar dit gaat vaak met vallen en opstaan. Er komt weliswaar steeds meer praktische kennis en ervaring beschikbaar, maar deze expertise is vaak ad hoc en gefragmenteerd. Ook levert onderzoek op het gebied van situationeel en sociaal leren relevante theorieën en concepten op die bruikbaar zijn bij het ontwerpen van een HLC, maar er is nog niet veel onderzoek gedaan naar het integraal ontwerpen van HLC's. Dit promotieonderzoek wil hier een bijdrage aan leveren.

We onderzoeken HLC's vanuit het perspectief van onderwijskundig ontwerponderzoek, waarbij we een HLC zien als een complexe interventie. We willen niet alleen weten uit welke elementen zo'n interventie bestaat, maar we zijn ook geïnteresseerd in de onderliggende principes of veronderstellingen waarop de vormgeving van de HLC is gebaseerd. Daarnaast willen we de professionals ondersteunen die HLC's ontwerpen. Zo'n interprofessioneel ontwerpteam kan bestaan uit onderwijskundig adviseurs, docenten, onderzoekers en andere professionals van bijvoorbeeld het bedrijfsleven of de overheid.

Om deze doelen te bereiken hebben we zes HLC's in het Nederlandse hoger en middelbaar beroepsonderwijs onderzocht. Eén van deze casussen is een gezamenlijk project van twee mbo-instellingen, twee hbo-instellingen en twee bedrijven. De andere casussen zijn verschillende HLC's in de context van een HBO-instelling.

De volgende twee vragen staan centraal in het onderzoek:

1. Welke ontwerpregels kunnen het ontwerp van een hybride leeromgeving onderbouwen?

2. Op welke manieren kunnen interprofessionele teams worden ondersteund bij het ontwerpen van hybride leeromgevingen?

In hoofdstukken 2 en 3 komt de eerste onderzoeksvraag aan bod; hoofdstukken 4 en 5 hebben betrekking op de tweede onderzoeksvraag.

Ontwerpprincipes voor HLC's

Hoofdstuk 2 gaat over de HLC als geheel. De centrale onderzoeksvraag is: "Welke set van principes kan het ontwerp van een HLC voor het opleiden van kenniswerkers onderbouwen?" Op basis van literatuuronderzoek en (ervarings)kennis van de ontwerpers is een set van initiële ontwerpprincipes ontwikkeld voor een HLC in het grensgebied tussen onderwijs en beroepspraktijk. Vervolgens hebben we onderzocht hoe deze principes vorm kregen in de HLC en of hiermee de beoogde leerprocessen in gang werden gezet, namelijk zelfgestuurd leren, authentiek leren, het ontwikkelen van een professionele identiteit en het gezamenlijk creëren van kennis over grenzen van disciplines, beroepen en perspectieven heen.

De initiële ontwerpprincipes zijn geëvalueerd vanuit het perspectief van de deelnemers door het analyseren van interviews met studenten, docenten, onderwijskundig adviseurs en participanten uit het bedrijfsleven. Dit heeft geresulteerd in zeven ontwerpprincipes voor het ontwerpen van een HLC: creëer een authentieke werkomgeving, vorm een lerende gemeenschap, maak gebruik van diversiteit, integreer leren en werken, faciliteer reflexiviteit, de organisatie ondersteunt leren en werken, zorg voor een goede inbedding in de omgeving. Deze principes kunnen worden gebruikt als ontwerprichtlijnen voor het ontwikkelen van hybride leeromgevingen in soortgelijke contexten.

Zelfgestuurd leren in HLC's

Hoofdstuk 3 gaat dieper in op het ontwerpprincipe 'faciliteer reflexiviteit'. Omdat kenniswerkers continu hun expertise moeten onderhouden en uitbouwen, moeten ze kunnen reflecteren op hun professionele competentie en zich met die inzichten voortdurend verder ontwikkelen. De vaardigheid om het eigen leren een leven lang te blijven sturen is essentieel voor de kenniswerker. De studenten in een HLC zouden daarom ondersteund moeten worden bij het ontwikkelen van deze vaardigheid. De onderzoeksvraag in dit hoofdstuk is dan ook: "Welke ontwerprichtlijnen kunnen een interventie onderbouwen die het zelfgestuurd leren door studenten bevordert wanneer ze werken aan niet-afgebakende, authentieke professionele taken?"

Om deze vraag te kunnen beantwoorden hebben we een interventie ontwikkeld, geïmplementeerd en geëvalueerd, in twee opeenvolgende uitvoeringen van een HLC die ingebed was in een cursus van een half jaar. De cursus was toegankelijk voor hbo-studenten van alle studierichtingen in het derde en vierde studiejaar. De cursus

is geëvalueerd door middel van interviews met de cursuscoördinator en studenten, vragenlijsten en logboeken en verslagen van de studenten.

Deze evaluatie heeft geleid tot vijf ontwerprichtlijnen voor de interventie: laat studenten minstens twee cycli van zelfgestuurd leren doorlopen, geef didactische ondersteuning, besteed aandacht aan emotionele en motivationele aspecten, beschouw zelfgestuurd leren als een sociaal leerproces, en positioneer zelfgestuurd leren als een vanzelfsprekend en integraal onderdeel van de cursus. De interventie bleek bruikbaar en effectief. De studenten ontwikkelden, op een basaal niveau, de vaardigheid van zelfgestuurd, levenlang leren. We concluderen dat verder onderzoek nodig is om te bepalen hoe studenten een hoger competentieniveau van deze vaardigheid kunnen bereiken in de loop van de opleiding en daarbuiten.

Gebruik van ontwerpprincipes voor HLC's

Hoofdstuk 4 gaat over het gebruik van de set van ontwerpprincipes die in hoofdstuk 2 is gegenereerd. Uit onderzoek blijkt dat het gebruik van ontwerpkennis de effectiviteit en doelmatigheid van het ontwerpproces kan vergroten. Toch hebben ontwerpteams vaak moeite om de onderbouwing van hun ontwerp goed te verwoorden. Daarnaast is het belangrijk om het genereren van ideeën en creativiteit te stimuleren wanneer teams een educatieve interventie ontwikkelen op basis van ontwerpprincipes.

Met dit doel hebben we een interventie verkend om het creatief gebruiken van ontwerpprincipes voor een HLC te ondersteunen. De interventie is gebaseerd op '*boundary crossing*'-theorie en het gebruik van prototypes als onderdeel van de methode '*design thinking*'. De interventie bestond uit een handreiking, waarin de ontwerpprincipes werden uitgelegd, en een workshop. De onderzoeksvraag luidde: "Hoe ervaren de deelnemers de effectiviteit van een *boundary-crossing* interventie (gebaseerd op een set ontwerpprincipes) voor het ontwerpen van hybride leeromgevingen?"

Vier ontwerpteams van verschillende hybride leeromgevingen in de context van een HBO-instelling hebben de handreiking gebruikt en de workshop gevolgd tijdens het (her) ontwerpen van hun HLC. De interventie is geëvalueerd met behulp van vragenlijsten die ingevuld zijn door leden van de ontwerpteams. De resultaten laten zien dat de deelnemers de interventie als relevant, consistent, praktisch en effectief hebben ervaren. Het bleek dat de interventie een conceptueel kader verschafte dat hielp om elementen van een HLC te begrijpen en te ontwerpen, en een taal om over ontwerpideeën te communiceren. Hiermee ondersteunde de interventie het creatieve gebruik van de ontwerpprincipes. In vervolgonderzoek kan verkend worden hoe het ontwerpen van hybride leeromgevingen op andere, aanvullende manieren ondersteund kan worden.

Cross-boundary leren bij ontwerp en implementatie van een HLC

Hoofdstuk 5 is gericht op het *'cross-boundary'*-samenwerken en leren binnen een interprofessioneel ontwerpteam van een HLC. Deze teams bestaan vaak uit studenten

en medewerkers van verschillende onderwijsinstellingen en medewerkers van andere organisaties zoals bedrijven of overheidsinstellingen. Als deze teamleden vanuit hun verschillende perspectieven samenwerken ervaren ze daarbij vaak grenzen. Grenzen definiëren we als 'belemmeringen in acties of interacties'. Grenzen kunnen de samenwerking hinderen, maar kunnen ook gelegenheid bieden om te leren. Dit heeft geleid tot de volgende onderzoeksvraag: "Op welke manieren kan een beter begrip van grenzen het leren bevorderen?"
In dit onderzoek zijn interviews met leden van een HLC-ontwerpteam geanalyseerd aan de hand van concepten uit de theorie van *boundary crossing*. Dit theoretisch kader werkte als een lens waardoor verschillende manieren van *boundary crossing*, leermechanismen en –processen zichtbaar werden. Het bleek dat de mate waarin teamleden grenzen hebben ervaren heel persoonlijk en subjectief was. Het zichtbaar maken van grenzen en daaraan gerelateerde praktijken of perspectieven maakte het mogelijk om deze grenzen verder te analyseren. Onze analyse leverde een aantal manieren op om het leren over grenzen heen te bevorderen. We concluderen dat grensobjecten en 'grensgangers' een belangrijke rol kunnen spelen in *cross-boundary* leerprocessen.

Conclusies in een breder perspectief

In het laatste hoofdstuk plaatsen we de conclusies van de vier studies in een breder perspectief. Het eerste doel van ons onderzoek was het ontwikkelen van ontwerpregels voor HLC's. Dit heeft vorm gekregen in een set van principes voor het ontwerpen van HLC's en een set van richtlijnen voor het ontwerpen van een interventie voor het bevorderen van zelfgestuurd leren in een HLC. We positioneren deze ontwerpregels in een *'conjecture map'*, die voor een interventie de relaties weergeeft tussen de ontwerpregels, de vormgeving (elementen) van de interventie, de beoogde processen die daarmee in gang worden gezet en de gewenste resultaten. Onze conclusie is dat het ontwerpproces beter kan worden geleid en ondersteund door de ontwerpregels te positioneren in *conjecture maps*, dan door de ontwerpprincipes te beschouwen als een serie oorzakelijke verbanden in de vorm van ontwerpstellingen.

Het tweede doel was het ondersteunen van ontwerpteams van HLC's. Met dit doel hebben we een interventie ontwikkeld en getest om het creatief gebruiken van ontwerpprincipes te faciliteren. Daarnaast hebben we aanwijzingen gegeven om het leren over grenzen heen in interprofessionele ontwerpteams te bevorderen. We hebben deze ontwerpkennis geplaatst in een breder kader, het *'ecological framework for conceptualizing teacher knowledge for technology-enhanced learning design'*. We vinden dit model ook relevant voor het ontwerpen van HLC's. We concluderen daarom dat ontwerpteams van HLC's kunnen worden ondersteund door een passend model voor ontwerpkennis te gebruiken. Op basis van de resultaten van ons onderzoek kan zo'n model worden aangevuld met kennis specifiek voor het ontwerpen van complexe interventies door interprofessionele ontwerpteams.

Vervolgonderzoek en praktische implicaties

We komen op basis van ons onderzoek tot een aantal aanbevelingen. Ons onderzoek heeft zich gericht op de processen die plaatsvinden in een HLC. Vervolgonderzoek zou zich kunnen richten op de leeruitkomsten van studenten.

We concluderen dat zelfgestuurd levenlang leren een vaardigheid is die tijdens de hele opleiding van een student ontwikkeld en in de praktijk gebracht zou moeten worden. Daarom zouden curricula in het hoger onderwijs de studenten de gelegenheid moeten bieden om te experimenteren en hun eigen pad te volgen, naast de voorgeschreven activiteiten en leeruitkomsten.

In de zes onderzochte casussen hebben we ons gericht op het leren door de student. Echter, bij een HLC zijn meer partijen betrokken, zoals docenten, onderzoekers, burgers en ondernemers. Daarom zou nader onderzoek moeten worden gedaan naar het faciliteren en evalueren van leerprocessen en leeruitkomsten van alle typen betrokkenen.

Ons onderzoek naar het ondersteunen van interprofessionele ontwerpteams was gericht op het gebruiken van ontwerpkennis in vroege stadia van (her)ontwerp van HLC's. Dit zou kunnen worden aangevuld met onderzoek naar het ondersteunen van teams in vervolgstadia in het ontwerpproces. In dit kader is het aan te bevelen om ook te kijken naar ontwerpwetenschap buiten het educatieve domein. Hierdoor kunnen de verschillende ontwerpdomeinen van elkaar leren en optimaal gebruik maken van wat al bekend is.

In ons onderzoek zijn de ontwerpprincipes vastgelegd en verspreid in de vorm van een handreiking. Verder onderzoek zou andere manieren van documenteren en verspreiden van ontwerpkennis kunnen opleveren, bij voorbeeld door middel van een database van ontwerprichtlijnen en ontwerpelementen van HLC's in verschillende contexten.

De *boundary-crossing* theorie bleek als een lens te werken waardoor grenzen en gerelateerde leerprocessen zichtbaar werden. De elementen van deze theorie kunnen worden vertaald naar richtlijnen of instrumenten waarmee *cross-boundary* leren in interprofessionele ontwerpteams, en waarschijnlijk ook in andere typen 'hybride teams', kan worden bevorderd.

Met dit proefschrift willen we bijdragen aan de kennisbasis voor het ontwerpen van hybride leeromgevingen. We doen dit met de intentie dat deze bijdrage gebruikt wordt en verder wordt ontwikkeld door onderzoekers en professionals die zich inzetten voor het opleiden van toekomstige kenniswerkers in een continu veranderende wereld.

About the author

Petra Cremers was born December 6, 1961 in Tegelen, the Netherlands. She studied Forestry at Wageningen University. Her master's programme focused on environmental education and included an nine-month internship at the Environmental Learning Center in Isabella, Minnesota. She subsequently obtained a teacher's degree in Biology. After graduation she took a one-year course in Geographic Information Systems (GIS) at Bureau Nieuwland in Wageningen and eventually taught parts of this course. In 1990 she began working at Hanze University of Applied Sciences in Groningen, the Netherlands. Until 1999 she developed and taught GIS courses for students and practitioners. From 1999 until 2005 she was involved in the design and implementation of the bachelor programme 'Human Technology' and in the redesign of the technology-oriented bachelor programmes. She also was an educational advisor in a curriculum redesign project of Takoradi and Kumasi Polytechnics in Ghana. Within the research group Human Technology, Petra participated in and conducted research on 'Communities of practice' in higher vocational education. From 2005 to the present time she worked as an educational consultant specializing in work-based learning in different educational contexts within and outside Hanze University. Several of these contexts provided the case studies for this dissertation.

Peer–reviewed publications

Cremers, P.H.M., Wals, A.E.J., Wesselink, R., Nieveen N. & Mulder, M. (2014). Self-directed lifelong learning in hybrid learning configurations. *International Journal of Lifelong Education*, 33(2), 207-232.

Cremers, P.H.M., Wals, A.E.J., Wesselink, R., & Mulder, M. (in-press). Design principles for hybrid learning configurations. *Learning Environments Research*.

Submitted manuscripts

Cremers, P.H.M., Wals, A.E.J., Wesselink, R. & Mulder, M. (2015). Utilizing design principles for hybrid learning configurations by interprofessional design teams. Manuscript submitted for publication.

Cremers, P.H.M., Wals, A.E.J., Wesselink, R. & Mulder, M. Learning across boundaries during the design and implementation of a hybrid learning configuration. Manuscript submitted for publication.

Professional publications

Cremers, P.H.M. (2016) Samenwerken en leren over grenzen heen bij het ontwerpen en implementeren van een hybride leeromgeving. In A. Bakker, I. Zitter, S. Beausaert, & E. De Bruijn (Eds), *Tussen opleiding en beroepspraktijk. Het leerpotentieel van boundary crossing.* Assen: Koninklijke van Gorcum.

Cremers, P.H.M. 2015. *Handreiking Innovatiewerkplaatsen*. Groningen: Hanze University of Applied Sciences.

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Cremers, P.H.M. & Wierenga, E.M. Zelfgestuurd leren in leerwerkomgevingen. *Manuscript submitted for publication*.

Cremers, P.H.M. (2012). Onderwijskundig ontwerponderzoek: onbekend maakt onbemind? *Onderwijsinnovatie*. Maart 2012.

Cremers, P.H.M. (2011). Arrangementen van interventies. In J. Van Aken & D. Andriessen (Eds), *Handboek ontwerpgericht wetenschappelijk onderzoek. Wetenschap met effect* (pp. 205-216). Den Haag: Boom Lemma.

Cremers, P.H.M., Hekman, E.G.A. & Bomhoff, G. H. (2010). *Value in the Valley, evaluatie van het leerarrangement*. Groningen: Value in the Valley.

Wierenga, E.M., Cremers, P.H.M., Hekman E.G.A. & Buikema, H. (2010). *Value in the Valley, het leerarrangement in de praktijk.* Groningen: Value in the Valley.

Cremers, P.H.M. & Valkenburg, R.C. 2008. Communities of practice in higher education. In C. Kimble, & P. Hildreth (Eds), *Communities of Practice. Creating learning environments for educators. Vol. 1.* (pp. 333-354). Charlotte: Information Age Publishing.

Cremers, P.H.M., Eggink J.J.M.H. & Hoetink, F. (2006). 4C/ID, de puzzel past steeds beter. *Onderzoek van Onderwijs*, jaargang 35, maart 2006.

Cremers, P.H.M. (2004). *Nothing is more permanent than change. The Human Technology Project. (Re)designing a Bachelor's degree course at Hanze University Groningen, the Netherlands.* Stichting AXIS: Delft.

Cremers, P.H.M. (2003). *Niets zo blijvend als verandering. Projectportret Human Technology. Curriculumontwerp in het HBO, ervaringen met het opzetten van de opleiding Human Technology*. Stichting AXIS: Delft.

Cremers, P.H.M. (2003). 'Niets zo blijvend als verandering'. *Onderwijsinnovatie*, November 2003.

Columns

2001-2002 12 monthly colums (in Dutch) on aspects of 'competence-based education' in '*De Hanze'*, magazine for students and staff of Hanze University of Applied Sciences, Groningen, the Netherlands.

1998-2000 6 columns (in English) on aspects of design and implementiation of geographic information systems in *Geo-informatics*, magazine for Geo-IT professionals in Europe.

Petra H.M. Cremers
Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan

Wageningen School of Social Sciences

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
Writing the research proposal		2008	6
'Rethinking education and learning in an era of (un)sustainability'	ECS, WUR	2010	0.6
'Designing a multidisciplinary learning configuration at the intersection of work-based and school-based learning'	EAPRIL, Lisbon	2010	2
'Ontwerpprincipes voor hybride leeromgevingen'	ORD, Maastricht	2011	1
'Het ontwerpen van een interdisciplinaire, hybride leeromgeving voor de lerende professional. Dilemma's en keuzes bij ontwerponderzoek in de onderwijspraktijk'	DSRG	2011	2
'Zelfgestuurd leven-lang leren in hybride leeromgevingen'	ORD, Wageningen	2012	1
'Exploring transboundary collaboration using a theoretical framework'	Uppsala University, Sweden	2013	2
' Designing hybrid learning configurations' and 'Self-directed lifelong learning in hybrid learning configurations'	HETL Conference Utah	2015	2
B) General research related competences			
Introduction course	WASS	2008	1.5
Research Methodology I - From topic to proposal	WASS	2008	4
Qualitative Research	ICO	2009	3.5
PhD Course Action Research and Action Learning: Social Learning in Nature-Society Relations.	ARALIG (Action Research Action Learning Interest Group)	2009	2
Preparing and facilitating 3rd meeting of CoP Action Research Gebiedsontwikkeling: Roles and Competences in Action Research.	WUR	2008	1
5 half-day meetings of CoP Action Research Gebiedsontwikkeling.	WUR	2008-2009	0.7
Educational design research	ICO	2011	3.5
Evaluation revisited: improving the quality of evaluative practice by embracing complexity.	WUR-CDI	2010	0.6
Information literacy including Endnote introduction.	ILP; WASS	2012	0.6
Monthly meetings of Design Science Research Group (regular attendance and 4x presentation).	DSRG	2009-2015	PM
C) Career related competences/personal development			
Wetenschapsjournalistiek voor promovendi	Radboud University Nijmegen	2012	3
Total			**37**

*One credit according to ECTS is on average equivalent to 28 hours of study load

Cover design: Bert van Ginkel (b.vanginkel@telfort.nl)
Printed & Lay Out by: Proefschriftmaken.nl || Uitgeverij BOXPress
Published by: Uitgeverij BOXPress, 's-Hertogenbosch