# Designing for Learning

## Studying learning environments in higher professional education from a design perspective

This research was carried out as a collaboration between
IVLOS Institute of Education/Utrecht University, Hogeschool Utrecht
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**Ilya Zitter**

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# Ontwerpen voor Leren

Een studie naar leeromgevingen in het hoger (beroeps)onderwijs vanuit een ontwerpperspectief (met een samenvatting in het Nederlands)

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[**]The digital version of the thesis has slight amendments in the footnotes about publications.

# Chapter 1
# Introduction

## 1.1 Background

> The day begins at a polytechnic, a Dutch institute of higher professional education. It is half past nine and about hundred first-year students sit in a large lecture hall of this higher educational institute. One of the teachers[*] introduces the guest-speaker, an outside expert working in professional practice. During the presentation, some students listen attentively, some are gaming on their laptop, others are chatting online or with a neighbour. After the presentation, the teacher thanks the external guest and tells the students that the presentation will be published online in the digital learning environment. The students move to the computer-classrooms of their sub-group. They are joined by students who did not attend the lecture. The students sit together with their project-team and work collaboratively on the design and development of a website for an external client. In each sub-group, about seven project-teams work in parallel for the same client. Two teachers are available for questions and guidance. When learners consult their teacher, they interact like a junior would with a senior colleague. While working, the learners frequently make use of the obligatory books and look up additional sources on the Web. After two hours, the teachers start to leave. Some project teams start leaving as well; they divide tasks and make arrangements to continue working online through their online workspace. Other project teams stay and continue working at the educational institute. Before the teachers leave, they remind the students of the upcoming presentations to the external client and the assessment meetings afterwards. The schedule of the presentations and the assessments is available in the digital learning environment.

How to analyse a learning environment as described above? Which role does technology play? How can teachers make feasible improvements? Designing a complex learning environment as described above can be a daunting task for teachers (Ten Berge, Ramaekers, Brinkkemper & Pilot, 2005). This triggered the research presented here. Higher education faces many changes, such as, novel modes of knowledge production, new professional requirements, and the massification and diversification of the higher education system (Tynjäla, Välimaa & Sarja, 2003). In response, higher education has increasingly adopted competence-based learning in which learners are educated towards flexible, employable professionals (Baartman, Bastiaens, Kirschner & Van der Vleuten, 2007; Biemans, Nieuwenhuis, Poell, Mulder & Wesselink, 2004). To become such professionals, learners are educated towards learning outcomes (Simons, Van der Linden & Duffy, 2000) that are durable, flexible, functional, meaningful, generalisable and application-oriented. These characteristics relate to the transferability of knowledge. Besides, there is also need for learning-, thinking-, collaboration- and regulation-

[*]The term teacher is used broadly throughout this thesis. It applies to all persons enacting the role of teacher, instructor, educator, lecturer, coach, supervisor, tutor or similar terms used in higher education.

skills. Educational institutes are struggling with how to achieve such learning outcomes and with our research we intend to contribute towards solutions.

### 1.2 Hybrid learning environments

A broad distinction between two modes of learning can be made: learning in schools and learning in the workplace. These two types of learning have different characteristics (Tynjälä et al., 2003). Learning in a workplace is mostly informal in nature while learning in schools is based on formal, intentionally planned educational activities. At schools learning tends to focus more on individuals, while in a workplace-setting activities are often carried out in collaboration or within an organisational structure, influencing the learning taking place. Learning in schools has an emphasis on mental activities, while in a workplace, the additional use of different tools and instruments is quite customary. In addition to these two distinct modes, a hybrid form of learning can be distinguished, blurring the strict distinctions between learning in schools and learning at the workplace. We plan to study a hybrid form of learning in which learning takes place at school and is intentionally planned, and at the same time, has many characteristics of learning in the workplace, by being collaborative in nature and incorporating the use of tools in similar ways as in the workplace.

Tynjälä et al. (2003) identify such a hybrid form of learning, namely, project-based learning in which learners work collaboratively on an actual (or simulated) real-life problem. A distinctive feature of project-based learning is problem orientation: the idea that a problem serves to drive learning activities. A second feature, constructing concrete artefacts, forces a student team to think through the steps of the construction process. A third feature is learner control of the learner process affording students 'the possibility and the motive to work their way to the solution in their own idiosyncratic way'. Fourth, contextualisation of learning in a more authentic or simulated context is another feature of project-based learning. Fifth, is the potential for using and creating multiple representations, e.g. abstract, concrete, pictorial, verbal etc. (Helle, Tynjälä & Olkinuora, 2006).

Similar to the concept of project-based learning is 'authentic learning': providing contexts that reflect the way knowledge is used in real life and providing activities that resemble the activities from practice (Herrington & Herrington, 2006). Van Merriënboer, Kirschner & Kester (2003) identify authentic learning tasks that are based on real-life tasks as the driving force behind learning. Additionally, Van Weert & Pilot (2002) indicate that the trend is to integrate Information and Communication Technology (ICT) in real-life tasks or projects. We plan to study learning from the socio-cultural approach to learning. According to this approach, learners do not just accumulate knowledge, but rather participate in activities that are distributed among the individuals, tools and artifacts of a community. ICT can also play a role from this socio-cultural perspective, since ICT can be used to promote connections: between one learner and other learners, between learners and teachers; between a learning community and its learning resources (Goodyear, 2001).

### 1.3 Research problem

Despite the described research and theory in the previous section, designing hybrid learning environments which integrate characteristics from learning in schools and learning in the work-place is far from straightforward yet. Educational institutes have only for the past decade or two been confronted with new demands from society, a

larger and much more diverse student population, increased competition between educational institutes, and the challenge to explicitly combine the needs of working life, professional training, and theoretical and practical knowledge (Tynjälä et al., 2003). Furthermore, it is often underestimated how difficult it is to integrate two different learning systems with different actors, coming from different cultural and historical backgrounds, and pursuing different interests (Biemans et al., 2004). Accordingly, educational institutes have to deal with relatively new and difficult problems. To help educational practice analyse and design forms of hybrid learning, they can find many valuable pieces of the puzzle in current literature. We will take these pieces and integrate them into a model. Our model will deliberately be generic in nature to make it usable for a wide target audience. In many educational institutes, there is already an abundance of educational theory, concepts and guidelines in use. Our compact model should be able to bypass and complement established insights of teachers.

Van den Akker (2003) provides us with three perspectives to study learning environments: (1) the intended perspective, consisting of the vision and the intentions specified in curriculum material; (2) the implemented perspective, which is how users interpret a learning environment and the actual process of learning and teaching (learning environment in-action); and (3) the attained perspective, consisting of the learning experiences as perceived by learners and the resulting learning outcomes. When learning environments are already implemented, there is less room for changes than when a learning environment is designed from scratch.

The model should help teachers to make feasible improvements in existing learning environments. In sum, we plan to find valuable pieces of the puzzle in current educational literature and integrate these pieces into a compact model. This model will be used to analyse hybrid learning environments as they exist in nowadays higher, professional education. The various analyses we will carry out have the intention of showing teachers how they will be able to apply the model. The analyses will also be used to generate design guidance useful to improve implemented learning environments if teachers decide it is relevant for their own context. Our research findings are intended to be complementary to current literature and an explicit design perspective will help to provide inventive new insights.

### 1.4 Research question from a design perspective

Broadly speaking, there are two types of sciences (Collins, Joseph & Bielaczyc, 2004; Van Aken, 2005). Firstly, there are the analytical or explanatory sciences trying to understand how phenomena in the world can be explained. These sciences are interested in pure knowledge problems. Secondly, there are the design sciences that have as main interest to develop valid knowledge to support the design of solutions to field problems by competent professionals (Van Aken, 2004), in our case, educational professionals. We plan to take an explicit design perspective throughout our research.

We will conduct research from a naturalistic paradigm (Guba, 1981). In this paradigm it is assumed that there are multiple, interrelated realities, in which variables cannot be singled out for study or control. Also, this paradigm acknowledges that the inquirer and the respondents are interrelated and influence each other. Guba states that this paradigm is based on the assumption that generalisations are not possible, and that the best one can hope for are ‘working

hypotheses' that relate to a particular context. These working hypotheses are similar to the CIMO-logic used in the design sciences (Denyer, Tranfield & Van Aken, 2008).

*1.4.1 CIMO-logic applied to this research*

The CIMO-logic is a powerful tool to structure a problem and a promising solution. There is a problematic Context. The Intervention is the proposed solution for the problem. The intervention should activate Mechanisms or processes, which are intended to produce the desired Outcomes. We use this tool to provide a structured overview of the main elements of our research from a design perspective.

The CIMO-logic corresponds with the educational perspectives of Van den Akker (2003). The intervention corresponds with the intended perspective. The mechanisms which should be triggered by the intervention are a more concrete interpretation of the implemented perspective. The outcomes correspond for the most part with the attained perspective. Van den Akker also includes the learning experiences in the attained perspective. In the CIMO-logic, positive experiences, like for example, an increased sense of responsibility is considered as a mechanism contributing to reaching the desired outcomes. Below, the CIMO-logic for the start of this research is presented.

*Context*. The context of the research is higher education trying to respond to changes, such as, novel modes of knowledge production, a much larger and diverse student population, and the demand for flexible, employable professionals from society (Tynjälä et al, 2003; Biemans et al., 2004; Baartman et al.; 2007). The problem we identified in this context is that of designing suitable learning environments which adequately respond to these changes.

*Intervention.* The proposed solution is a hybrid learning environment: a learning environment situated in a school, while also having characteristics of workplace learning. It is a project-based, ICT-supported learning environment characterised as authentic. A learning environment (Goodyear, 2001) consists of the physical and digital setting in which learners carry out their work, including all the tools, documents and other artefacts to be found in that setting. Besides the physical and digital setting, it includes the socio-cultural setting for such work.

*Mechanisms.* The hybrid learning environment is intended to activate certain mechanisms or processes. From current literature, we identified five authentic mechanisms that potentially play a role in the above type of intervention (Herrington & Herrington, 2006):

- Use expert performances and the modelling of processes.
- Enact multiple roles and apply multiple perspectives.
- Collaboratively construct knowledge.
- Reflect to enable abstractions to be formed.
- Articulate to enable tacit knowledge to be made explicit.

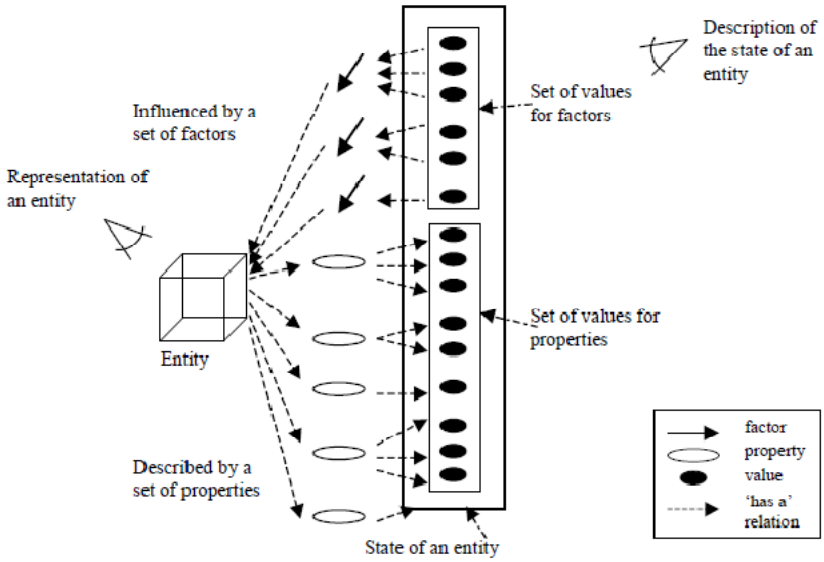
*Outcomes.* The learning environment is intended to educate learners towards flexible, employable professionals (Baartman et al., 2007) in possession of transferable knowledge and learning-, thinking-, collaboration- and regulation-skills (Simons et al., 2000).

We plan to study the intervention and the mechanisms within real-life contexts as described above. Overall, the above presented CIMO-logic functions as the working hypothesis formulated from a design perspective and is the starting point of this research.

*1.4.2 Map our research concepts to a domain-independent model of design processes*
To connect the concepts we plan to study with the design science research domain, we use a domain-independent model of design processes (Reyman, 2001; Reymen, Hammer, Kroes, Van Aken, Drost, Bax & Basten, 2006) to make the process of designing learning environments explicit.

In figure 1 the main representation of this domain-independent model of design processes is shown. The different elements of this model can be mapped on the research process we intend to carry out from a design perspective. All the concepts printed in *italics* in the remainder of this section are shown in figure 1. The explanatory text is based on Reymen (2001) and Reymen et al. (2006).

Figure 1: Domain-independent model of design processes




A *state* is the central concept in this domain-independent model of design processes. A state is defined at a certain moment in time and states are changed by making transitions. Transitions are equivalent to carrying out design activities.

An *entity* is an object or a process and exists in reality. The entity we plan to study is a learning environment. Or to be more exact, the learning tasks of a learning environment, with a focus on the professional objects that are instrumental in these tasks [see table 1].

*Properties* describe the characteristics of an entity. We plan to identify two sets of properties: (1) the position along the dimensions of acquisition-participation and simulation-reality; and (2) the properties or features of professional objects.

Table 1: Overview entities, properties and values

| Entities | Properties | Values |
|---|---|---|
| Learning tasks as building blocks of learning environment | Position along dimensions | Acquisition-Simulation<br>Acquisition-Reality<br>Participation-Simulation<br>Participation-Reality |
| Professional objects instrumental in tasks | Facilitate interaction between roles (agency) | e.g. learner enacting role of junior professional interacting with external client as problem-owner. |
| | Facilitate interaction in physical or digital spaces (spatial) | e.g. classroom used as workspace, online collaborative workspace |
| | Facilitate interaction across timeframe (temporal) | e.g. long term |

Properties have *values*. In the case of the position along the dimensions, four properties will be used (acquisition/simulation, acquisition/reality, participation/simulation and participation/reality).

The values for the properties of the professional objects will come from the empirical data and are, for example, a learner enacting the role of junior professional, an online collaborative workspace, and a long term timeframe.

*Factors* are external influences that cannot be determined by designers. Some factors can be influenced by interaction with the design context. Many factors will turn out to play a role in our research from a design perspective. The factor we explicitly intend to include are the limitations of learning environments that have to fit into an existing educational context. Educational contexts can studied at different levels. First, there is the meso-level of a school or institution (Van den Akker, 2003). In our studies, this level is represented by a University of Applied Sciences. The next three levels are in between the meso and the micro-level of a classroom. This university of applied sciences consists of six independent faculties. Within these faculties, there are different educational programs. Within these programs there are yearly curricula, consisting of a number of sequential learning environments. Each learning environment is instantiated in parallel, to accommodate the number of learners. For example, one of our case studies will be carried out at the Faculty of Communication and Journalism, at the educational program Digital Communication. Within the first-year curriculum, we will study the learning environment 'System development'. This learning environment is to be instantiated six to seven times to accommodate the number of learners. Therefore, there will be multiple learning environments in action at the same time, in parallel. Each instantiated learning environment accommodates about 25 learners, guided by two educators. One instance of a learning environment represents the micro-level of a classroom (Van den Akker,

2003), which is the level we will study. The levels above this level are considered as factor. We intend to ensure that our research agenda is in line with the educational vision employed throughout these levels. By carefully selecting our cases, we can align our research questions with the local educational agendas. Some factors can be influenced by interaction with the design context. By prolonged interaction with the selected cases, as much positive influence as possible will be exerted. It should be noted, that influencing these factors will only done before and after a learning environment is in action. While a learning environment is in action, the focus will shift completely towards the research perspective and systematic data collection.

Designers make *representations* of the entities they design, in the form of a textual description, graphics, or some other form. Throughout the chapters, especially in chapter 2, we present different representations of the entities we researched from a design perspective. There are also *descriptions of the state of an entity* which describe the properties and values of an entity at a certain moment in time. These descriptions are the empirical results presented in the chapters 2-6.

In sum, our research from a design perspective will result in different design products. The descriptive model of learning environments we will introduce [chapter 2] helps to make the entity more concrete by identifying crucial properties. We will use different representations to make the descriptions, showing how the entities and properties can be analysed in educational practice. The empirical results represent the values of the properties [chapters 2-5]. Insight into how the entities and properties can be instantiated could help educators to design their own entities and properties. Designs are made to reach a design goal. In our studies, the designed entities are meant to facilitate the activation of authentic mechanisms. These authentic mechanisms should lead to the development of integrated competencies. We will connect the values of the properties of professional objects to the authentic mechanisms [chapter 5] and we presented effect measures of the learning outcomes [chapter 6]. The latter efforts will be undertaken to show that the identified entities, properties and values have the potential to reach the intended design goal.

### 1.5 Method

The method we choose is the case study. The strength of this method is to study a case in-depth within its real-life context (Yin, 1989; 2005). While an intended learning environment can be studied by examining the educational material, it is only possible to really study an implemented environment while it is in-action. The above presented CIMO-logic can be considered as equivalent to an operational framework that needs to be made explicit in advance, as Yin (1989) recommends as a desirable characteristic of good case studies.

The main sources of data are the curriculum material, observations and questionnaires. The curriculum material consists of student manuals, hand-outs, resources (e.g. books, links to online material), formats, announcements in the digital learning environment, and so on. We plan to carry out observations of all the face-to-face interaction that will be organised by teachers for the learners. The observations will also include monitoring of the interaction in accompanying digital learning environments. Questionnaires will be used to the above two data sources triangulate (Guba, 1981; Yin, 1999; 2005; Onwuegbuzie & Leech, 2007). To further increase the quality of naturalistic inquiries, Guba (1981), Yin (1999;2005) and

Onwuegbuzie & Leech (2007) suggest a number of measures. We plan to use different measures to increase the trustworthiness of our research.

*Prolonged engagement at a site*. The studied cases are conducted within one educational institute. A single researcher (the author of this thesis) will be present before, during and after the enactment of the design of the learning environment. In two cases, the presence will last for two subsequent years. Spending extended time at a site helps the locals to adjust to the presence and should give sufficient time to check the developing perceptions.

*Persistent observation*. In the studied cases, the researcher will carry out between 25-50 hours of structured observation and is to be present for many more hours as informal observer. This time enables the researcher to identify the common qualities as well as the atypical characteristics.

*Peer debriefing and Reflexivity*. The researcher intends to discuss the developing insights frequently with practitioners, educational experts and educational researchers. Also, presentations and workshops are planned, to expose the intermediary research results to critical questions. These frequent discussions, presentations and workshops are explicitly used as peer debriefing and to critically reflect on the research activities.

*Member checks*. After the enactment of the learning environments elaborate evaluation reports will be written. These reports are discussed with the key participants of the studied contexts. These discussions are used as member checks, to test the interpretations that are made.

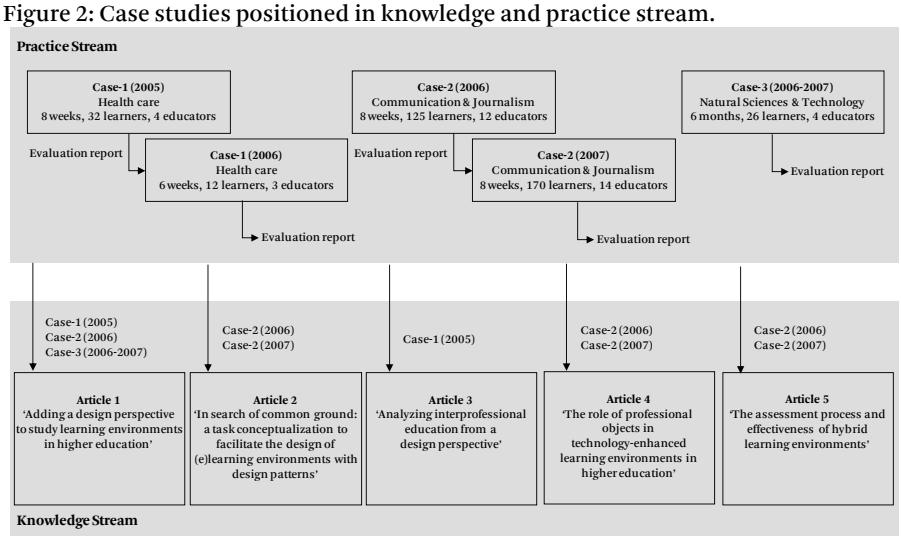
*Collect thick descriptive data and develop thick descriptions.* We plan to collect rich data and make rich, thick descriptions. These descriptions are intended to help the target audience to make judgments about how fitting and usable the presented results could be for their own problematic context.

### 1.6 Two streams of the research process

A number of in-depth case studies will be carried out in the context of higher education. The cases can be positioned in two distinct, interwoven streams of inquiry, the practice and the knowledge stream (Andriessen, 2007). The objective of the knowledge stream is to generate scientific knowledge. The objective of the practice stream is to contribute to solving particular problems in the context in question. The introduced CIMO-logic helps to structure the scientific knowledge generated in the knowledge stream in such a way that it is applicable in the practice stream to help solve a particular problem in the context in question.

In figure 2 the selected cases are positioned in the two streams. The case studies are to be carried out in three different educational contexts. In each context, one learning environment will be studied. The three learning environments are situated in one educational institute. The educational institute is a Dutch University of Applied Sciences with about 35.000 students. The institute consists of six independent faculties. The case studies took place at three different faculties (Health care, Communication & Journalism, and Natural Sciences & Technology). During the first case study, the University of Applied Sciences collaborates intensively with an accelerated, four-year medical program of a University Medical Center.

Figure 2: Case studies positioned in knowledge and practice stream.




In figure 2 is shown how the learning environments from educational practice (practice stream) function as case studies for five scientific articles (knowledge stream). Each studied environment will produce results for both the practice and the knowledge stream. In the practice stream, the intended learning environments will collaboratively be (re)designed with teachers. When the learning environments are implemented, the focus will shift to a research perspective and the priority will be on systematic data collection. After each learning environment, evaluation reports including advise for improvement will be made in the practice stream. In the knowledge stream, the scientific results will be generated from the collected data and presented as empirical studies for scientific journals. Balancing the practice and the knowledge stream and attuning the agenda from daily educational practice with the research-agenda are the two major challenges of this research. This aspect will be reflected on in the last chapter [chapter 7].

### 1.7 Research questions and Chapter overviews

We formulated the following research question to drive our research:

- How can we design and improve project-based, ICT-supported learning environments in higher professional education?

The above general research question is specified into a number of more detailed sub-questions. To conclude this introductory chapter, these sub-questions are introduced and an overview of each chapter is given.

*Chapter 2 (Article 1).* In chapter 2, the designable elements and the main problems of project-based, ICT-supported learning environments are identified. In this article, the following research questions are addressed:

- How can we characterise the designs of learning environments in current higher education, consisting of spaces, artifacts and events, on a dimension with on the one end 'specified' and on the other end 'open'.
- What problems can be identified when a learning environment is carried out?

We explore the data of Case-1 (2005), Case-2 (2006) and Case-3 (2006-2007) with the help of a global, descriptive model of learning environments to identify the elements of a design of a learning environment. We use this model to make systematic descriptions of the learning environments and identify the main problems.

*Chapter 3 (Article 2).* In chapter 3, we introduce a model of the building blocks of learning environments, namely, learning tasks. We explore the data of Case-2 (2006) and Case-2 (2007) in more detail. We use this task-model to analyse learning environments and to generate design guidance in the form of design patters. In this article, we address the following research question:

- Which task conceptualisation will facilitate the (re)design of (e)learning environments in higher education with the help of design patterns?

An important aspect will be to consider the artefacts of a learning environment as 'boundary objects'. This concept adds an analytical perspective, helping to focus on objects that facilitate coordination, alignment and integration of the various activities of individuals with different viewpoints (Star & Griesemer, 1989; Schmidt & Wagner, 2004). The focus in this chapter is on products, methods, representations, formats, tools and so on, which are already in use in the professional community in question and can be introduced into a learning environment to be instrumental in learning tasks.

*Chapter 4 (Article 3).* In chapter 4, the descriptive task-model is developed further, leading to an improved model of both the learning environment and the learning tasks. We explore the data of Case-1 (2005). This case dealt with a learning environment for learners from different health care professions, aimed at learning how to collaborate in an interprofessional team. Therefore, there is an additional focus on interprofessional education in this article. In this article we address the following research question:

- How to design hybrid interprofessional education?

*Chapter 5 (Article 4).* In this chapter, we focus on the instrumental perspective of learning tasks. We study professional objects, which can function as boundary objects and use the data of Case-2 (2006) and Case-2 (2007). In this article we address the following research questions:

- How do professional objects function as boundary objects and which role do they play in activating authentic mechanisms?
- How was the technology enhancing the learning environment used in relation to these objects?

*Chapter 6 (Article 5).* In this chapter, we study the effectiveness of learning environments. We use the data of Case-2 (2006) and Case-2 (2007). The following research questions are addressed in this article:

- How can the assessment process of a hybrid learning environment be characterised?
- How effective is a hybrid learning environment?

With a set of quality criteria for competency assessment, authenticity, cognitive complexity, meaningfulness, fairness, transparency, educational consequences, directness, reproducibility of decisions, comparability and costs and efficiency

(Baartman et al., 2007), we assess the quality of the assessment process of hybrid learning environments.

*Chapter 7*. We conclude this research with a final discussion-chapter. We present our conclusions and discuss the theoretical approach, the methodological approach, future research and practical implications.

To wrap this section up, we present an overview of the chapters and the relations between the chapters [see figure 3].

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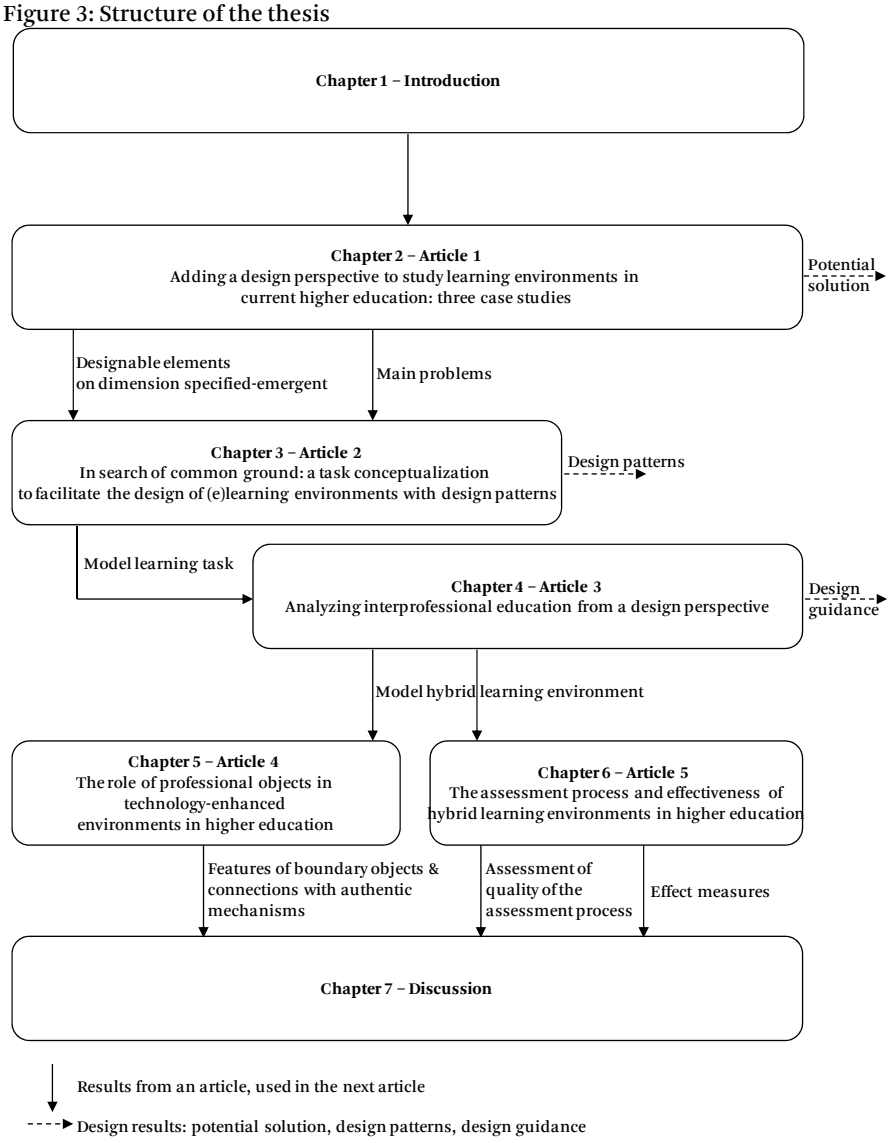
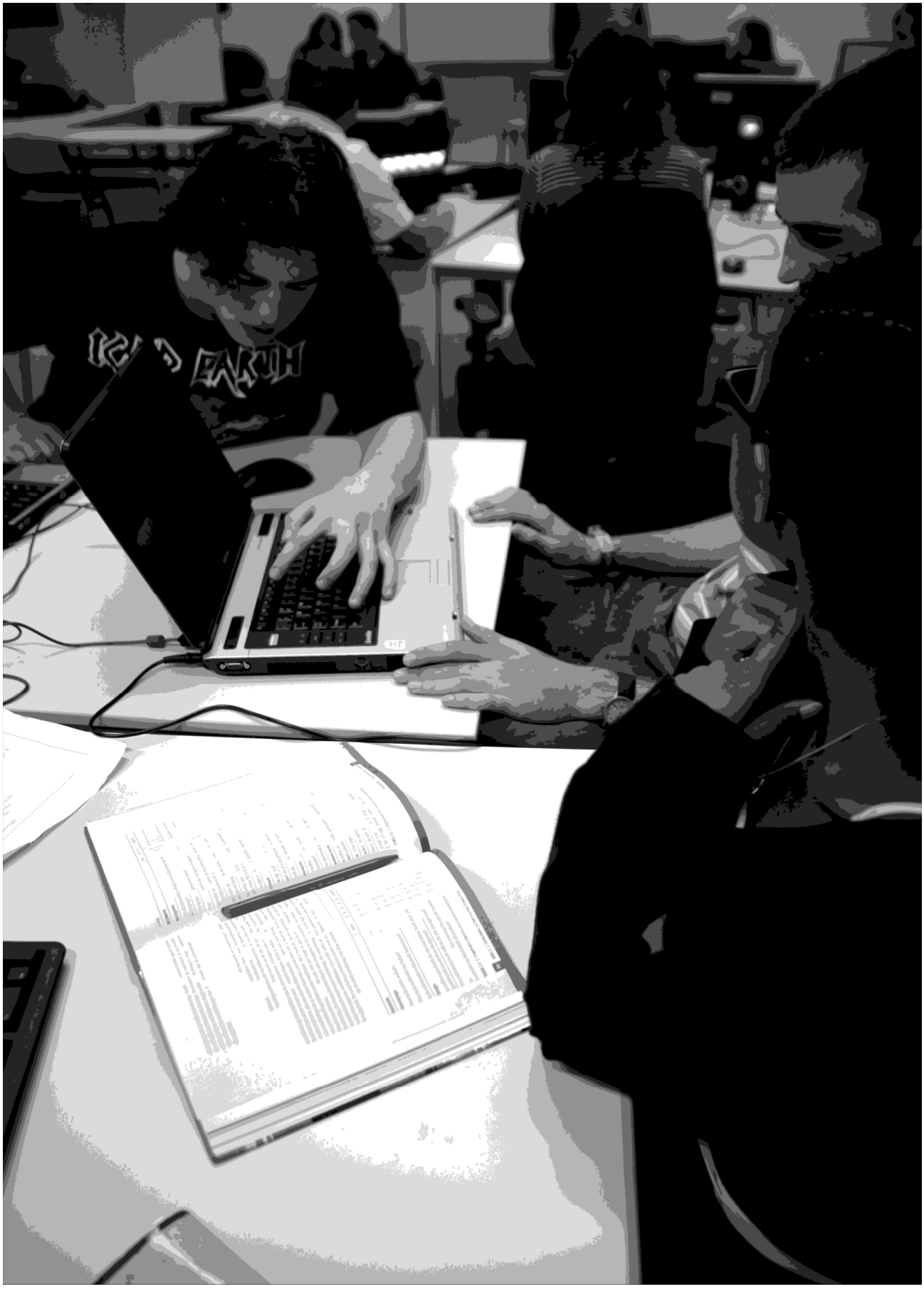
Figure 3: Structure of the thesis





# Chapter 2
# Adding a design perspective to study learning environments in higher education: three case studies[*]

**Abstract**

How to design project-based learning environments is still controversial. Three case studies analyse the designs of learning environments in higher education more closely. We identified the designable elements of project-based learning environments and positioned them on a scale ranging from specified to open elements. The main problem we identified was the integration of specified and open elements. Learners had difficulties connecting what they learned in specified elements in the open elements; they had difficulties to switch from a guided role they enacted in specified elements to an initiating role in open elements; and there was a difficulty of matching the rich reality of open elements with the intentional and planned, specified elements. We introduced adaptive elements as a potential solution. We observed participants adapting these elements to suit their own needs or the needs of others. The designable and adaptive elements had to fulfil a dual function: they should offer contextual clues that would be available in professional practice and also scaffold learners who are in need of support.

[*]Previous/Unrevised version of Zitter, I., De Bruijn, E., Simons, P. R. J., & Ten Cate, Th.J. (2009). Adding a design perspective to study learning environments in higher professional education. *Higher Education [Conditionally accepted*]

## 2.1 Introduction

Current higher education extends, changes and replaces established roles, resources and locations of learning. Cognitive apprenticeship (Brown, Collins & Duguid, 1989), situated learning and legitimate peripheral participation (Lave & Wenger, 1991) are approaches attempting to break the encapsulation of school learning in different ways (Engeström, 1991). Why are established educational practices changing? Tynjälä, Välimaa & Sarja, (2003) indicate that the massification and diversification of the higher education system, economic globalisation, novel modes of knowledge production, new professional requirements and the establishment of new vocational higher education systems in many countries have challenged higher education to develop new forms of collaboration with working life. They state that project-based learning, in which learners work collaboratively on an actual (or simulated) real-life problems, is a good example of such a new form of collaboration between education and working life.

Designing project-based learning environments can seem a daunting task for educators (Ten Berge, Ramaekers, Brinkkemper & Pilot, 2005). This triggered us to study the designs of project-based learning environments in higher education more closely. The following main research question was addressed in this article: *How can we characterise project-based learning environments in current higher education from a design perspective?* The concept of design was taken broadly, including all elements as specified in the curriculum documents and/or material (Van den Akker, 1999). We studied the problems with the designs of project-based learning environments. The results were used to identify a potential design solution.

## 2.2 Problem definition

### *2.2.1 Dichotomies in current educational research and educational practice*

On a conceptual level a distinction can be made between the acquisition and the participation metaphor (Sfard, 1998). In the acquisition metaphor, knowledge is considered as a commodity that can be acquired, applied, transferred and shared with others. The participation metaphor characterises learning as becoming a member of a professional community. Another dichotomy has on the one hand encapsulated, school learning and on the other hand, open learning approaches, such as, situated learning and legitimate peripheral participation (Lave & Wenger, 1991).

Kirschner, Sweller & Clark (2006) identify the traditional cognitivist paradigm in which curricula are subject matter oriented, versus competence based learning based on situated cognition in (electronic) learning environments that more or less mimic real world contexts. They also describe a dichotomy concerning the amount of instructional guidance offered to students. On one end of this distinction there is direct instructional guidance, which claims that learning is most successful when it is as explicit, direct and highly scaffolded as possible. On the other side is the minimal guidance in approaches which foster learning by challenging students to solve “authentic” problems or acquire complex knowledge in information-rich settings based. In these approaches, learners are encouraged to take charge of one's own learning, while they are suitably supported and scaffolded (Kirschner et al., 2006; Kuhn, 2007). This last dichotomy will be the focus of the studies reported here.

Complementary to the above dichotomies, we introduced a dichotomy with respect to the specificity of a design of a learning environment, namely, a dichotomy with on one end 'specified' and on the other end 'open'. Specified elements are directive and recipe-style: the ingredients and the steps that need to be taken to deliver the intended result are made explicit. Open elements are more emergent in nature. The quality of the intended result will be usually be known, while the learners will need to jointly decide on the ingredients and the steps to take. This dichotomy is related to the guidance dichotomy, but fits better in a design perspective. Designs of learning environments can be *specified* by educators or they can be less specified in advance and left *open*. The open elements of a design will gradually be fleshed out in the course of joint interaction during learning activities.

### *2.2.2 Operational framework*

A learning environment consists of the physical setting in which learners carry out their work, including all the tools, documents and other artifacts to be found in that setting. Besides this physical setting, it also includes the social/cultural setting for such work (Goodyear, 2001). Therefore, we identified as designable elements of learning environments, the physical spaces in which learning activities take place and the tools, documents and other artifacts that play a role in the activities. We also identified the learning activities that are planned and organised. The learning activities that are planned and organised are named 'events'.

To overcome the duality inherently related to dichotomies, Simons (1999) suggests to look for dimensions and degrees instead of dichotomies. Following this suggestion, the distinction between specified and open can be positioned on either side of a dimension. The resulting operational framework consists of designable elements as described in the curriculum documents and/or material (Van den Akker, 1999), which we defined as spaces, artifacts and events. These three kinds of elements can be positioned on a dimension, ranging from specified elements to open elements.

### *2.2.3 Research questions*

The above operational framework was used to characterise the designs of three project-based learning environments in current higher education. The following research questions were formulated:

- How can we characterise the designs of learning environments in current higher education, consisting of spaces, artifacts and events, on a scale with on the one end 'specified' and on the other end 'open'.
- What problems can be identified when a learning environment is carried out?

## 2.3 Method

### *2.3.1 Case studies*

To answer the research questions we carried out three in-depth case studies. The strength of the case study method is its ability to examine, in-depth, a "case" within its "real-life" context (Yin, 2005). This method was selected to study the designs of project-based learning environments within their real-life contexts.

The case studies were carried out in three different educational contexts. In each context, one learning environment has been studied. The three learning environments were situated in one educational institute. The educational institute is a Dutch University of Applied Sciences and consists of six independent faculties. To select suitable cases, in each context, preliminary meetings were held with coordinators of the learning environments. During these meetings the learning environments were discussed. Two selection criteria were checked: whether the learning environment was project-based and the prospective active involvement.

The decisive criterion was whether the learning environment was project-based, involving learners working collaboratively on actual (or simulated) real-life problems (Tynjälä et al., 2003). This criterion was met by the selected cases. In the first case, learners worked on patient cases based on cases from real patients. In the second case learners worked on the design and development of websites for real, external clients. In the third case, learners worked on project from real, external clients in the domain of urban area development. For the second criterion, it was confirmed that the participants, especially the involved educators, should potentially be willing to be actively involved in educational research from a design perspective for a prolonged period of time. The following three case studies were selected [see table 2]

1. Faculty of Health care: Physiotherapy, Nursing and Speech therapy, in collaboration with an accelerated, four-year medical program of an Academic teaching hospital (Case-1).
2. Faculty of Communication and Journalism: Digital communication (Case-2).
3. Faculty of Natural Sciences and Technology, Institute for the Built Environment. This context was open to students from other faculties and educational institutes (Case-3).

Table 2: Overview selected case studies

| | Case-1 (2005) | Case-2 (2006) | Case-3 (2006/2007) |
|---|---|---|---|
| Faculty | Faculty of Health care & Academic teaching hospital | Faculty of Communication and Journalism | Faculty of Natural Sciences and Technology |
| Programs | Physiotherapy, Nursing and Speech therapy & Accelerated medical program | Digital communication | Open to students from other faculties and educational institutes. |
| Topic | Interprofessional collaboration | System development | Management of Urban area development |
| Number of learners | 32 | 125 | 26 |
| Duration | 8 weeks, 4 ECTS[*] | 8 weeks, 14 ECTS | 6 months, 30 ECTS |
| Position in overall study | Third-year students of the Faculty of Health care (elective); First-year medical students (obligatory) | Final module for first-year students. | Elective minor course for third-year students |

*Case-1*
The first case study was carried out in the medical and paramedical domain. The learning environment involved thirty-two learners and four educators for a period of eight weeks. The learning environment dealt with the interprofessional treatment and care of stroke-patients and more broadly, how to collaborate in an interprofessional healthcare team.

Students worked on a case of stroke-patients requiring the treatment and care of different healthcare professionals. The patient-cases were based on real patient-cases and the case material consisted of video and paper material. This educational setting had to deal with a number of restrictions: costs, technical limitations, avoidance of danger, ethics, psychometric requirements and time constraints (Issenberg, Mcgaghie, Petrusa, Gordon & Scalese, 2005). Involving real patients was not possible in this context, since there was limited budget, limited time and danger had to be avoided to offer the learners involved a safe learning environment.

*Case-2*
The second case study was carried out in the domain of digital communication. It was an obligatory learning environment for first-year students and the concluding course of their first study-year. The learning environment was set up in the form of an organisation: two educators enacting the role of coordinator, twelve educators enacting the role of senior professional, and 125 learners enacting the role of junior

[*]European Credit Transfer and Accumulation System. The student workload of a full-time study program in Europe amounts in most cases to around 1500-1800 hours per year and in those cases one credit stands for around 25 to 30 working hours (European Commission, Directorate-General for Education and Culture, 2007).

professional. The work was carried out in small project teams of three to four learners. The project teams worked on the design, development and implementation of a website for external clients. Offering real problems to learners was possible in this context. The teachers had access to a large pool of potential external clients willing to collaborate. The clients were from the small and medium enterprises domain or the non-profit sector. At the end, each client could select the website s/he considered the best. On request, the selected project team would implement the website and put it online.

*Case-3*
The third case was carried out in the domain of urban area development. There were twenty-six learners involved, four project coaches and four external clients. There were four projects, with four different types of urban development problems in the Dutch area. The projects were globally defined by the project coaches and the external clients beforehand. Each project consisted of six to seven positions, for example, project leader, domain-expert and designer. At the start, learners were required to formally apply for a position in a project, by sending an application letter and their resume. On the basis of these applications the project coaches formed the project teams. The learning environment in this context had to be equivalent to a trainee assignment in professional practice.

### *2.3.2 Participants*
The participants were the learners participating in the selected learning environments. They have mainly been studied from a group-perspective. The focus was on how the participants handled and experienced the designable elements of the learning environments. In each of the cases, the spaces, artifacts and events of the whole group of participating learners have been studied. In each of the cases, the whole group was divided in sub-groups. The observations, as described below, were carried out with one sub-group of each case.

### *2.3.3 Data collection*
To study the designable elements, all the educational material was collected. To study how the design were implemented, observations were carried out. The face-to-face events organized for learners in each learning environment were observed. During the observations, extensive field notes and photos or screenshots were taken. The observations and monitoring were carried out by a single observer. The field notes were used to describe the events, while the photos and screenshots were taken to systematically collect data about the spaces and the artifacts.

The trustworthiness of these observations has been increased by the use of prolonged engagement and persistent observation (Guba, 1981). All organised face-to-face events were observed and the interaction in the accompanying digital learning environments was monitored. In Case-1 and Case-2 these observations took place for a period of eight weeks, in Case-3 for a period of six months. These data were used to answer the first sub-question of how to characterise the designs of project-based learning environments in current higher education. In Case-1, approximately 24 hours (about 4 hours/week) of observations were carried out, in Case-2 approximately 48 hours (6 hours/week) and in Case-3 approximately 50 hours (2 hours/week). The digital learning environments were monitored on a weekly basis, for the entire duration of each case.

Evaluation questionnaires were used to triangulate (Guba, 1981) the above types of data. These questionnaires were not made specifically for the purpose of this research, but were part of the standard evaluation procedure of the educational institute in question. A similar evaluation questionnaire was distributed to all participating students in each case. The response to the questionnaire was as followed: Case-1: 94%; Case-2: 26% for the whole group, 62% for the observed sub-group, and Case-3: 100%. In this article, only the answers to the final open question of the questionnaires were used to study the learning experiences. The observational data and the answers to the open question were used to answer the second sub-question of identifying the main problems with the designs of learning environments.

For each participating educational context, an evaluation report was made on the basis of a global analysis of the above data. The evaluation reports included recommendations to solve the identified problems. These evaluation reports were extensively discussed with peers, both educational researchers and educational experts, as a form of peer debriefing (Guba, 1981). They were also discussed with participants of the educational contexts with a coordinative role, as a form of member check (Guba, 1981). These data provided additional input to find a potential design solution.

*2.3.4 Data analysis*
First, the designable elements were identified by globally analysing the three cases. The identified designable elements have been used as a coding scheme for the analysis of each case. The level of specificity/openness was determined on the basis of the collected educational material. When elements were highly specific and recipe-style, they were considered as 'specified'. When elements were designed more globally, they were considered as intermediate specified/open. When elements were only designed in a generic way, they were considered as 'open'.

With respect to the problems, the answers to the open questions were categorised to identify the main problems across the three cases. The observations were used as additional evidence for the problems reported by the learners.

The above described data analysis process was carried out in close collaboration with an educational expert. Multiple, consecutive rounds of discussion took place, until consensus was reached. This collaboration can be considered as an intensive form of peer debriefing (Guba, 1981).

## 2.4 Results

### *2.4.1 Identified designable elements*

The selected cases were analysed to further detail the designable elements: spaces, artifacts and events [see table 3].

When the physical spaces were coded as specified, they were planned in an hourly schedule. The educators were also in charge of the furniture in the physical space. They positioned the tables and chairs to suit the planned event. In case of intermediate specified/open elements, the spaces were available at fixed times in a weekly schedule. When left open, a physical space was reserved for the whole duration. How this reserved space was used, emerged from the joint interaction in this space. The project-teams took the initiative. At times the space was used as workspace, at other times as a meeting or presentation room. For the digital spaces similar distinctions were identified. From a specified digital space used as information channel, which could not be changed by the learners, to digital workspaces which were partly specified by educators (intermediate), to digital workspaces which were only made available (open).

The artifacts which functioned as resources varied from specific, detailed student material that was obligatory and had the form of a student manual, a reader and hand-outs. At the intermediate level, resources which facilitated the process were offered, such as, methods, guidelines, formats and software. The latter were found to be similar to resources used in professional practice. When left open, learners had to find their own resources. The artifacts in the form of descriptions of deliverables which were expected from learners varied from specific descriptions to generic descriptions. At the specified level, there were the reports, summaries and presentations requested after each activity. At an intermediate level, we identified the descriptions of a professional nature, like a diagnosis or a treatment and care plan in Case-1 and a project plan, prototype and website in Case-2. The open deliverables only specified three generic deliverables, namely, a project plan, one intermediary deliverable and the final deliverable.

The types of events varied from specific and planned in each detail (e.g. lectures and guided group assignments), to guided project work (intermediate), to meetings on request (open). The sequence of events varied from hourly schedules (specified), to a weekly planning accompanied by a sequence of deliverables covering eight weeks (intermediate), to a global sequence covering six months (open).

The role descriptions varied from specific descriptions for a role within one activity (e.g. Chair person), to roles within a project (intermediate), to functions with multiple roles (open). The roles of the external clients were also left open, they could be enacted by the client as s/he wanted.

In table 3, an overview is presented of the levels of specificity/openness of the learning environments. The granularity of the learning environments varied. Case-1 consisted mainly of specified elements at micro-level. Therefore this learning environment can be considered as fine-grained. Case-2 consisted of globally specified elements at an intermediate level of specificity/openness. This learning environment was medium-grained. Case-3 consisted mostly of generic, open elements and was coarse-grained.

Table 3: Levels of specificity/openness of learning environments

| Designable Elements | Specified | Intermediate specified/open | Open |
|---|---|---|---|
| Physical spaces | | | |
| Case-1 | All classrooms + positioning of furniture specified | | |
| Case-2 | | Classroom available as workspace for project teams | |
| Case-3 | | | Classroom reserved for six months for all activities |
| Digital spaces | | | |
| Case-1 | Information channel which cannot be changed | Common spaces to be used by learners | |
| Case-2 | | Workspaces for project teams, partly specified | |
| Case-3 | | | Workspaces available |
| Artifacts to be used as resources | | | |
| Case-1 | | Methods, formats, guidelines | Select own domain-specific resources |
| Case-2 | | Methods, formats, guidelines and software | |
| Case-3 | | | Select own resources |
| Artifacts: descriptions of (intermediary) deliverables | | | |
| Case-1 | Specific descriptions of deliverables (reports, summaries, presentations) | | |
| Case-2 | | Global descriptions of deliverables of professional nature | |
| Case-3 | | | Generic deliverables (Project plan, intermediary results, final result) |
| Different types of events | | | |
| Case-1 | Lectures, self-study group assignments, presentations | Two events similar to professional practice | |
| Case-2 | | Guided project work<br>Planned meetings with external client | |
| Case-3 | Series of workshops | | Meetings on request with project coach and external client |
| Role descriptions | | | |
| Case-1 | Specific instructions for role within an activity | | |
| Case-2 | | Global descriptions of project roles | No strict role description for the external client |
| Case-3 | | | Descriptions of functions with multiple roles<br>No strict role description for the external client |
| Sequence of events | | | |
| Case-1 | Weekly and hourly schedule | | |
| Case-2 | | Weekly schedule<br>Sequence of deliverables | |
| Case-3 | | | Global sequence of six months |

| Key | Case-1 | Case-2 | Case-2 |
|---|---|---|---|

*2.4.2 Identification of problems*
We identified the main problems occurring when the designable elements as identified in the previous section were implemented. The main problem consisted of different aspects of the integration of specified and open elements. The identified integration-problems are presented below.

*Difficulties with connecting what is learned in specified elements in open elements.* In both Case-1 and in Case-3 it was observed that learners had difficulties with connecting what was intended to be learned in specified elements, in the open elements. In Case-3 learners remarked: 'The workshops should be applied better to the projects'. From this remark it became clear that the learners did not understand that it was their own responsibility to apply what was offered in the workshops while working on the project.

*Difficulties with switching roles.* In all cases, learners experienced difficulties with switching from the guided role enacted in the specified elements, to an initiating role required by the open elements. This was especially found in Case-1. In Case-1, learners complained that open elements were 'too vague', 'too slow' and they wanted 'more concrete assignments'. Learners tended to expect the stricter guidance from the specified elements, while in the more open elements they were expected to set their own pace and make activities concreter when they felt the need.

*Difficulties with the reality of open elements vs the intentional specified elements.* In Case-2, learners experienced problems with the reality of the open elements, especially the involvement of the external client, which in their opinion collided with the stricter, specified elements. Learners made the following remarks: 'There was too little feedback from the external client and it was much too slow'; 'We would have expected much more feedback from the external client'; 'The external client should be better informed, so he will provide the necessary input in time'. The role of the external client was intentionally left open, to offer an authentic project-experience. However, at the same time, the deadlines for (intermediary) results were specified in advance by the educators.

*Difficulties with matching the open problems with the specified learning goals.* In all three cases, the learners experienced difficulties with matching the real problems with the learning goals they expected to achieve. In Case-1, learners remarked: 'For people with experience in conducting meetings with an interprofessional healthcare team, there was not much new'; 'One of the cases was really difficult, more knowledge about stroke-patients would have helped to make the interprofessional meetings run more smoothly'. The learners did not realise that they could have taken the initiative to adjust the level of complexity, either by including more aspects in their role or request additional support to develop needed knowledge. In Case-2, learners remarked: 'There should be a better match between what a client wants in relation to our educational program, namely, a program with average technical skills'. Again, learners did not take the initiative to request additional support or seek collaboration with a more technically skilled learners. In Case-3, most remarks were made in relation to this aspect. Learners made many remarks, like the following: 'The project roles you could apply for do not match the roles offered by my project'; 'There should be much more work for designers!!!!!'. In the last case, it also became clear that it was difficult to acquire external projects that would match the learning

goals of the learners or make clear that learners could take the initiative to adjust a project to suit their learning goals.

## 2.5 Discussion

In answer to the first research question, we found that we could typify designs in terms of differences in granularity. Specified designable elements were described at a micro-level, intermediate elements were designed globally and open elements were designed generically. As such, a learning environment can also be seen in terms of granularity. The more specified learning environment was fine-grained, while the more open learning environment was coarse-grained.

The answer to the second research question showed that the main problem was the integration of specified and open elements. Learners had difficulties connecting what they learned in specified elements in the open elements; they had difficulties to switch from a guided role they enacted in specified elements to an initiating role in open elements; and there was a difficulty of matching the rich reality of open elements with the intentional and planned, specified elements. We will now turn to a potential design solution for the identified problems.

### *2.5.1 Adaptive designable elements*

During the data analysis we found a specific characteristic of designable elements: adaptivity. We will explain the concept of adaptivity by giving a concrete example. A specified physical space is, for example, a lecture hall with fixed benches and a fixed whiteboard. When the use of space is left open, learners can choose where to carry out their activities: at home, at the library or in other available workspaces. When a space is adaptive, it is multifunctional. Such a space is suitable for different kinds of work: individual, collaborative, guided or unguided.

Analysis showed that some elements could be adapted by participants. Educators, learners, senior learners and external participants were observed to adapt designable elements. They adapted designable elements by specifying them for their own use or for the use of others. The next three sub-sections will present the three in-depth sub-cases showcasing adaptive designable elements.

*Case-1: Adaptive artifacts.* Case-1 took place in the Healthcare domain. To support communication and collaboration between different healthcare professions, a common framework has been developed for the diagnosis, treatment and care of patients from multiple perspectives. This framework can be translated into a visual representation, a feature that is of benefit in educational contexts (Allan, Campbell, Guptill, Stephenson & Campbell, 2006). The framework was used as one of the fundaments for the learning environment. Observations showed that when a teacher noticed that the students had difficulty with the analysis of a patient case, she drew the visual representation of the common framework on the whiteboard. In interaction with the students, the patient case was ordered according to the framework. Other observations showed students using the visual representation to summarise patient cases, to exchange these and to give each other feedback, when one student turned out to be more knowledgeable than another. Furthermore, students found resources about the framework online, using the Web to complement resources offered in the learning environment.

*Case-2: Adaptive use of physical space.* The learning environment of Case-2 was large scale and involved 150 students. To feasibly accommodate this large number of students, the learning environment was positioned at the physical location of the educational institute. There were six sub-groups, for each sub-group, a regular classroom was available as workspace for a fulltime working week. At scheduled times, six hours each week, a duo of teachers was present in the workspace. The sub-groups, consisting of about seven project-teams worked side by side in classrooms. Students helped each other and showed each other intermediary results. There was also a senior student, fulfilling the role of account manager (liaison between the project teams and the external client). Students also requested advice and feedback from the senior student. When the teachers were present, students could request help or show intermediary results to receive feedback. The teachers also walked around and offered their advice without direct requests from learners.

By having a physical space available according to a weekly schedule, with access to educators, a senior peer, peers and team members, the participants were able to adapt their workspace and support to suit their needs.

*Case-3: Adaptive event with external participants.* In Case-3, students worked more independently than in the other two cases. This independence was caused by the differences in projects. In Case-3 the students worked on very different projects. To help students improve the quality of the (intermediary) results, students were required to present their intermediary and semi-final results to a panel of practitioners/experts three times. During these sessions, students received feedback on how to improve their results. The content of the activity could be adjusted to suit the needs of students. The panel, consisting of external participants, offered supportive structure and guidance for some teams, while for other project teams, the feedback closely resembled feedback as given in professional practice.

By planning the above event and organise it as described above, the external participants were able to adapt their feedback to suit the situation.

In the above three sub-cases three adaptive, designable elements have been showcased. The elements differ from both the specified and the more emergent elements. The specified elements are specified in advance and are to be used as specified. The more emergent elements are to be jointly developed during interaction. The adaptive elements are open to be specified by all participants, educators, learners and external participants. An individual learner can specify them or they can be specified for a group of learners.

*2.5.2 Dual function of designable elements: scaffolds and contextualisation.*
The designable elements as introduced in this article can be related to the concept of 'scaffolds'. The original use of scaffolding described interactions between a parent and a child or a tutor and a student in which the parent or tutor offers support. Since then, 'scaffolding is no longer restricted to interaction between individuals – artifacts, resources, and environments themselves are also being used as scaffolds' (Puntambekar & Hübscher, 2005). Puntambekar & Hübscher state that there are two main facets of the current scaffolding construct. The construct has been enriched in the techniques of proving support; and second, in current implementations there is a lack of emphasis on the process. Continuous diagnosis of the need for support and fading of scaffolding when suitable are replaced by more permanent and

unchanging support. This lack of emphasis on the process is also recognisable for the designable elements, either they are specified by the educators or they are left more emergent. The adaptive elements do provide means for more emphasis on the process. They are designed in such a way that participants, educators, external participants senior learners and learners, are able to continuously diagnose whether support is needed. If this is the case, the element can be specified for single or multiple learners, not only by educators, but also by other participants.

An important function of the designable and adaptive elements is to help contextualise a learning environment. Learners are expected to work on deliverables in physical and digital spaces that are situated in educational institutes. When they would work in a professional context, the spaces, artifacts and events in that context would provide contextual clues of how to proceed. In an educational context, these clues need to be specified by educators when necessary. The designable and adaptive elements are to be designed to fulfil a dual function: they should offer contextual clues that would be available in professional practice and scaffold learners if they need support.

### *2.5.3 Future research*

The results presented in this chapter are the result of in-depth, qualitative research. Future research will have to be carried out to study the effectiveness of the adaptive elements introduced here. Future research will also have to include studying how to systematically improve the design of learning environments in current higher education.

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# Chapter 3
# In search of common ground: a task-conceptualisation to facilitate the design of (e)learning environments with design patterns[*]

**Abstract**

Many studies report changes taking place in the field of higher education, changes which present considerable challenges to educational practice. Educational science should contribute to developing design guidance, enabling practitioners to respond to these challenges. Design patterns, as a form of design guidance, show potential since they promise to facilitate the design process and provide common ground for communication. However, the potential of patterns has not been fully exploited yet. We proposed the introduction of a task conceptualisation as an abstract view of the concept chosen as central: the task. The choice of the constituting elements of the task conceptualisation has established an analytical perspective for analysis and (re)design of (e)learning environments. One of the constituting elements is that of 'boundary objects', which added a focus on objects facilitating the coordination, alignment and integration of collaborative activities. The presented task conceptualisation is deliberately generic in nature, to ease the portability between schools of thought and make it suitable for a wide target audience. The conceptualisation and the accompanying graphical and textual representations showed much promise in supporting the process of analysis and (re)design and add innovative insights to the domain of facilitating the creation of design patterns.

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## 3.1. Introduction

### *3.1.1 Design patterns in response to educational challenges*

Many studies report changes taking place in the field of higher education: 'New educational methods are being introduced to support complex learning and the development of professional competencies. These also stress the collaborative construction of knowledge through active learning ('social constructivism') and the importance of higher order skills such as problem solving skills, learning strategies and self-regulation' (Jochems, Van Merriënboer & Koper, 2004). Different concepts have been introduced to analyse and design educational changes, such as, 'competency-based learning' which has taken off since about 1996 (Schlusmans, Slotman, Nagtegaal & Kinkhorst, 1999), the 'participation metaphor' of Sfard (1998), which describes learning as becoming a member of a community, and the concept of 'new learning', which emphasises the new learning outcomes required to become a life long learning professional (Simons, Van der Linden & Duffy, 2000).

Mentioned changes present considerable challenges to educational practice. Educational science should in our view contribute to developing the necessary design guidance to respond to these challenges. As a result, educational science moves into the realm of design science. Van Aken (2004) states that the goal of design sciences is to develop knowledge for designing solutions to problems, which is also the driving force behind the concept of design patterns. The theory of design patterns has originated from the field of architecture and 'describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it in the same way twice' (Alexander, Ishikawa, Silverstein, Jacobson, Fiksdahl-King & Angel, 1977 cited in Goodyear, Avgeriou, Baggetun, Bartoluzzi, Retalis, Ronteltap & Rusman, 2004). Patterns show potential, since they promise to provide common ground for communication and facilitate the design process. The potential of patterns has not been fully exploited yet. 'This is largely due to (…) the difficulty of identifying the proper perspective, level of abstraction, and granularity for shaping a design problem and for describing its solutions' (Call for papers Computers in Human Behavior, 2007).

Before carrying out the two case studies described in this chapter, we carried out an exploratory case study. The exploratory case study yielded a number of preliminary design patterns which we presented to a panel of educational experts. Analysis of the results showed that the experts were quite positive about the presented patterns, but they were of the opinion that the patterns had an arbitrary feel to them. They made statements about why these patterns emerged from the exploratory case study and not others, furthermore, they missed an underlying structure or rationale.

### *3.1.2 Introducing a task conceptualisation*

To overcome the above mentioned and experienced difficulties with design patterns, we propose the introduction of a task conceptualisation [see also appendix of this chapter]. This conceptualisation is an abstract view of the concept chosen as central, namely the task, and consists of a selection of related elements. The choice of constituting elements establishes a perspective which can be adopted for analysis and (re)design of (e)learning environments. The conceptualisation is meant to help with the interpretation and integration of the data collected through literature and field studies. Furthermore, the conceptualisation has a number of accompanying

representations, both graphical and textual, to facilitate analysis and (re)design activities. The task conceptualisation as presented here, is deliberately generic in nature, to ease the portability between different schools of thought and to make it suitable for a wide target audience. We believe that by declaring the task as base element and by making this element explicit with a conceptualisation, a firm basis will become available for working with design patterns. Retalis, Georgiakakis & Dimitriadis (2006) corroborate our beliefs: 'Design pattern creation, especially in the e-learning domain, is a highly complex process that has not been sufficiently studied and formalized'. We anticipate that a task conceptualisation will contribute to establishing a form of group cognition in the domain of design patterns for (e)learning. 'Group cognition is argued to provide a basis for the coordination of individual actions as well as for future communication and activity of the group' (Clark & Brennan, 1991; Hutchins, 1995 cited in Akkerman, Van den Bossche, Admiraal, Gijselaers, Segers, Simons & Kirschner, 2007).

Above, we mentioned (e)learning environments, which have many different meanings in the educational domain. In this chapter, we connect to the ideas of 'networked learning': learning in which communications technology (ICT) is used to promote connections: between one learner and other learners, between learners and tutors; between a learning community and its learning resources' (Goodyear, 2001).

The main question we will answer in this chapter is: Which task conceptualisation will facilitate the (re)design of (e)learning environments in higher education with the help of design patterns?

The remainder of this chapter is organised as follows. First, the methodological section is presented. In this section, the overall research design is described followed by descriptions of the data collection and the educational setting. Next, the task conceptualisation, which was based on the results of a literature study, is introduced. This version of the task conceptualisation was used to carry out an initial data analysis. Consequently, the task conceptualisation was adapted to reflect the initial analysis. Then, two examples of design patterns are given. Each design pattern is followed by a section clarifying how the task conceptualisation was used for detailed data analysis and construction of the pattern. Finally, the discussion, including thoughts on future research, concludes this chapter. In the appendix, an overview of the task conceptualisation and the accompanying representations including brief explanations of each representation can be found.

## 3.2. Constructing a task conceptualisation through literature and field studies

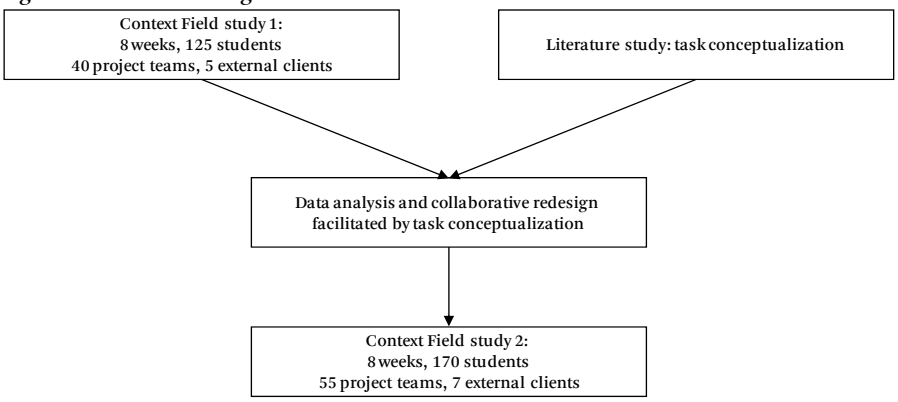
### *3.2.1 Research design: field studies and literature study*

This chapter is underpinned by data collected from two successive field studies and a literature study [see figure 4]. The field studies took place in a Dutch institute of Higher education, namely, a University of Applied Sciences. The duration of each study was eight weeks, and the studies took place in two subsequent school years. Parallel to collecting data for the first field study, a literature study was carried out to find input for the task conceptualisation we aim to introduce.

Both field studies can be considered as two, successive case studies, in which the task as central unit of analysis is embedded (Yin, 1989). Though the field studies can

be considered as case studies, they were carried out from an explicit design perspective. Also, in between the successive case studies, the educational setting studied in both case studies was redesigned in collaboration with the involved practitioners. As a consequence, the overall research design shares characteristics with design-based research and has faced similar challenges: 'one challenging component (…) is to characterize the complexity, fragility, messiness, and eventual solidity of the design and doing so in a way that will be valuable to others' (Barab & Squire, 2004). The literature study was carried out to complement the field studies. The process and results of the literature study will be elaborated on in a later section.

Figure 4: Research design




*3.2.2 Data collection*

The data collection consisted of educational material, observations of events organised for students, observations of teacher meetings, interviews with students, teachers and external clients, collection of intermediary and final results, monitoring of the use of the Computer Supported Collaborative Learning and Working environment (CSCL/W-environment), and an online, evaluative questionnaire.

The observations were made during all the face-to-face events which were organised for students, while monitoring the CSCL/W-environment was used to gain insight into the student activities outside of the organised setting. For this latter purpose, students were also interviewed. To complement the student perspective, the teacher meetings were observed and interviews with teachers and external clients were conducted.

The observations were made by a single researcher being present at the above mentioned events. Extensive, descriptive field notes were taken, using the (adapted) task conceptualisation to focus the observations. Besides the field notes, throughout the observations, photos and audio recordings were made. In Table 4 an overview of the collected data is presented.

Table 4: Overview data collection field studies

| Data collection | First field study | Second field study |
|---|---|---|
| Educational material | All educational material | All educational material |
| Observations of events organised for students: notes, photos and audio recordings | 6 hours a week, 8 weeks, 48 hours of observations in total | 6 hours a week, 8 weeks, 48 hours of observations in total |
| Observations of teacher meetings: notes, photos and audio recordings | 7 meetings, 1 hour each, 7 hours in total | 5 meetings, 1 hour each, 5 hours in total |
| Interviews students | 4 students, 4 interviews each, 16 interviews in total | 4 students, 3 interviews each, 12 interviews in total |
| Interviews senior students | 1 senior student, 2 interviews, 2 interviews in total | 3 senior students, 1 interview each; 3 interviews in total |
| Interviews teachers | 2 teachers from observed group, 2 duo-interviews each, 4 teachers from other groups, 1 interview each, 6 interviews in total | 14 teachers (whole team of teachers), 1 interview each, 14 interviews in total |
| Interviews external clients | 1 client, 1 interview | 3 clients, 1 interview each, 3 interviews in total |
| Intermediary and final results | 4 project teams, 15 tasks, 60 (intermediary) results in total | 4 project teams, 15 tasks, 60 (intermediary) results in total |
| Monitoring use CSCL/W | 4 project teams, 8 weeks | 4 project teams, 8 weeks. |
| Evaluation questionnaire | distributed to 125 students, response 26% | distributed to 170 students, response 48% |

*3.2.3 Educational setting*

The educational setting of both fields studies was the first year of the four-year program 'Digital Communication' at a University of Applied Sciences in the Netherlands. The students worked on an authentic task, namely, a project to develop a website for an external client from the Small- and Medium-sized Enterprises sector (SME-sector). Students worked in project teams of three students and each student fulfilled the role of Junior professional and two team roles, for example, Project leader or Graphical designer. About eight project teams worked in parallel on the same assignment, for the same client. In the first field study, there were five external clients and in the second field study, there were seven external clients from the SME-sector. There was a competitive element in this learning environment, since at the end, the client picked out the project team s/he thought provided the best solution. The selected project team was expected to implement the developed website, which could lead to an online website. Next to the competitive element between project teams, students were expected to work and learn collaboratively within their own project team. Project teams were guided by teachers in the role of Senior professional and Facilitator. Also, senior, second-year students were involved, they fulfilled the role of Account manager and were responsible for the communication with the client on behalf of the project teams. The teachers and the senior students also played the role of Expert and when necessary, external experts were invited. To support the

working and learning processes a Computer Supported Collaborative Working and Learning environment was available, namely SharePoint (n.d.).

### *3.2.4 A task conceptualisation as result of literature study*

*Main concept: task.* To guide the analysis of the collected data and facilitate the collaborative redesign of the learning environment as described above, a literature study has been carried out to create a task conceptualisation. The main concept we chose, is that of a task. Ten Berge, Ramaekers & Pilot (2004) state that the use of complex, real life cases is 'in line with current concepts on learning, competence development and the "whole task" approach, as well as emerging views on the preparation of students for the complexity of issues and questions of modern society and work'. The "whole task" concept is also the backbone of the Four Component Instructional Design (4C/ID) method (Van Merriënboer, De Clark & De Croock, 2002) in which the learning tasks are 'concrete, authentic, whole task experiences'. Kirschner, Martens & Strijbos (2004) characterise tasks on a spectrum, with on the one end the more traditional school tasks which are well-structured, well-defined and short, and on the other end of the spectrum the kind of authentic tasks this chapter is dealing with: '"real life" problems that are mostly ill-structured and/or wicked and generally need team effort to solve them'. Since team effort is needed, collaborative learning is involved. Van Weert & Pilot (2003) establish a role for Information and Communication Technology (ICT) in the above tasks. They say that the trend is to structure activities in real-life tasks, projects or case situations in which ICT is integrated.

Consequently, we studied literature to conceptualise the task in more detail. We adopted elements from different theories and models to assemble the task conceptualisation. The following criteria guided the selection process of the elements we adopted for the task conceptualisation. Foremost, we aimed to keep the task conceptualisation as generic as possible. The task conceptualisation should facilitate designing with design patterns, instead of imposing a specific school of thought. Also, the task conceptualisation is meant to establish common ground, generic and portable concepts are therefore preferable to highly specific concepts.

Next, we have aimed for a simple and at the same time expressive conceptualisation, to appeal to a wide target audience. The former two guidelines have as a consequence that the task conceptualisation could also be suitable for redesigning. Because we were dealing with a redesign process, there were already models and educational material in place, all of which should be relatively easy to map to the task conceptualisation. Lastly, the task conceptualisation has to be prescriptive in nature, each element should be within the scope of design, in other words, each element should be 'designable'.

*Boundary object.* The first theory we considered for the task conceptualisation was Activity theory. Therefore, the primary unit of analysis of the task conceptualisation is an object-oriented activity system, the same unit of analysis as in Activity theory (Engeström, 2000). 'An activity system integrates the subject, the object and the instruments (material tools as well as signs and symbols) into a unified whole. Activity is driven by a collective object and motive, but is realised in goal-oriented individual and group actions' (Center for Activity Theory and Developmental Work Research, n.d.). Activity theory is descriptive in character, while we were looking for input for a prescriptive conceptualisation to facilitate (re)designing with design

patterns. Therefore, we kept the elements that are within the scope of design, namely, the objects or goals, the instruments and the outcomes, and merged them into one concept as explained below. The most important notion we adopted from activity theory was that of mediation or the use and creation of artifacts, which is considered as crucial in this theory (Engeström, 1999).

Norman (1991), uses the term 'cognitive artifacts' for artifacts that affect our cognitive performance and make us smarter and faster. Others, such as Emig (1983), discuss the effect of artifacts on cognitive processes in relation to writing. In her opinion writing serves learning in a unique way since 'information from the process is immediately and visibly available as that portion of the product already written'. In her opinion the importance of such a familiar and available medium that allows one to re-scan and review, cannot be overstated. Smith (1994) describes how artifacts are transformed into different states while groups collaborate. He distinguishes intangible information (both in a private and a shared form) that can be transformed into tangible information, sometimes via an intermediary ephemeral state. Both in the ephemeral state and the tangible state, there are artifacts representing this information, although ephemeral products are destroyed or lost in the process. In the tangible state, there are two types of artifacts: target products, that represent successful completion of the group's task, and instrumental products that support the group's work.

We chose to adopt the concept of 'boundary object', first introduced by Star & Griesemer (1989): 'They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognisable, a means of translation'. Similarly, Wenger (1998) focuses attention on the social aspects of artifacts: although an artifact appears to be a self-contained object, it is in fact a nexus of perspectives. He considers artifacts to be boundary objects, not only designed for use, but also for participation. Others like Sellen & Harper (2002) and Schmidt & Wagner (2002, 2004) follow this notion. Schmidt and Bannon (1992), Schmidt (2000) and Schmidt and Wagner (2004) use the term 'coordinative practices', in which artifacts play a crucial role, and through which workers 'coordinate, align and integrate their various individual activities'.

The concept of boundary objects represented an analytical perspective, which helped to focus on objects that facilitate coordination, alignment and integration of the various activities of individuals of the involved communities like, for example, the community the external client belongs to, the future professional community, the teacher community and the community of learners collaborating in teams. To comply with the criterion of designable elements, the boundary objects taken into consideration should be within the scope of design. As a consequence, the boundary objects are to be the products, methods, representations, formats and tools which are already in use in the professional community in question.

*Role & Event.* Since the rise of e-learning, educational technology and the likes, there are many developments in the domain of educational modeling languages. The current de facto standard is the IMS Learning Design Specification, IMS-LD for short (Koper, Spoelstra & Burgos, 2004; Koper & Olivier, 2004; Unfold, n.d.). The core notion is a conceptual structure consisting of elements such as person, role, activity, method and environment. The structure of IMS-LD is quite elaborate, we chose to

focus on specific elements, also to stay closely connected to aforementioned concepts adopted from activity theory and boundary objects.

For our conceptualisation, we adopted the role and merged it with person. This choice complies with the criteria mentioned before: to keep the task conceptualisation as simple as possible and focus on elements that are 'designable'. A type of person is outside the scope of design, therefore we conceptualised a type of person that can carry out role as a feature of the role, instead of as a separate element. We also adopted the notion of 'method' modeling: which role carries out, which activities, at what moment in the process. At this point, it is important to distinguish a 'task' from an 'activity'. Wisner (1995, as cited in Goodyear, 2005) says: 'tasks are what managers set - they are the prescribed work. Activity is what people actually do. Educators set tasks. Learners interpret the specifications of the task'. Therefore, for conceptual clarity and to meet the criterion of only including designable elements, we used the term 'task'.

To comply with the criterion of meeting a wide target audience, we chose to replace the term 'method' with that of 'event'. The term 'method' has many connotations, while we want to focus on the pragmatic aspect of organising different types of events. The term 'environment' of IMS-LD, represented the concept of boundary object.

*Collaboration scripts and the task conceptualisation.* Collaboration scripts have become fairly popular especially in the domain of Computer Supported Collaborative Learning (Kollar, Fischer & Hesse, 2006; Kobbe, Weinberger, Dillenbourg, Harrer, Hämäläinen, Häkkinen & Fischer, 2007). Collaboration scripts specify a sequence of learning activities, together with appropriate roles for learners. 'Collaboration scripts are designed to trigger engagement in social and cognitive activities that would otherwise occur rarely or not at all' (Kobbe et al., 2007). We chose to adopt several elements from the framework for collaboration scripts from Kobbe et al. To begin with, we have adopted their aim to have an economic framework, enabling descriptions with just a small number of components. This aim fits precisely with our criterion of a simple and at the same time expressive conceptualisation. Furthermore, from the components of the framework, we adopted the concepts of participants, roles and groups, and merged them into one element, namely role, as already explained before. We also adopted the concept of 'resources', though we used the broader term of 'boundary objects' as explained before. Next, we used the concept of 'activities', which we named 'events', as explained above. From the mechanisms of the framework we incorporated their concepts of task distribution and group formation in 'role'. The mechanism of 'sequencing' is represented by the relations between different tasks and how accompanying events are to be planned in time.

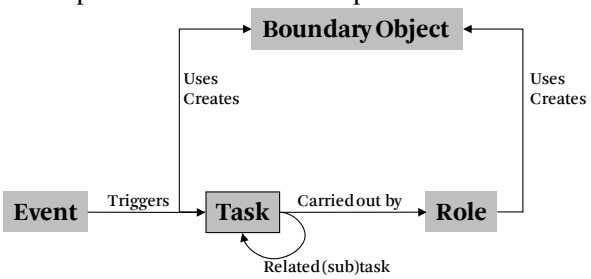
*Scaffolding and the task conceptualisation.* The last concept we adopted for the task conceptualisation is that of 'scaffolding'. A central dilemma in designing authentic tasks is how to reduce the complexity of an authentic task. When authenticity is compromised too much, this may lead to adverse effects. Examples are, students getting bored, or a superficial approach, since students perceive the task to be less difficult than it actually is. Nevertheless, when tasks are presented in their full complexity, this may have other adverse effects, like for example, students experiencing difficulties in getting started, or having difficulties in activating their

prior knowledge, or students losing confidence and feeling lost (Ten Berge et al., 2004). A popular notion for the above dilemma is that of 'scaffolding': assistance to perform a task beyond reach, if pursued independently (Wood et al. cited in Pea, 2004). We adopted the notion of scaffolding since each element of the task conceptualisation should be designable. In sum, each element of the task conceptualisation is to be considered as a scaffold, which are to be designed to assist students performing a task.

*3.2.5 Representations of the task conceptualisation*

To visualise the elements adopted from activity theory, boundary objects, IMS-LD, collaboration scripts and scaffolding, we turned to the domain of Computer Supported Collaborative Work, in which task analysis plays a crucial role. There, we found a suitable model, namely a task ontology of Van Welie (2001). We decided to use a similar visualisation [see figure 5]. It should be noted that in the appendix of this chapter an overview of the structure of the task conceptualisation and the accompanying representations can be found.

Figure 5: Graphical representation of task conceptualisation




Initially, the task conceptualisation was used as a coding scheme to analyse the educational material or the intended curriculum. Next, the implemented curriculum was studied. On the basis of this initial analysis, the task conceptualisation as presented above was adapted. The adapted task conceptualisation, which reflects the initial analysis, is presented in a tabular representation [see table 5 and appendix of this chapter].

The adapted conceptualisation was used as main coding scheme to analyse the data in detail and to construct design patterns. The observations and the (intermediary) results were considered as the primary data sources. The interviews and the questionnaire were considered as the secondary sources, and were used to facilitate interpretation of the findings of the primary sources.

Table 5: Tabular representation adapted task conceptualisation

| **Name task: develop prototypes** | |
|---|---|
| *Boundary object* | |
| Learning goal | Learn to develop prototypes as result of collaborative effort. The prototypes should capture both the creative and analytic aspects of the intended website and be used as a tool to engage the client into professional dialogue. |
| Output specification | Make professional prototypes which capture the preliminary analysis in a creative way, engage the client in dialogue, are produced professionally and customer oriented and result from goal oriented, collaborative effort. |
| Process specification | Students were expected to use a book on Web design for instructions on how to carry out the necessary activities. |
| Tool | The following tools were at the disposal of students:<br>▪ Fully equipped classrooms with PCs, wireless access for the use of laptops, Beamer and Whiteboard.<br>▪ Access to the (online) Library media centre.<br>▪ Standard and domain specific software, for example, Word, PowerPoint and Photoshop.<br>▪ Computer Supported Collaborative Learning and Working Environment (Sharepoint, 2008). |
| *Event* | |
| Work | Students were expected to work full time on this project. |
| Advisory/ Presentation | Students had to present their prototypes to the external client. These presentations also had an advisory character. |
| Informative | There were no informative events planned for this task. |
| Formative | Students could get formative feedback on request from the seniors, prior to the presentation to the client. Each project-team received formative feedback after the presentation. |
| Summative | The prototype was part of the formal, summative assessment. |
| Incident | During this task no incidents occurred. |
| *Role* | |
| | ▪ The main role played by students was that of Junior professional. Besides, a Project leader, Functional designer, Graphical designer, Technical developer and Content creator made up a project team. Students were asked to select two team roles. Eight project teams worked in parallel on the same assignment for an external client, and were guided by teachers playing the roles of Senior professional, Expert, Facilitator and Assessor.<br>▪ The external client fulfilled the role of Problem owner.<br>▪ Communication with the clients went through the Account manager, a role fulfilled by senior, second-year students of the same program. |

### 3.3 Design patterns

In the next sections, we present two examples of design patterns, which were made with the help of the adapted task conceptualisation. After the description of each pattern, we clarify how the task conceptualisation helped to construct it. For the data analysis and the construction of the design patterns, we made use of the representations derived from the task conceptualisation. According to Reymen (2001), representations are a reproduction of a subset of the relevant properties 'in a mental image, a picture, a textual description, a drawing, a model, a graph, a computer visualisation, a prototype, or in some other way'.

With these representations, different views on the learning environment could be made. Since the representations are derivates of the task conceptualisation, the representations have helped to provide a coherent view of a learning environment. Additionally, multiple perspectives of all representations are possible. These perspectives are introduced by Van den Akker (2003) to approach educational problems from different analytical angles. He uses the following common, broad distinction between the three levels of the 'intended', 'implemented', and 'attained' curriculum. The following representations accompany the task conceptualisation [see also appendix]:

- Representations for relations between tasks, related tasks and sub-tasks, for example, a task hierarchy.
- Representations for the constituting elements of a task, for example, a role representation.

The representations presented below are the result of the qualitative data analysis that was carried out. The description of the presented design patterns is based on the description format of the E-LEN project (n.d.). To directly connect this chosen format with the presented task conceptualisation, we added a scenario description. This scenario briefly describes the situation for which the design pattern in question might be suitable. The key elements of the task conceptualisation (tasks, boundary objects, roles and events) were used to make the brief scenario descriptions [see also appendix].

*3.3.1 Design pattern*

**Name design pattern: Introduce primary boundary objects at the start of a project**

**Scenario:** *description of situation for which this pattern could be suitable*

| | |
|---|---|
| Task | Explore scope of a project; Determine global requirements of a project; Plan a project. |
| Events | Unguided collaborative work sessions at start of project.<br>Initial meetings external client representative client domain. |
| Roles | Student in . role of junior professional at the start of project.<br>External participant in role of problem owner (or end-user). |
| Objects | Little early, primary boundary objects (like mood boards).<br>Many (or focus on) secondary boundary objects (like project management documents). |

**Problem:** *description of the problem area*
At the start of a project, students often experience difficulties in starting up and growing into their roles. These difficulties lead, for example, to students asking for relatively much guidance, students showing quite a passive attitude, or slow and unproductive interaction with an external client. Also, students experience difficulties when working on more abstract, supportive products like project management documents. They experience these documents as a necessary evil, and only make them because they are obligatory. Students tend to divide this type of documents into separate chapters and work on them individually. The final product becomes a stack of disconnected chapters, only held together by a staple, instead of an integrated document resulting from collaborative effort.

**Analysis:** *what makes this problem a problem?*
At the start of a project, students are often required to work on project management documents, like for example, a project plan or a Project Initiation Document (PRINCE2, n.d.). Such documents are examples of secondary boundary objects, objects which facilitate the work around the primary object. A primary object is a particular (technological) artifact which has the focus of a project, for example, a website. After completion of initial project management documents, students are suggested to start working towards the final primary object, for example, by making prototypes, which are early versions of the final product. When comparing students working on primary and secondary objects and asking for their experiences, the following can be noticed:

- Students tend to dislike working on the more abstract, secondary objects, like project plans.
- Students tend to like working on primary objects, like for example, prototypes.
- Students experience working on primary objects as easier.
- Secondary objects, like project management documents, seem easier to divide into separate chapters, while primary objects tend to elicit more collaborative effort.
- Primary boundary objects mediate interactions in a different way than secondary. Primary objects are often more concrete in nature, and tend to ease interaction, especially with an external client.

**Known solutions***: good practices that show how the problem can be solved*
A known solution to the above problem, is to try and capture the advantages of primary boundary objects, which are usually planned later in a project, and move them to the start of a project. Introducing primary boundary objects at the start of a project can have the following advantages:

- Students tend to like working on the more concrete primary objects, which helps them to get started.
- Students experience primary boundary objects as easier to work on, which helps students to work independently, also at the start of a project.
- Primary boundary objects tend to elicit collaborative effort, which helps students to grow into their (team)roles.
- Primary boundary objects tend to ease the interaction with external clients, which may lead to more lively and productive interaction at the start of a project.

**Conditions:** *description indicators/factors influencing use/implementation of solution*
Different domains, have different primary boundary objects. Suitable primary boundary objects are concrete in nature and are fit to discuss with participants outside of the project. Examples of primary boundary objects are Mood boards and early prototypes.

**References**
Prototyping: Alavi, M. (1984); Mood boards: McDonagh, D. & Denton, H. (2004); Primary and secondary objects: Garrety, K., & Badham, R. (2000); Project management: PRINCE2 (n.d.).

*Analysis of the problem.* The adapted task conceptualisation was used to identify and analyse the problem as presented in this pattern. We started by analysing the events organised for students and the roles involved in these events. As representation for the events, we used event flows, which give a condensed overview of the organised events. To make the event flows, the events were plotted on a timeline [see figure 6 and appendix]. For the roles, a graphical and a tabular representation were made [see figure 7, table 6 and appendix]. In table 6, only a few roles are described as an example.

Figure 6: Graphical representation of events & boundary objects (first field study)

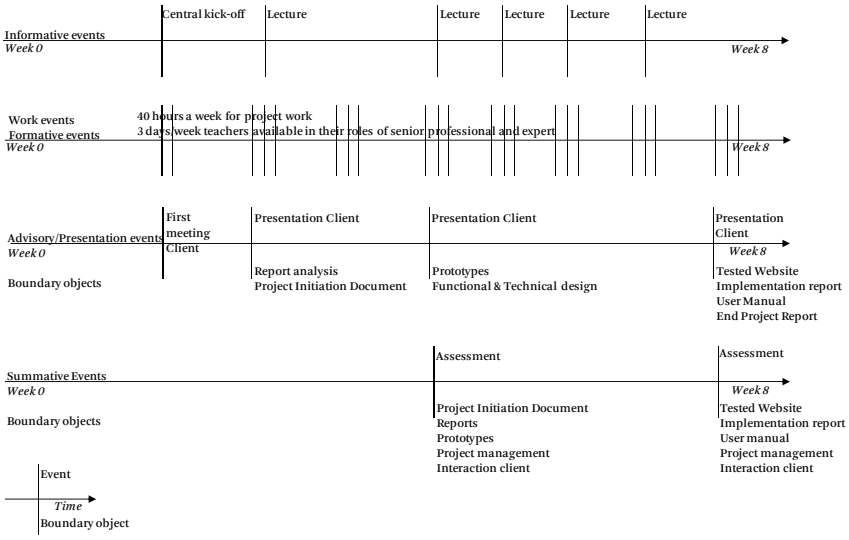



Figure 7: Graphical representation of roles (first field study)

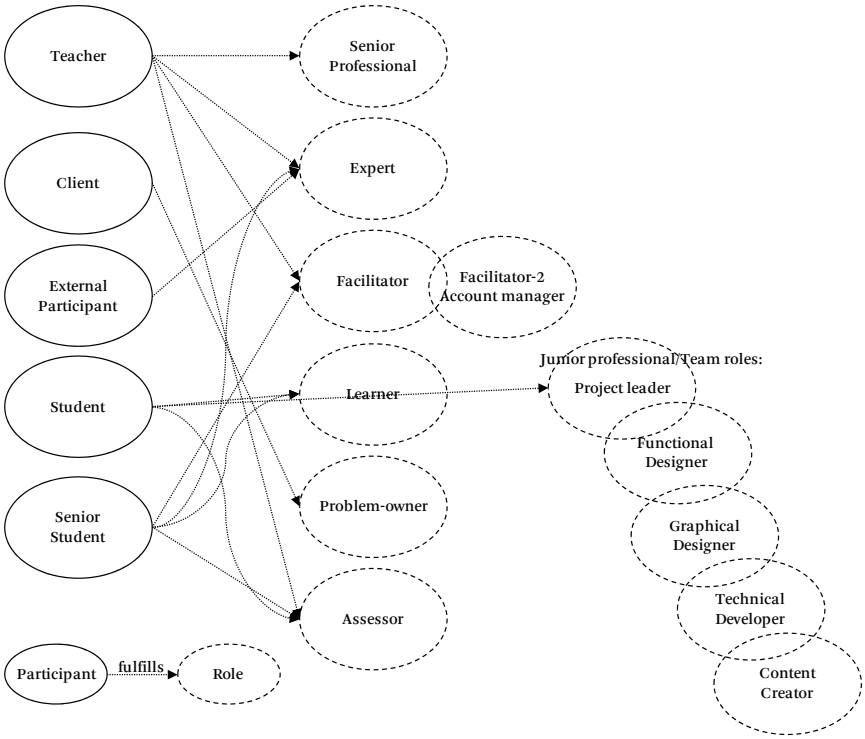


Table 6: Tabular representation of roles (first field study)

| Roles | Description | Participant |
|---|---|---|
| Expert | For guidance regarding content, experts were available with expertise of specific domains. If necessary, external experts were invited. | Teacher<br>Senior students<br>External |
| Problem owner | Most important stakeholder, owner of the problem. Here, an external client requiring a website. | External Client |
| Project leader | Responsible for leading the project team. | Student |
| Learner | Was to learn from carrying out authentic, collaborative activities and regulate his/her learning process with the help of a facilitator (role played by teacher and senior student). | Student<br>Senior student |

Next, the observations of the events were analysed. Observations of the first field study, of work events during which students worked in their role of junior professional and in their chosen team roles under the guidance of teachers in their role of senior professional, showed that students experienced difficulties to get started. Also, observations of the first advisory/presentation events with the external client in the role of problem-owner, have shown that students in their role of junior professional were quite passive, they had, for example, the opportunity to put questions to the client and could not come up with any questions. Interviews with students confirmed that they felt overwhelmed at the start. Observations of later work events showed students working much more independently. Also, the students were able to engage the client into interactive dialogue in a much more professional way.

Consequently, we focused on the boundary objects in the above events [see figure 6]. At the start of the project, students were required to work on a Project Initiation Document, a document that 'brings together the key information needed to start the project on a sound basis' (PRINCE2, n.d.). During later events, students had to work on prototypes of the website. Observations have shown us that the prototypes facilitated communication within a project team and between students in their different team roles. At the same time, the prototypes facilitated communication with the external client. The prototypes helped to cross the boundaries between the perspectives of the different team roles, for example, between the graphical designer and the rest of the team. The prototypes also helped to cross the boundary between the students in their role of junior member of the professional community and the community of future users the client represented.

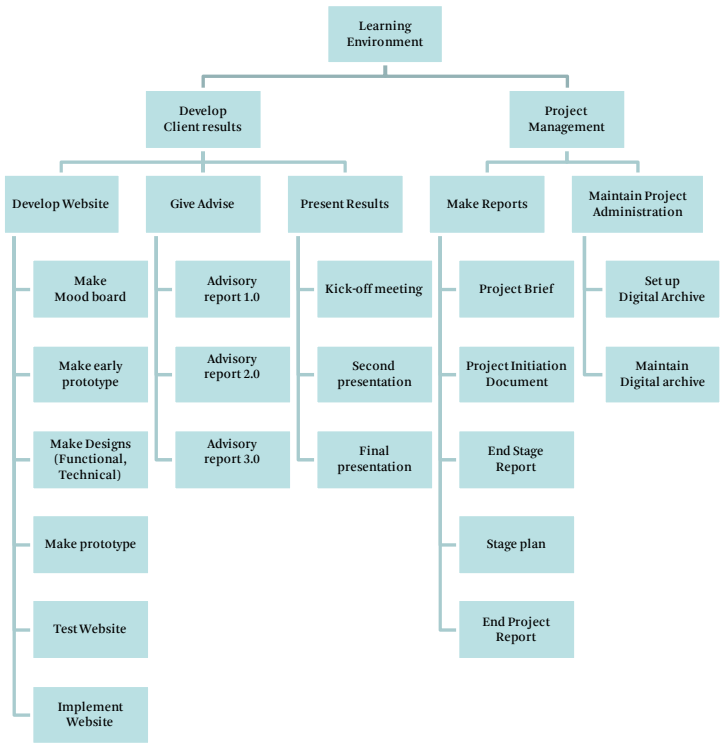
*Analysis of the solution*
When redesigning the learning environment between the first and second field study, it was decided to try to capture the observed advantages of the prototypes and apply these to the start of the project. Therefore, we looked for similar boundary objects in the professional community, and have come up with an early prototype and a mood board. In literature, we found the concepts of primary and secondary boundary objects (Garrety & Badham, 2000). Primary boundary objects are the technological artifact around which all activity is focused, while secondary boundary objects facilitate the collective work around the primary object. Prototypes are examples of primary objects, while project management documents, like the

mentioned Project Initiation Document, are secondary. A prototype is an early version of a system that exhibits the essential features of the later operational system (Alavi, 1984). Mood boards 'are often used in both establishing and agreeing an initial ambience for a product with a client' (McDonagh & Denton, 2005).

We anticipated that by introducing primary boundary objects early in the project, observed advantages could be captured. Also, the first advisory/presentation event with the external client was moved slightly backwards, which would give students the opportunity to work on the above products and grow into their roles. Observations of the second field study have shown that the mood board functioned as anticipated, while the early prototype did not. The visual nature of the mood board turned out to be accessible for the client, which lead to lively interaction with the students. Much less attention was paid to the early prototypes. In the interview, the client stated that she had difficulties with understanding the early prototypes, which were too sketchy in her opinion. It was planned to make the specifications for this output, the early prototypes, more elaborate and specific in a next study year.

Analysis of the educational material and the organised events resulted in an overview of all the tasks and sub-tasks. A graphical representation of the tasks and sub-tasks is presented in figure 8. The tasks and sub-tasks are presented in a hierarchical representation [see also appendix].

Figure 8: Graphical representation of tasks & sub-tasks (second field study)



*3.3.2 Design pattern*

**Name design pattern: Connect to an outside online community**

**Scenario:** *description of situation for which this pattern could be suitable*

| | |
|---|---|
| Task | Detailed/precise/specific, sometimes technical, task or sub-task. |
| Events | Informative events, often lecture-style events.<br>One-on-one tutoring;<br>Unguided work sessions, often of an individual nature. |
| Roles | Student in role of junior professional dealing with precision (sub)task.<br>Teacher in role of expert; Outside expert. |
| Objects | (Online) resources.<br>Professional tools, often software-tools, to support precision work. |

**Problem:** *description of the problem area*
Students often get stuck when working on detailed or specific aspects of a project. An example of such aspects are the technical aspects of developing a website.

**Analysis:** *what makes this problem a problem?*
Student turn to their teachers in the role of expert, and expect them to be able to help. However, this is not always the case. Technological developments move rapidly and teachers are not always able to keep up to date with the latest technological trends. Teachers experience in such cases that their authority is negatively affected, since they are not able to support their students adequately.

**Known solutions:** *good practices that show how the problem can be solved*
Explicitly connecting to an outside, online community is a known solution. Both to facilitate the working and learning process of the students, and to relieve teachers of having to be(come) experts on everything.

Students tend to be quite capable of tapping into online resources. They tend to use all kinds of online resources, for example, frequently asked questions and templates. They also interact online with experts or professionals of their future professional community through online discussion boards. By connecting to an outside online community, students find support to help them solve detailed problems. Also, they interact with professionals of their future professional community, as a result, they come into contact with more and different role models besides their teachers playing the role of senior professional.

**Conditions:** *description indicators/factors influencing use/implementation of solution*
A well organised online community is needed. Furthermore, students need a reason to interact with such a community. For example, by making an explicit choice for a tool to support the working process. When available, an open source tool is preferable, since these tools tend to have a well established online community. An example of such a tool with an online community is Joomla!
Accompanying informative events need to guide students to high quality online resources and familiarise them with the outside, online community.

**References**
Example open source tool: Joomla! http://www.joomla.org/

*Analysis of the problem.* This pattern emerged from analysis of the events with students in the role of Technical developer and teachers in the role of Expert. The observations have shown that students often got stuck while working on the technical aspects of developing the website. Students would then turn to their teachers, in their role as expert, and expected them to be able to help with their detailed, technical problems. However, not all teachers were able to carry out their role of technical expert adequately. During the teacher meetings, several teachers brought this subject forward. Also, during the interviews, teachers made remarks about this subject. For example, they felt that their authority was negatively affected by not being able to support students adequately. The boundary object in question was standard software to support website development. This object helped students to cross the boundary into their future professional community, and specifically, the sub community of technical developers. In the first field study, students were expected to use a content management system, a website development tool, which also offered easy support for the maintenance of the final website. In the first field study, it was suggested to students to use Joomla! (n.d.), an open source tool.

*Analysis of the solution.* Besides the above experienced difficulties, observations in the first field study have also shown positive aspects. There were many students who found their way to online resources for technical help. We observed students using all kinds of online resources: frequently asked questions, templates developed by experienced Joomla! developers, and they also found their way to experts through online discussion boards. Joomla! has an elaborate, well-organised online community, which turned out to provide adequate support to the students. In the second field study, Joomla! was more emphasised as a suitable tool, and was made less permissive. Also, one teacher with much Joomla! expertise organised an informative event for all students, presented how to use Joomla! and gave references to online resources. After interviewing the teachers, it turned out that Joomla! was the main tool of an obligatory, earlier course which all students had attended. This also explained why during the second field study, students were more at ease with Joomla! and knew how to find and use suitable online resources. By choosing a specific tool, with a well-organised online community, students in their roles of learner and junior professional had a reason to access the available resources and interact with experts of their future community. Furthermore, teachers in their role of expert, felt supported by the online community.

## 3.4 Discussion

### *3.4.1 Research question*

The answer to our question can now be formulated as follows: a task conceptualisation which adopts elements from activity theory, boundary objects, IMS-LD, collaboration scripts, and scaffolding, shows much promise in facilitating the process of (re)designing (e)learning environments with the help of design patterns. By making the core concepts needed to design (e)learning environments explicit, a tool has become available which could facilitate designing with patterns. The authentic or "whole" *task* was chosen as main concept, since we think there is clear consensus on this concept in the educational domain. Also, the concept of *role* is widely used. Furthermore, the concept of *event* was adopted to focus on the concrete and pragmatic aspects of organising meetings and sessions for learners. Besides, we chose the concept of *boundary object* to add a specific analytical perspective. Finally, we adopted the concept of scaffolding. When the roles, events

and boundary objects are suitably designed, they offer students the necessary support when they carry out a task. In our opinion, this chapter shows that the task conceptualisation helped to construct valuable design patterns. Especially when redesigning, in which case there are usually theories and approaches in place, the task conceptualisation has turned out to be generic enough to handle the concepts which were already in use.

*3.4.2 Theoretical points*

Retalis et al. (2006) mention in their discussion a number of methods which help with the construction of patterns, such as, pattern mining, automated methods and mind maps. Furthermore, they present a design pattern elicitation approach of which we have used many of the ideas from which patterns can be derived, such as, experts' experience, observations of user tasks, review of literature about pedagogical strategies and study of other patterns already published in areas such as HCI. Baggetun, Rusman & Poggi (2004) also discuss different techniques for identifying and constructing patterns and issue an invitation to others who discover new methods of producing patterns while trying to identify and construct them.

We think the task conceptualisation presented in this chapter is an innovative addition to current insights, since the above mentioned methods and techniques focus mainly on how to construct design patterns, or in other words, the *process* of pattern construction. The presented conceptualisation deals with the *content* of design patterns, it focuses on the constituting elements of a pattern. To enable focusing on the content, it was necessary to adopt generic concepts, which helped to keep the task conceptualisation potentially portable across different contexts.

*3.4.3 Task conceptualisation versus IMS-LD and Collaboration scripts*

In this chapter, we advocate the use of a task conceptualisation to facilitate the (re)design of (e)learning environments with the help of patterns. Of course, it is also possible to identify and construct patterns without the task conceptualisation. Similar developments are going on, even a de facto standard is emerging, in the form of IMS-LD. Why not use that as a basis for designing with patterns? 'Few instructional designers and teachers have, however, experience in designing learning materials using IMS-LD' (De Vries, Tattersall & Koper, 2006). On the other hand, authoring tools like COLLAGE are becoming available, which offer support since IMS-LD 'is a complex technical specification and modeling collaborative characteristics can be tricky' (Hernández-Leo, Villasclaras-Fernández, Asensio-Pérez, Dimitriadis, Jorrín-Abellán, Ruiz-Requies & Rubia-Avi, 2006). We think that IMS-LD, and especially the accompanying tools are indeed promising. If such tools become mainstream and widely used, they could very well facilitate the design of (e)learning environments with patterns. In the mean time, we aimed to introduce a conceptual tool to facilitate the design process without the need for authoring tools. Therefore, the task conceptualisation has been kept as economic as possible, since we think that a simple and at the same time expressive conceptualisation would be suitable for a wide audience without affinity with, or access to, specific tools.

Besides IMS-LD, we also consider collaboration scripts as useful. Therefore, we chose to adopt many elements of the framework for collaboration scripts of Kobbe et al. (2007). Still, we felt that a more generic approach would also have added value. In particular since we adopted elements from activity theory and boundary objects, to add focus to the generic task conceptualisation.

*3.4.4 Future research*
In this chapter, two patterns for the design of (e)learning environments were presented, which were identified and constructed with the help of the task conceptualisation. Future research is necessary in the direction of a pattern language (Goodyear et al., 2004).

Overall, it is necessary to use the task conceptualisation in different educational settings and by practitioners with varying levels of expertise. Only by extensively using the task conceptualisation to identify and construct design patterns for (e)learning environments a more substantial validation of its usability is possible.

Table 7: Appendix: Structure of the task conceptualisation and the accompanying representations

| Task conceptualisation<br>Concepts and relationships | | Accompanying representations<br>Derivates of the conceptualisation for developing a coherent view of a learning environment |
|---|---|---|
| Key elements of the task conceptualisation, reflecting the literature study. | Tasks, related tasks & sub-tasks<br>Boundary object<br>Role<br>Event<br>Two types of relations:<br>▪ Relations between tasks, they can be related or subordinate<br>▪ Relations between other elements: triggers, uses/creates & carried out by. | Graphical representation of the task conceptualisation, representing the key elements and the mutual relationships.<br>See figure 4. |
| Adapted task conceptualisation reflecting the field studies. | Tasks, related tasks & sub-tasks<br>Boundary object:<br>▪ Learning Goal<br>▪ Output specification<br>▪ Process specification<br>▪ Tool<br>Event:<br>▪ Work events<br>▪ Advisory/presentation<br>▪ Informative<br>▪ Formative<br>▪ Summative<br>▪ Incident<br>Role (was not adapted) | Tabular representation of the adapted task conceptualisation, to describe, analyse or (re)design (sub)tasks.<br>For example table 4. |
| Separate elements of task conceptualisation. | Tasks and sub-tasks seen from a hierarchical perspective. | Graphical representation of tasks and sub-tasks in the form of a task tree, to describe, analyse or (re)design the |

| | | |
|---|---|---|
| | | overall task-structure. For example figure 7. |
| | Events and boundary objects from a temporal, sequential perspective. | Graphical representation of the flow of events and boundary objects, which are plotted on a timeline for this purpose; to describe, analyse or (re)design the sequence of events and boundary objects. For example figure 5. |
| | Participants can fulfil single or multiple roles. | Graphical representation of participants and which roles they can fulfil, for an overview of roles. For example figure 6. Tabular representation of roles to describe, analyse or (re)design roles in more detail. For example table 5. |
| Design pattern:<br>▪ is based on analysis with task conceptualisation & accompanying representations.<br>▪ others could implement design pattern with the help of the task conceptualisation & accompanying representations. | Scenario:<br>▪ Tasks, related tasks and sub-tasks<br>▪ Boundary objects<br>▪ Roles<br>▪ Events | Tabular representation of the scenario-description, using the task conceptualisation to describe a situation for which the design pattern in question could be suitable. A scenario description in this form helps to connect a design pattern directly with the task conceptualisation and the accompanying representations. For example part of the design patterns in sections 3.3.1 and 3.3.2 |
| | Name<br>Problem, Analysis<br>Known solutions<br>Conditions<br>References | Tabular representation of a design pattern, consisting of descriptive and prescriptive elements, based on the format for design patterns of E-LEN (n.d.). For example design patterns in sections 3.3.1 and 3.3.2 |

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# Chapter 4
# Analysing interprofessional education from a design perspective[*]

**Abstract**

Education of healthcare professionals should align with the high demands of clinical practice and contribute to the development of interprofessional abilities. The aim was to analyse interprofessional learning environments and formulate design guidance for interprofessional education (IPE). We used a qualitative, in-depth case study and sub-cases. Forty-eight tasks in an interprofessional learning environment for medical, nursing, physiotherapy and speech therapy students were observed with multiple techniques and analysed from a design perspective. As a result, we present a model to analyse and design IPE is presented. IPE blends acquisitional, simulated learning with participative, realistic learning. This model has four perspectives: the agency perspective for the roles of the participants, the temporal perspective for accelerating or decelerating time, the spatial perspective for the physical and digital places, and the instrumental perspective for the tools. We concluded that in hybrid IPE, teachers and students are easily drawn to the more acquisitional roles of expert and novice, instead of towards realistic, professional roles. Teachers should aim for participative, realistic IPE. For acquisitional, simulated aspects of IPE, teachers should avoid hidden roles, compensate for the lack of clinical reality, make the timeframe explicit and offer powerful tools to students.

[*]Zitter, I. , De Bruijn, E., & Ten Cate, Th.J. (2009). Analysing interprofessional education from a design perspective. Manuscript submitted for publication.

## 4.1. Introduction

Society is changing and has high demands for health care professionals. One established example of an objectives framework that reflects these demands is the CanMEDS model, defining the key competencies needed in medical practice. Interprofessional competencies are part of this framework and are formulated as the ability to (a) 'participate effectively and appropriately in an interprofessional healthcare team' and (b) 'effectively work with other health professionals to prevent, negotiate, and resolve interprofessional conflict' (Frank, 2005). Similarly, the World Health Organisation (2006) includes working as a member of a multidisciplinary team as a core competency. Education in the healthcare domain has to align with these demands and contribute to educating healthcare professionals towards the required interprofessional abilities. The importance of such education becomes evident in interprofessional literature. Numerous reviews synthesise research results about interprofessional education (IPE) (Zwarenstein, Reeves & Perrier, 2005; Hammick, Freeth, Koppel, Reeves & Barr, 2007).

To define IPE, we use the definition of the Centre for the Advancement of Inter-Professional Education (United Kingdom) 'Interprofessional education is those occasions when members (or students) of two or more professions learn with, from and about one another to improve collaboration and the quality of care' (cited in Hammick et al., 2007). This article focuses on IPE at educational institutes for students from different health-sciences faculties.

IPE was studied from a design perspective. The most compelling argument for taking a design perspective is to increase the relevance of research for educational practice (Van den Akker, Gravemeijer, McKenney & Nieveen, 2006). Research carried out from a design perspective has as goal to develop knowledge which professionals of that discipline can use to design solutions for the problems in their field (Van Aken, 2005).

### *4.1.3 Two dimensions of IPE*

In our view, two dimensions can be distinguished when designing IPE.

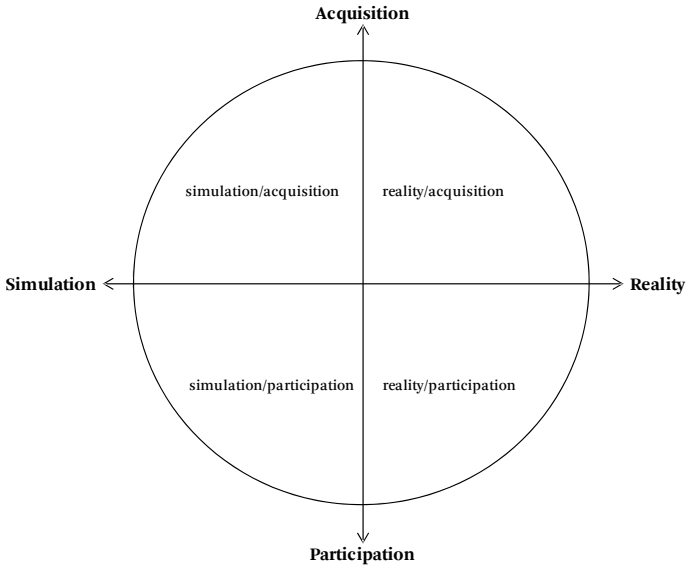
*Acquisition versus Participation dimension.* The most commonly applied ideas from learning theories in medical education continue to emphasise the more traditional approaches of isolated individuals acquiring knowledge, rather than socio-cultural approaches advocating participative learning. The more traditional approaches sharply contrast with the crucial role of the apprenticeship system in health care education and do not align with interprofessional learning goals requiring a team perspective (Bleakley, 2006). The dimension we identify here, has on one side the knowledge acquisition metaphor, in which knowledge is considered as a commodity that can be acquired, applied, transferred and shared with others. On the other side is the participation metaphor, characterising learning as becoming a member of a professional community, here specifically an interprofessional community (Sfard, 1998).

*Simulation versus Reality dimension.* The second dimension is the use of simulations in health care education. A simulation can be defined as a person, a device or a set of conditions, which attempts to present problems authentically and which is never completely similar to the 'real thing', for obvious reasons, such as costs, technical

limitations, avoidance of danger, ethics, psychometric requirements and time constraints (Issenberg, McGaghie, Petrusa, Gordon, & Scalese, 2005). This dimension characterises how realistic learning tasks are. Simulated settings are characterised as a low-fidelity. They are situated in educational settings and the rich reality of professional practice is reproduced. Moving towards the reality-side of this dimension, simulations can become much more advanced and high-fidelity, for example, involving immersive technology or a patient simulator closely resembling a real patient. Realistic settings closely mirror the real professional context. In such settings, learners are immersed in real problems from actual professional practice.

To overcome the dualism associated with the above dimensions, they can also be considered as two continua [see figure 9]. Four quadrants can be distinguished: simulation/acquisition, reality/acquisition, simulation/participation and reality/participation. When IPE integrates positions from along these spectra, they are to be characterised as mixed or hybrid IPE.

Figure 9: Two educational continua




*4.1.4 Central research question*

The central question is: *How to design hybrid IPE?* We intend to show that positions from along each side of both continua can be identified in IPE and that all of these positions have their own value. We plan to show the difficulty of explicitly taking and maintaining a position and of making transitions and connections between different positions in the continua. In other words, we focus on balancing positions along the identified continua and designing hybrid IPE. Designing IPE can be a difficult (Westerveld, Zitter, Wittink, Croiset & Ten Cate, 2005); the IPE literature confirms our previous experiences. One reason can be that IPE is sometimes initiated without a systematic prior analysis of all educational aspects. Educational science should in our view contribute to developing design guidance to help constructing effective IPE. We used a design model approach with a focus on analysing observations in practice. Next, design guidance was generated.

## 4.2 Method

### *4.2.1 Case study research*

Our research question has descriptive and explanatory aspects, making it highly suitable for a case study approach in which direct observations are made in natural settings (Yin, 2005). The potential richness of data gathered from direct observation close to practitioners as suitable for generating design guidance was the decisive criterion. The study consisted of forty-eight sub-cases embedded in a single, holistic case study.

### *4.2.2 The IPE course*

In the studied IPE four programs and two educational institutes participated: Physiotherapy, Speech Therapy and Nursing of Hogeschool Utrecht University of Applied Sciences and the Selective Medical Master Utrecht, an accelerated, four-year medical program of the University Medical Center Utrecht [see table 8]. The studied IPE dealt with patients suffering from a cerebrovascular accident or stroke.

The overall learning goal of the course was 'A student is able to prepare, carry out and evaluate an interprofessional meeting resulting in an interprofessional treatment plan'. An 'interprofessional meeting' is to be considered similar to interprofessional meetings carried out in healthcare practice, such as a hospital or a convalescent centre. Such meetings are meant to inform and consult each other, and to collaboratively determine patient care policy.

Table 8: Overview of the IPE course

| | |
|---|---|
| (Sub)Cases | ▪ Hybrid IPE with 48 learning tasks. |
| Duration | ▪ 8 weeks (last 2 weeks online only) |
| Study load and duration | ▪ 4 ECTS over a period of 6-8 weeks. ECTS: European Credit Transfer System in which 1 ECTS equals 28 hours of study load |
| Programs and Educational institutes | ▪ Physiotherapy, Speech Therapy and Nursing of a University of Applied Sciences and an accelerated, four-year medical program of an Academic teaching hospital. |
| Learning goal | ▪ 'A student is able to prepare, carry out and evaluate an interprofessional meeting resulting in an interprofessional treatment and care plan' |
| Cases | ▪ Patients suffering from a stroke: 4 video cases and 1 paper case. |

*4.2.3 Participants*
The case study involved thirty-two students, four teachers and different groupings [see table 9].

Table 9: Participants

| | |
|---|---|
| Students | ▪ 32 students: 16 medical, 7 physiotherapy, 5 nursing and 4 speech therapy |
| Teachers | ▪ 4 teachers, from each educational program 1 teacher |
| Grouping | ▪ 4 uniprofessional groups (16, 7, 5 and 4 respectively)<br>▪ 1 large interprofessional group (32) → divided into 3 sub-groups<br>▪ 3 interprofessional sub-groups (10 each) |

*4.2.4 Procedures*
The data collection consisted of educational material, observations of face-to-face events organised for students, interviews with students and teachers, collection of student material, monitoring of the use of the e-learning environment and an evaluative questionnaire [see table 10]. To strengthen the case study approach, data from varied and multiple sources were collected. Furthermore, prolonged engagement and direct participant observation were considered as beneficial to the quality of the gathered data (Guba, 1981).

Table 10: Procedures

| | |
|---|---|
| Educational material | ▪ All educational material. |
| Observations | ▪ Observations of organised face-to-face meetings: notes, photos and audio recordings. Approximately 24 hours (about 4 hours/week). |
| Monitoring e-learning | ▪ Weekly monitoring of the use of the e-learning environment (8 weeks). |
| Student material | ▪ Material of 12 students (the interviewed students). |
| Interviews students | ▪ Semi-structured, individual interviews with 1 student of each participating program (4), of each sub-group (3), total of 12 students. |
| Interviews teachers | ▪ Semi-structured, individual interviews with 4 teachers of the 3 sub-groups (one sub-group as tutored by 2 teachers). |
| Questionnaire | ▪ Evaluative questionnaire (response 94%). |

*4.2.5 Design model*
The design model presented in figure 10 aims to support the data gathering and analysis, and the generation of the design guidelines for IPE. The concept of IPE was refocused to an interprofessional learning environment, i.e. the physical setting in which a learner or community of learners carry out their work, including all the tools, documents and other artefacts to be found in that setting, and the social/cultural setting for such work (Goodyear, 2001). The building blocks of a learning environment for health care professions can be characterised as Entrustable Professional Activities (EPAs) (Ten Cate 2005, 2006; Ten Cate & Scheele, 2007). An EPA is defined as 'a unit of work that should only be entrusted upon a competent

enough professional'. Examples are, measuring blood pressure, giving morning report after night call, or chairing an interprofessional meeting.

The EPA-concept is defined for learning in clinical settings. Here, EPAs are to be considered the units of work, simulated as learning tasks. Ideally, the criteria for assessing these units of work are derived from the corresponding EPAs. With reference to figure 9, learning tasks can be positioned in the four quadrants and can be characterised as simulation/acquisition, reality/acquisition, simulation/participation or reality/participation. Hybrid learning environments are composed of learning tasks from each of the four quadrants. The design model consists of four perspectives as described below.

*Agency perspective.* An agent is the role of a significant person in the health care IPE setting: patients, professionals & educational roles. The roles represent the agency perspective, answering the question: who carries out which task? Who is intended to carry out intended activities? One is the patient role, further specified by type of complaint or illness. Professional roles signify healthcare professionals involved in the treatment and care of a patient, e.g. medical specialists, nurses, physiotherapists, speech therapists, psychologists, social workers. Since the studied learning environments are situated at educational institutes, there are also educational roles, like, assessor, peer-assessor, teacher, facilitator and learner.

*Temporal perspective*: timeframe. This perspective specifies the available and planned timeframe of learning tasks. In the clinical reality, tasks have a certain duration, highly influenced by the development of the complaint or illness of the patients. In educational settings, time can be accelerated or slowed down. When time is accelerated, a lengthy procedure or illness-process can be dealt with in much less time. When time is slowed down, intricate procedures or snap-decisions can be analysed in detail.

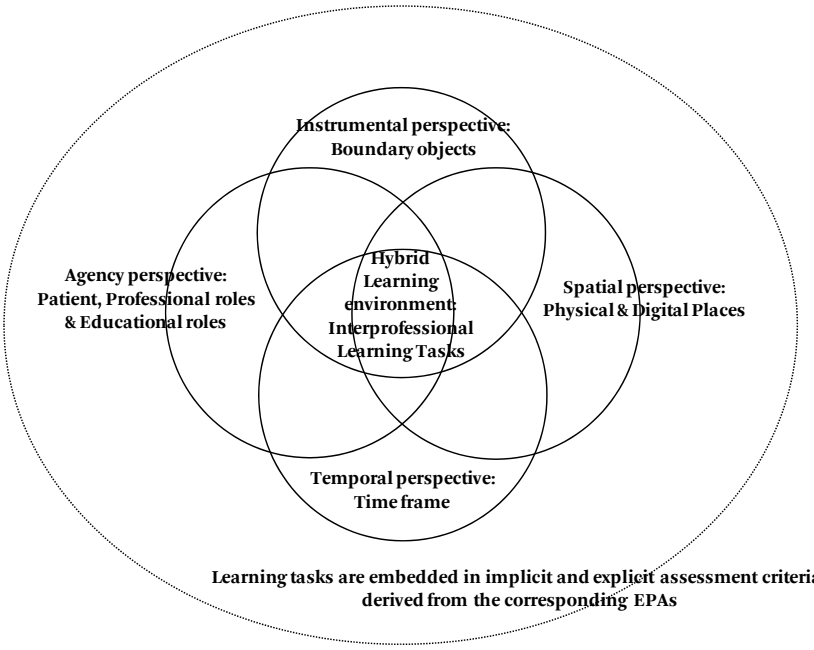
*Spatial perspective*: physical & digital places. The spatial perspective specifies the places in which the learning tasks are carried out. At school, learners generally interact in a limited amount of physical places, namely, the locations of the participating educational institutes. Besides, the actual places depend on how the role of the patient is enacted, e.g., as a real life patient, a video presentation, a paper case or a computer simulation.

In a clinical setting, the context or the place in which a patient would be encountered provides clues to which professional activities are suitable. An encounter in an emergency unit is very different from an encounter at a rehabilitation centre. The spatial perspective also take digital places into account. These digital places may range from limited, formal e-learning environments, to online workspaces, sophisticated simulations including aspects of the equivalent places in reality, and to the Internet in all its rich reality.

*Instrumental perspective*: boundary objects. Boundary objects, introduced by Star & Griesemer (1989), help experts from different professions to collaborate, by their concrete, often tangible and material nature. Expert professionals working in an interprofessional healthcare team, face the challenge to combine ingredients from different professions to achieve interprofessional solutions (Engeström, Engeström & Kärkkäinen, 1995). Boundary objects can coordinate activities from people with

different approaches, like different health care professionals, around an object, which gives common meaning across the settings where activities take place (Tuomi-Gröhn, Engeström& Young, 2003). A good example of a boundary object in the healthcare domain is a shared (computerised) patient record (Engeström, 1999).

Figure 10: Design model




*4.2.6 Data gathering and analysis*
All the educational material used in the course was collected. This material consisted of both the material designed in advance and the material that was added during the learning environment in-action. All the face-to-face activities organised for students in each studied learning environment were observed by a single observer. During the observations, extensive field notes and photos or screenshots were taken. To triangulate the above types of data (Guba, 1981), evaluation questionnaires were used to collect data about the experiences of the students.

The analytical perspectives of the two educational dimensions and the design model was used to unravel the holistic character of a learning environment and its learning tasks. Next, design guidelines were generated. The data analysis was carried out by a single researcher. The results were discussed extensively with peers, both researchers and educational experts, as a form of peer debriefing (Guba, 1981).

### 4.3 Results

*4.3.1 Positioning the learning tasks along the educational dimensions*
Table 11 shows the positions of the tasks in the four quadrants and short characterisations of each type of task. Noteworthy are the differences between the planned and delivered tasks. Many more tasks were planned as reality/participation

than carried out in-action. At the same time, many more tasks were delivered as simulation/acquisition than planned. A shift from the reality/participation quadrant to the simulation/acquisition quadrant took place.

Observations showed that students did not participate in participative tasks as actively as planned. They tended to follow the instructions without questioning them. When in doubt, they turned to their teacher, instead of resolving matters independently and in participation. The teachers tended to comply with such requests for guidance. In the interviews they stated that actively guiding students felt more comfortable than watching their student struggle. Both the teachers and the students indicated that they appreciated the tasks that were most similar to interprofessional practice. Specifically two of the realistic/participative tasks, namely the interprofessional meetings, dedicated to discussing a patient case by an interprofessional team. During the interviews, both the students and the teachers made comments to this effect: 'During the interprofessional meetings, I started to think what the other professions could contribute to the treatment of speech therapists, and what I need from other professions to make my treatment as effective as possible'.

Table 11: Characterisation of the learning tasks

| | Planned tasks | Delivered tasks | Type of tasks |
|---|---|---|---|
| Simulation/Acquisition | 9 | 30 | ▪ Self-study tasks<br>▪ Lectures by teachers and guest-teachers<br>▪ Write reflection-reports |
| Reality/Acquisition | 2 | 2 | ▪ Visits to interprofessional, clinical practice |
| Simulation/Participation | 17 | 12 | ▪ Presentations by students<br>▪ Demonstrations by students<br>▪ Face-to-face discussions<br>▪ Online discussions (on given topics) |
| Reality/Participation | 22 | 3 | ▪ Make uniprofessional diagnosis<br>▪ Apply measuring instruments<br>▪ Make interprofessional treatment and care plan<br>▪ Make patient and family communication plan<br>▪ Prepare, chair, conduct and evaluate interprofessional meeting |

*4.3 2 Learning tasks analysed with the design model*

*Analysis from the agency perspective* shows that the roles of the teachers and the students are traditional in the simulation/acquisition tasks and gradually become similar to roles of the corresponding EPAs in clinical practice [see table 12]. In the reality/participation tasks, students carried out the roles of novice expert and junior

professional, similar to health care professionals carrying out such tasks. The role of the patient varied across the type of tasks. In the simulation/acquisition tasks, abstract stroke-patients featured. In the participative tasks, the video and paper cases enacted the role of the specific stroke-patients.

The teachers involved had to play multiple roles, i.e. expert, assessor, facilitator, professional-role model and simulated patient. The teachers indicated that they had difficulty with handling these roles, especially with switching between their roles. Furthermore, observations showed that the locus of control shifted when the traditional roles of domain-expert and domain-novice were enacted by the teachers and the students. This was observed in different types of tasks: in simulation/acquisition tasks and during participative tasks. One of the teachers emphasised this point during the interview: 'before you are aware of it, you are being very directive as a tutor, not giving a group the chance to really collaborate, they just do what you are suggesting. At some point during the course, I had to leave (…) then they started working independently, that was an eye opener to me'.

Table 12: Learning tasks from agency perspective

| Type of tasks | Roles | Number of roles |
|---|---|---|
| Simulation/Acquisition | ▪ Teachers: expert, assessor | 2 |
| | ▪ Student: learner | 1 |
| | ▪ Patient: abstract stroke-patients | 1 |
| Reality/Acquisition | ▪ Teacher: organiser of visit to clinical practice | 1 |
| | ▪ Student: observer, interviewer | 2 |
| | ▪ Patient: real patients present in visited clinical practices (two) | 2 |
| Simulation/Participation | ▪ Teacher: expert, senior professional, facilitator, simulated patient, assessor | 5 |
| | ▪ Student: novice expert; junior professional in simulated clinical contexts: hospital, stroke unit hospital, rehabilitation center, at home with peripheral treatment & care; peer-assessor | 6 |
| | ▪ Patient: video (4) and paper (1) cases of specific stroke-patients | 5 |
| Reality/Participation | ▪ Teacher: expert, senior professional, facilitator, assessor | 4 |
| | ▪ Student: novice expert; junior professional in simulated clinical contexts: hospital, stroke unit hospital, rehabilitation center, at home with peripheral treatment & care; peer-assessor | 6 |
| | ▪ Patient: video (4) and paper (1) cases of specific stroke-patients | 5 |

*Analysis from the spatial perspective* demonstrates that the learning tasks were carried out in a large number of varied spaces: uniprofessional and interprofessional digital spaces (common spaces or workspaces), physical educational spaces, and realistic and simulated clinical spaces [see table 13]. Observations showed that participants had to orient themselves in each space. Participants had to readjust to new surroundings and actively make connections between activities in different spaces. Also, the spaces did not provide clues about the stage of the clinical process. One patient case dealt with a patient just admitted to hospital, while the same patient would later be transferred to a rehabilitation centre.

Observations showed that when carrying out the learning tasks, some students were talking about the patient in the hospital setting, while others were discussing the patient in the rehabilitation centre. Three of the four teachers remarked on this point during the interviews of the first case study: 'During the case of Mrs. Stam, the different groups were clearly searching what to do and questioning the phase they had to make a treatment plan for'. Furthermore, the tasks were not sequenced according to the clinical process. Tasks related to specific clinical contexts, like a hospital or a convalescence centre, were alternated with tasks with no relation to a specific clinical context. Also, tasks which were subsequent in the clinical process, jumped ahead or backtrack. Since the tasks were not sequenced similar as in professional practice in a more logical way, this lead to confusion and miscommunication. When there was confusion and miscommunication, students would not participate as actively as planned. They would turn to the teachers for guidance and the teachers tended to comply.

Table 13: Learning tasks from spatial perspective

| Type of tasks | Spaces | Number of spaces |
|---|---|---|
| Simulation/Acquisition | ▪ Lecture halls/Class rooms<br>▪ Central spaces offering (obligatory) sources in digital space | 2 |
| Reality/Acquisition | ▪ Rehabilitation center for mobility impairments<br>▪ Stroke unit Academic teaching hospital. | 2 |
| Simulation/Participation | ▪ Classrooms for presentations, demonstrations and discussions<br>▪ Classroom used as simulated clinical contexts: hospital, stroke unit hospital, rehabilitation center, at home with peripheral treatment and care<br>▪ Online discussion spaces | 6 |
| Reality/Participation | ▪ Classroom used as realistic meeting room for interprofessional meeting in clinical contexts: hospital, stroke unit hospital, rehabilitation center, at home with peripheral treatment and care<br>▪ Online collaborative spaces | 5 |

Analysis from the *temporal perspective* shows that the face-to-face simulation/acquisition tasks were interspersed with the other types of tasks. The realistic/acquisitional tasks consisted of two visits to interprofessional practice (each lasting about 2-3 hours). The remaining time was divided between simulation/participation and reality/participation tasks. In the simulated/participative and reality/participation tasks, patient time was accelerated, while professional time was decelerated. Observations showed that the extent to which the patient time was accelerated was not always clear to the participants, leading to confusion and miscommunication.

In table 14, the analysis from the *instrumental perspective* is summarised by listing the instruments selected for the different types of tasks. We highlight the data about the International Classification of Functioning, Disability and Health (ICF-framework). Different instruments based on the ICF-framework were used during the case. A frequently used instrument was the 'Rehabilitation Problem-Solving Form' (Steiner, Ryser, Huber, Uebelhart, Aeschlimann & Stucki, 2002). This form is an instrument designed to allow healthcare professionals to analyse patient problems and is based on the ICF-framework. Observations showed that patient summaries made on the basis of this form were shared in the uniprofessional workspace of the e-learning environment, prior to face-to-face meetings. Furthermore, students gave feedback on each others' versions and merged them into one version during the subsequent uniprofessional, face-to-face meeting. During the enactment of the interprofessional meetings, several students brought print-outs and used it as a reminder for themselves or as an aid during the interprofessional discussion in the meeting.

Another instrument of the ICF-framework was the visual mapping of the six basic categories of the ICF-framework (Body functions & structures, Activities, Participation, Environmental factors and Personal factors). An teacher drew this visual mapping of the ICF-framework on the whiteboard. Next, the categories were filled-in interactively with the students. This learning task had been intended as simulation/participation, but was adjusted towards more acquisitional by taking the lead in front of the whiteboard.

Different instruments from the ICF-framework were used across three types of learning tasks: simulation/acquisition, simulation/participation and reality/participation. They were used in the physical and digital spaces. Both the teachers and the students experienced the use of the ICF as positive. The students indicated that they liked working with a framework that is also used in interprofessional practice. Furthermore, they regarded the ICF as a basis for crossing professional borders. The following student quote substantiates this: ‘I think we all started to think more with the ICF in mind, and I also think we learned to speak each others language’.

Table 14: Learning tasks from instrumental perspective

| Type of tasks | Instruments |
|---|---|
| Simulation/Acquisition | Theoretical or evidence based models, guidelines measuring instruments and protocols, e.g. Stroke protocol and the ICF-framework (provided by teachers). |
| Reality/Acquisition | (Quality of) patient and family information/communication plan |
| Simulation/Participation | Topics for online discussions (provided by teachers); (PowerPoint presentations of) uniprofessional diagnoses, (demonstrations of) measuring instruments, ICF-framework, Patient & family information and communication plan. |
| Reality/Participation | the ICF-framework, agenda interprofessional meeting, format for treatment & care plan. |

## 4.4 Conclusions

### *4.4.1 Two forces*

The presented data showed that two forces can be distinguished in hybrid IPE. The first force pulls a learning environment towards simulation/acquisition tasks. Teachers and students are easily drawn to the more traditional roles of domain-expert and domain-novice. These tasks are suitable for different groupings (small and large), for a variety of time frames and for different spaces, both physical and digital. The other force deals with aiming for interprofessional learning goals as required by CanMEDS (Frank, 2005) and the World Health Organization (2006). When designing hybrid IPE, teachers are advised to be aware of these opposite forces and keep aiming for reality/participation learning goals while being drawn towards the simulation/acquisition quadrant.

### *4.4.2 Design guidance for learning tasks*

On the basis of our analyses, design guidance was generated [see figure 11].

When designing learning tasks, the corresponding clinical process and EPAs should be the starting point. Next, the identified perspectives are to be used to design clear and consistent tasks. From an agency perspective, the main point is to clearly distinguish acquisitional and participative roles.
The data has shown that both teachers and students are drawn towards acquisitional roles, therefore, it is advised make participative roles explicit. Furthermore transitions between acquisitional and participative tasks should be made clear. Clear transitions give participants the opportunity to adjust.

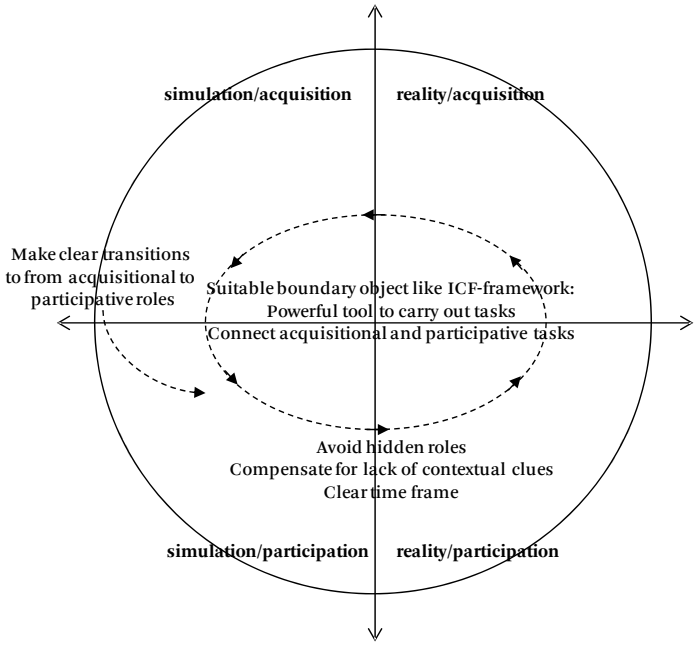
From the spatial perspective, it is advised to make explicit which clinical settings are simulated in educational spaces. Teachers should be aware that educational spaces lack the clues offered by rich clinical reality and should compensate for this lack of contextual information. As demonstrated by the data, this lack of contextual clues could lead to confusion and miscommunication. In case of confusion and miscommunication, analysis has shown that tasks move towards the acquisition/simulation quadrant, making it less feasible to develop realistic learning goals in participation.

Similar guidance accompanies the temporal perspective. For each task, the time frame should be clear, so participants know whether the time is accelerated or decelerated, to avoid confusion and miscommunication.

The instrumental perspective offers opportunities to connect acquisitional learning tasks with participative tasks and provide powerful tools for students to carry out tasks in participation.

In this chapter, the use of the ICF-framework was highlighted. The ICF-framework functioned very well as a boundary object. It was used across different types of tasks, across the participating professions, across the boundary of education and interprofessional, clinical practice, and across the digital/physical boundary; making it more feasible to develop the required realistic learning goals in participation.

Figure 11: Design guidance




It should be noted that we do not wish to imply that it is necessary to make all aspects of each task explicit and make every connection between all tasks explicit. On the contrary. First of all, it would hardly be feasible to make all of the rich, subtle and implicit aspects of complex, realistic/participative tasks explicit. Also, it would not be advisable, since it would lead to a rigid and inflexible learning environment strongly interfering with the realistic, participative learning goals of a hybrid learning environment. Simons (2003) uses the term of 'educationalising', also appropriate here: '[Educationalising] is often a mistake. It is trying to preplan and preorganise learning where it had better occur spontaneously in the context of work'. Trying to properly plan and organise IPE and at the same time leaving enough space for participants to adjust and co-design learning tasks, while also offering enough

complexity to be tackled in participation by the learners, is the tricky balancing act teachers face when trying to design hybrid interprofessional learning environments.

### 4.5 References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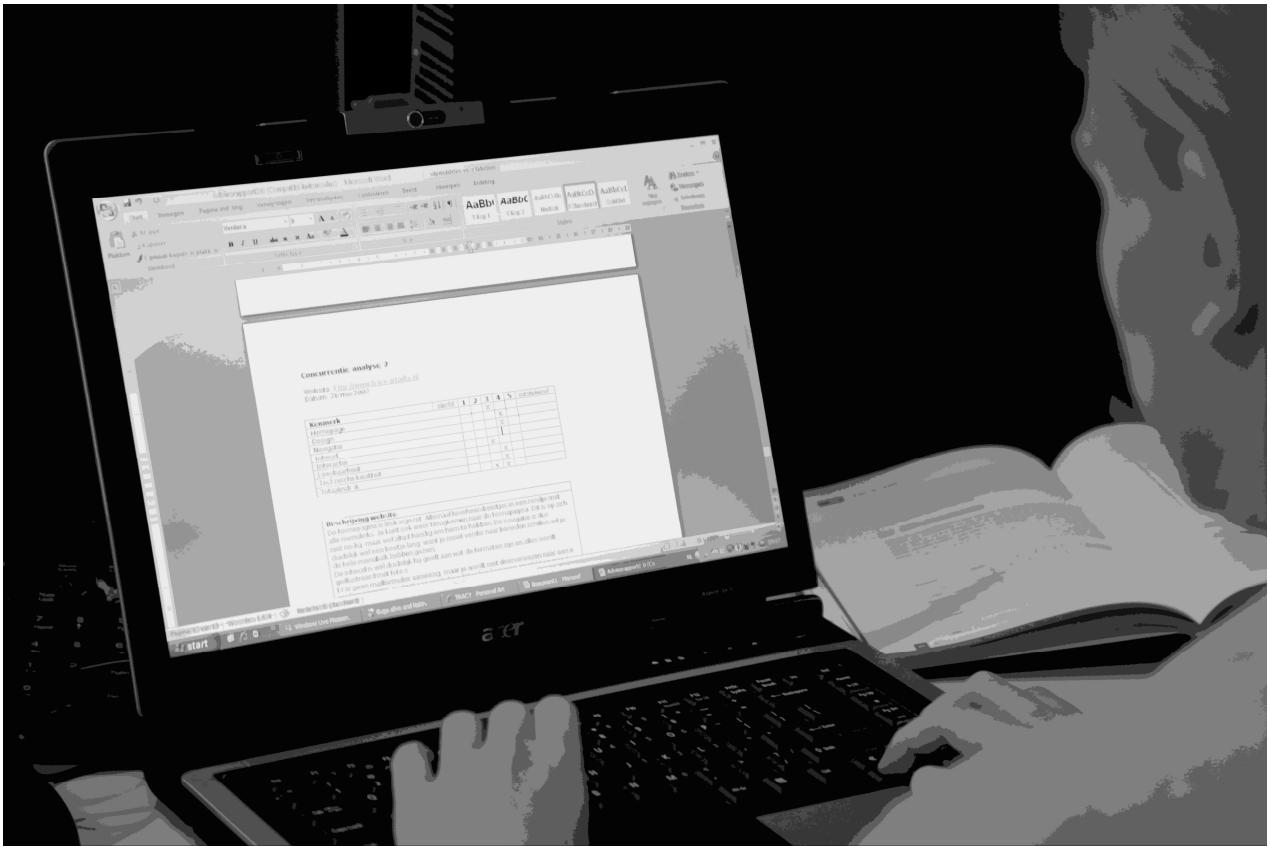
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# Chapter 5
# The role of professional objects in technology-enhanced learning environments in higher education[*]

**Abstract**

We studied project-based, technology-enhanced learning environments in higher education, which should produce, by means of specific processes or mechanisms, learning outcomes in terms of transferable knowledge and learning-, thinking-, collaboration- and regulation-skills. Our focus was on the instrumental perspective of objects from professional practice and the authentic mechanisms they were to activate. Objects that facilitate the interaction between actors with different viewpoints and help to join heterogeneous information during creation function as boundary objects. We identified three sets of features of boundary objects: (1) facilitation of the interaction between actors enacting various roles; (2) handling in diverse physical and digital spaces; and (3) usage across certain timeframes. Data from an in-depth case study showed that the identified features helped to activate authentic mechanisms, namely, using expert performances, enacting multiple roles and perspectives, collaborative construction of knowledge, reflection and articulation. The identified features of boundary objects and in particular the way they trigger authentic mechanisms for learning, provide concrete guidance for the design of project-based, technology-enhanced learning environments in higher education.

[*]Previous/Unrevised version of Zitter, I., De Bruijn, E., Simons, P.R.J. & Ten Cate, Th.J. (2009). The role of professional objects in technology-enhanced learning environments in higher education. *Interactive Learning Environments [Under revision]*

### 5.1. Introduction

It is expected from higher education to become more visibly useful for economy and society (Brennan, 2008). In this context, educational institutes aim to educate learners towards learning outcomes that are durable, flexible, functional, meaningful, generalizable and application-oriented. These characteristics relate to the transferability of knowledge oriented learning outcomes. Besides, there is a need for learning-, thinking-, collaboration- and regulation-skills (Simons, Van der Linden & Duffy, 2000). The question now is: how to achieve these intended learning outcomes?

The above problem can be described with the CIMO-logic (Denyer, Tranfield & Van Aken, 2008), which is a useful tool to structure a problem and a promising solution. In a certain *Context*, there is a problem. The *Intervention* should activate *Mechanisms* or processes, which are intended to produce the desired *Outcomes*. Table 15 presents an overview of the CIMO-logic applied to our research.

Table 15: CIMO-logic applied to research

| CIMO | Description | CIMO-logic applied to our research |
|---|---|---|
| Context | Identified problem | It is expected from higher education to become more visibly useful for economy and society (Brennan, 2008). |
| Intervention | Proposed solution | A project-based, technology-enhanced learning environment in which learners work collaboratively on an actual (or simulated) real-life problem (Tynjälä, Välimaa & Sarja, 2003). |
| Mechanisms | Processes or mechanisms that are to be activated | Authentic mechanisms:<br>– Use expert performances and the modelling of processes<br>– Enact multiple roles and apply multiple perspectives<br>– Collaborative construction of knowledge<br>– Reflect, to enable abstractions to be formed<br>– Articulate, to enable tacit knowledge to be made explicit<br>(Herrington & Kervin, 2007; Herrington & Herrington, 2006). |
| Outcomes | Intended outcomes | Learning outcomes: transferable knowledge and learning-, thinking-, collaboration- and regulation-skills (Simons et al., 2000). |

The intervention studied here is a technology-enhanced learning environment. A learning environment consists of the physical and digital setting in which learners carry out their work, including all the tools, documents and other artifacts to be found in that setting. Besides the physical and digital settings, it also includes the social/cultural setting for such work (Goodyear, 2001). In this learning environment, information and communication technology is used to promote connections: between one learner and other learners, between learners and tutors; between a learning community and its learning resources (Goodyear, 2001).

Tynjälä, Välimaa & Sarja ( 2003) state that environments aiming for the above learning outcomes should be based on a form of work-based learning combining the needs of working life, vocational training, and theoretical and practical knowledge. A specific form of work-based learning is project-based learning, in which learners work collaboratively on an actual (or simulated) real-life problem (Tynjälä et al., 2003). Herrington & Kervin (2007) and Herrington & Herrington (2006) use the concept of authentic learning environments instead of project-based learning, meaning about the same. Authentic learning environments should provide contexts that reflect the way knowledge is used in real life and they should provide activities that resemble the activities executed in practice; these two characteristics are met by project-based learning. Besides, authentic learning environments should offer coaching by the teacher at critical times, scaffolding and fading of teacher support and they should offer authentic, integrated forms of assessment. Following Herrington & Kervin (2007) and Herrington & Herrington (2006) we identify five authentic mechanisms that play a role in authentic learning environments:

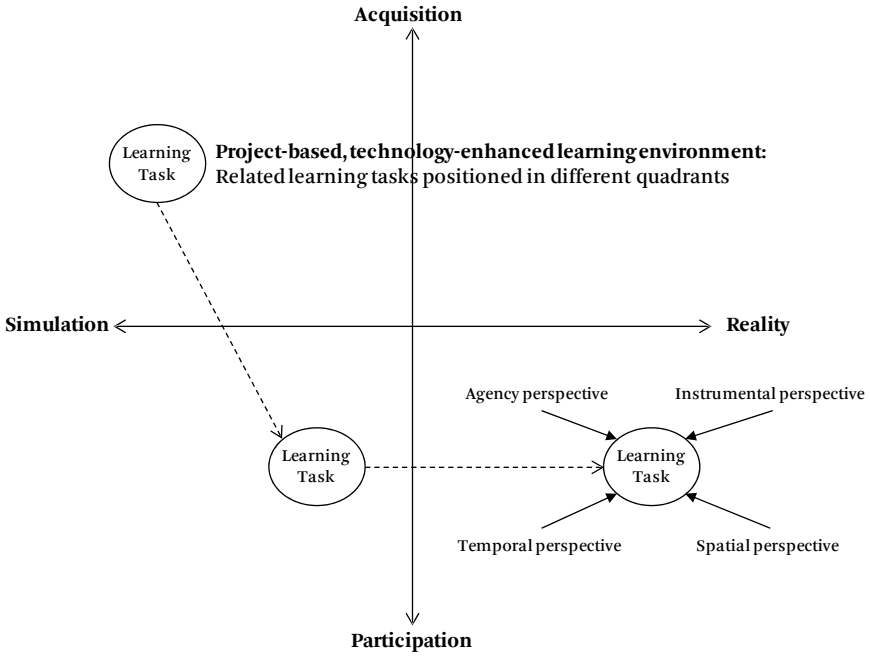
- Use expert performances and the modelling of processes.
- Enact multiple roles and applying multiple perspectives.
- Collaboratively construct knowledge.
- Reflect, to enable abstractions to be formed.
- Articulate, to enable tacit knowledge to be made explicit.

Herrington & Kervin and Herrington & Herrington identify nine characteristics of authentic learning environments. Five of these characteristics can be characterised as mechanisms. The other four characteristics are characteristics of the intervention as described above, namely, 'provide an authentic context that reflects the way knowledge will be used in real life'; 'authentic activities'; 'coaching and scaffolding' and 'authentic assessment'. These four characteristics should be part of the solution (the intervention) and activate the above five authentic mechanisms.

*5.1.1 Descriptive model of the intervention*

In preceding research we introduced a descriptive model of project-based, technology-enhanced learning environments as shown in figure 12 (Zitter, Kinkhorst, Simons & Ten Cate, 2009; Zitter, De Bruijn, Simons & Ten Cate, submitted).

Figure 12: Descriptive model learning environment




The descriptive model consists of two dimensions, namely, acquisition-participation (Sfard, 1998) and simulation-reality (Herrington, Reeves & Oliver, 2007). The first dimension has on one side the knowledge acquisition metaphor, in which knowledge is considered as commodity that can be acquired, transferred and shared with others. On the other side is the participation metaphor, characterising learning as a situated, ongoing, participatory activity which is never considered separately from its context. The second dimension has simulation on one side and reality on the other. This dimension characterises how realistic learning tasks are. Simulation is characterised by a context which is situated in an educational setting and in which the rich reality of professional practice is reproduced as a more simplified and restricted context. Realistic settings, on the other hand, closely resemble the real professional context.

We consider concrete, authentic learning tasks (Van Merriënboer, Clark & De Croock, 2002) as the building blocks of learning environments. Learning tasks can be positioned in the four quadrants of our descriptive model. Four perspectives were distinguished to characterise learning tasks:

1. Agency perspective, to study the roles enacted by participants.
2. Spatial perspective, to study the physical and digital spaces in which the learning tasks take place.
3. Temporal perspective, the timeframe as relevant to the learning tasks.
4. Instrumental perspective, the boundary objects which are instrumental to deliver the intermediary and final results of the learning tasks.

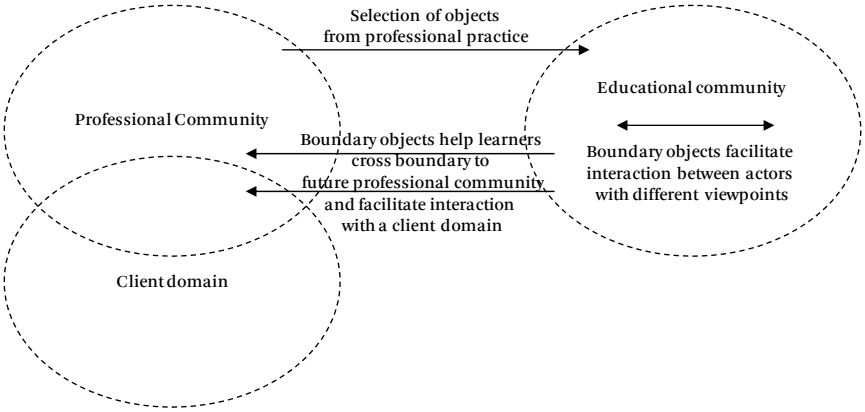
*5.1.2 Focus on instrumental perspective: boundary objects*
We focus on the instrumental perspective of learning tasks, more specifically the role that professional objects play in activating authentic mechanisms.

Boundary crossing is a process across different communities of practice with different tools, languages, rules and social relations (Engeström, Engeström & Karkkainen, 1995). In the project-based learning environments of our research, there are two main communities, namely the educational community and the future professional community [see figure 12]. The professional community usually consists of multiple sub-communities and related communities. Besides, professionals often work for clients and have to interact with different client-domains. These clients usually offer products or services to customers. For example, the professional community studied in this article was the digital communication community. Sub-communities of this community are, for instance, graphical designers, website developers and project managers. A related community could be the marketing and communication community. The digital communication community works for different client-domains, such as, finance, non-profit and retail. In these client-domains, products and services are delivered to different groups of customers (teenagers, singles, the elderly etc.).

By selecting objects which are used in professional practice, an explicit connection can be made with working life [see figure 13]. These objects can help learners to cross the boundary into their future professional community and can therefore be seen as boundary objects. Tuomi-Gröhn, Engeström & Young (2003) state that boundary crossing involves entering unfamiliar territory in which one is to some significant extent unqualified. This is also the case for learners. They are entering the territory of professional practice, which is still unfamiliar to them and in which they are still unqualified.

Boundary objects facilitate the interaction between actors with different viewpoints and help to join heterogeneous information during creation (Star & Griesemer, 1989; Star, 1992). Within the educational community, professional objects can function as boundary objects by playing a role in facilitating the interaction between actors with different viewpoints.

Figure 13: (Boundary) objects in educational community



*5.1.3 Research questions*

In summary, we studied objects that were selected from professional practice by educators, to be instrumental in the learning tasks of project-based, technology-enhanced learning environments in higher education. We also studied how technology was used in relation to the boundary objects. This article focuses on the following research questions:

- How do professional objects function as boundary objects and which role do they play in activating authentic mechanisms?
- How was the technology enhancing the learning environment used in relation to these objects?

## 5.2 Method

The method we chose to answer the research questions was the case study. The strength of the case study method is its ability to examine, in-depth, a "case" within its "real-life" context (Yin, 2005).

Two case studies were carried out at the same educational institute, in the same educational context, namely, learning environments of two subsequent study years (2006 and 2007). The research presented here took place at a Dutch University of Applied Sciences, at the faculty of Communication and Journalism, at the department of Digital Communication. The learning environments were the final, obligatory course for first year students with as topic 'system development'. During an eight-week course students worked in small project teams (three-four students) on the design and development of a website for an external client. In 2006, 125 students and six external clients participated; in 2007, 170 students and seven external clients. The external clients were small and medium sized enterprises or of the non-profit sector.

*5.2.1 Case selection*

To select suitable cases, preliminary meetings were held with the coordinators of the courses. Following the specification of the CIMO-logic as presented in table 15, five selection criteria were discussed and checked during these meetings: (1) Intended learning outcomes; (2) Whether the learning environment was project-based; (3) Whether it was technology-enhanced; (4) Whether it could be characterised as authentic; and (5) Prospective active involvement.

*(1) Intended learning outcomes.* The intended learning outcomes should be formulated in terms of transferable knowledge and learning-, thinking-, collaboration- and regulation-skills. During the preliminary meetings it was confirmed that this criterion was met by the selected context. Learners were to collaboratively work on solving real problems from external clients, requiring complex learning-, thinking-and collaboration-skills. It was explicitly chosen to develop a website, since there was a strong chance that learners would participate in projects to design and develop websites in their future professional practice, indicating the need to develop transferable knowledge. Learners enacted to role of junior professional and were expected to regulate their own learning process, with the help of educators in the role of senior professional.

*(2) Project-based*. The learning environments were project-based, since the learners worked in project teams on actual, real-life problems (Tynjälä et al., 2003) formulated by external clients.

*(3) Technology-enhanced.* The learning environments were technology-enhanced since the physical learning environments with face-to-face interaction were accompanied by digital learning environments. The digital learning environments consisted of common spaces for educational material, spaces for each sub-group working for an external client (six sub-groups in 2006 and seven in 2007), and collaborative workspaces for each project team (seven to eight project teams in each sub-group). The digital environment in question was SharePoint (2007) in both years. For developing and testing the websites, there was a basic development environment available. Besides, the learners had full access to the World Wide Web.

*(4) Characterised as authentic*. Two of the authentic characteristics (providing authentic contexts and authentic activities) were already met by the abovementioned project-based criterion. Furthermore, the learning environment 'offered coaching by the teacher at critical times, scaffolding and fading of teacher support', since educators were available to coach and scaffold the individual learners and project-teams. There was 'authentic, integrated assessment', since it involved the assessment of the (intermediary) project-results and presentations to the external client.

*(5) Prospective active involvement.* It was planned to study the learning environment for two subsequent years. Therefore, it was necessary that the coordinators as representatives of the educational context would be willing to collaborate in the research for two years. This criterion was also met by the selected educational context.

### *5.2.2 Collected data*

*Curriculum documents and material.* All documents and material specifying the designs of the learning environments were collected. The materials consisted of student manuals, hand-outs, obligatory resources (e.g. books, links to online material), formats, announcements in the accompanying digital spaces and so on. The documents and material of the two subsequent study years were collected.

*Participants & Observations*. The main participants were the learners of the selected learning environments. In both study-years the whole group was divided in sub-groups. The observations were carried out within one sub-group in each year. The two observed sub-groups were selected on the basis of the willingness of the educator to participate in the research for the two subsequent years. In both years, the observations were focused on four project-teams within the sub-group in question. At the start of the learning environment, the coordinator introduced the researcher and asked which teams were willing to participate. It was chosen to observe project-teams that volunteered, since they would be observed up-close and personal for the duration of the learning environment.

Observations were carried out to gain insight into the role of professional objects activating authentic mechanisms and to gain insight how technology was used. The face-to-face activities organised for students in the physical educational spaces were observed (approximately 48 hours) and the activities in the accompanying digital learning environments were weekly monitored during eight weeks. Extensive field notes were taken during the observations and monitoring. Photos were taken to

collect data about the objects in the physical spaces. Screenshots were made to collect data about the objects in the digital spaces.

*5.2.3 Selection of the professional objects*

During the learning tasks, the professional objects functioned as boundary objects and helped to join information from across different viewpoints, leading to the results of the learning task in question. It is important to realise that while a learning task are carried out, the objects function as instruments to help produce the intended results. This means that the selected objects have a dual meaning: they are generic instruments for all learners and project-teams and are used to develop the specific (intermediary) results of specific project-teams.
The selected objects are briefly described below.

- Mood board. The mood board was a visual representation, using images, text and colours and was used to communicate the initial design ideas of a project team.
- Project plan. Prince2 (2003) was the obligatory project management method, giving directions on how to plan and manage a project. In this method, the project was globally defined in a project brief. The project brief was consequently expanded into a project plan.
- Prototype. Half-way during the project, the project teams were expected to make a prototype of the website that had to be developed. The prototype was to be a working model of the final result, demonstrating the way it was intended to work.
- Website. The project had to result in a website for the external client, ready to be implemented and go online.

Advising, designing and developing were the three core tasks central in the intended learning outcomes. Besides, the educators indicated during the preliminary meetings that the task of project management played an important role. The selected objects represented the three core tasks and the task of project management [see table 16].

Table 16: Selected objects in relation to core tasks

| Core task | Advising | Designing | Developing | Project management |
|---|---|---|---|---|
| Object | | | | |
| Mood board | | X | | |
| Project plan | | | | X |
| Prototype | X | X | | |
| Website | | | X | |

The mood board was meant to articulate the initial design ideas and was therefore instrumental during the task of designing. The project plan was to articulate the requirements, risks, scope and planning of a project. Making a project plan belonged to the task of project management. A prototype should articulate design ideas and was to be instrumental in advising a client towards the final result. The website needed development and was the only object that could be identified as instrumental in the task of developing.

*5.2.4 Data analysis*
Three analyses of the collected were carried out: positioning of the objects, a feature analysis and a task analysis. Two learning environments were studied (2006 and 2007). For the first two analyses (positioning the objects and feature analysis), the differences between the subsequent years were fractional. Only in the last analysis, the task analysis, the two years were considered separately.

*Positioning the objects*. The learning tasks in which the selected objects were instrumental can be characterised with the model as presented in the introduction [see figure 12].

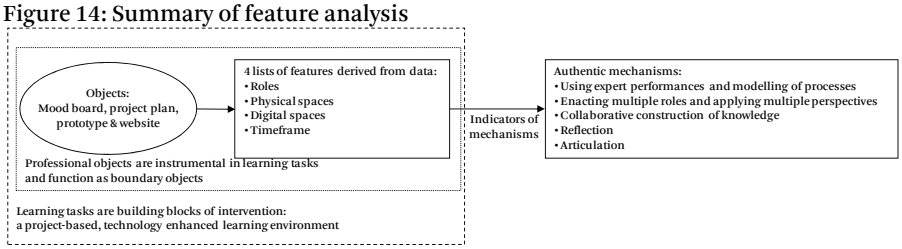
*Feature analysis*. Again, the model [see figure 12] was used to study the selected objects. The focus in this article is on the instrumental perspective. The three remaining perspectives, agency (roles), spatial (physical and digital spaces) and temporal (relevant timeframe) were used for this analysis. The collected educational material and observational data were analysed. Each time a role, physical space, digital space or a timeframe were encountered, they were added to a list. At the same time, it was noted to which selected object the role, space or timeframe related. For example, the mood board was presented on a laptop during a meeting at the educational institute by the project team to the external client. This observation would result in the following items on the list of the mood board:

- Agency (roles): learners enacting a project-role, external client in role of representative of a client domain.
- Spatial (spaces): classroom at educational institute, digital workspace of a project-team to access the digital version of the mood board.
- Temporal (timeframe): short-term, a mood board is meant to engage a client in dialog; afterwards, the mood board does not really play an active role anymore.

The lists, which were derived from the collected data, can be considered as the features or properties of the selected objects. These features specify in which roles a object was instrumental (i.e. functioned as boundary object), in which physical and digital spaces it was handled and across which timeframe. The complete lists of the four selected objects are presented in the results-section [see table 17].

Next, connections between the features and the authentic mechanisms were made. Continuing the above example, project-teams had to articulate their initial design ideas in the form of a mood board to engage the external client in dialog. The feature of 'external client in role of representative of client-domain' was considered as an indicator for the mechanism of 'articulate, to enable tacit knowledge to be made explicit'. The rationale behind all of the connections that were made is explained in the results-section.
The process of identifying features helped to make the intervention-level of the CIMO-logic [see table 15] more specific. We started with a project-based, technology enhanced learning environment at the intervention-level. Learning tasks are considered as the building blocks of learning environments. In learning tasks, professional objects are instrumental and can function as boundary objects. We now went one step further and identified the features of such objects. The feature analysis that was carried out can be summarised with the next figure [see figure 14].

Figure 14: Summary of feature analysis




*Task analysis.* Task analysis is the process of analysing and articulating the kind of learning that takes place (Jonassen, Tessmer & Hannum, 1998). For this analysis a salient photo representative of the learning task in which the professional object was instrumental was selected. This photo was analysed by using the four analytical perspectives of our model [see figure 12]. The results are presented in the result-section. In this analysis, attention was also paid to the connections between the features of the selected objects and the mechanisms. The rationale for these connections resulted from the previous feature analysis. The task analysis was used to help substantiate the connections between the features and mechanisms.

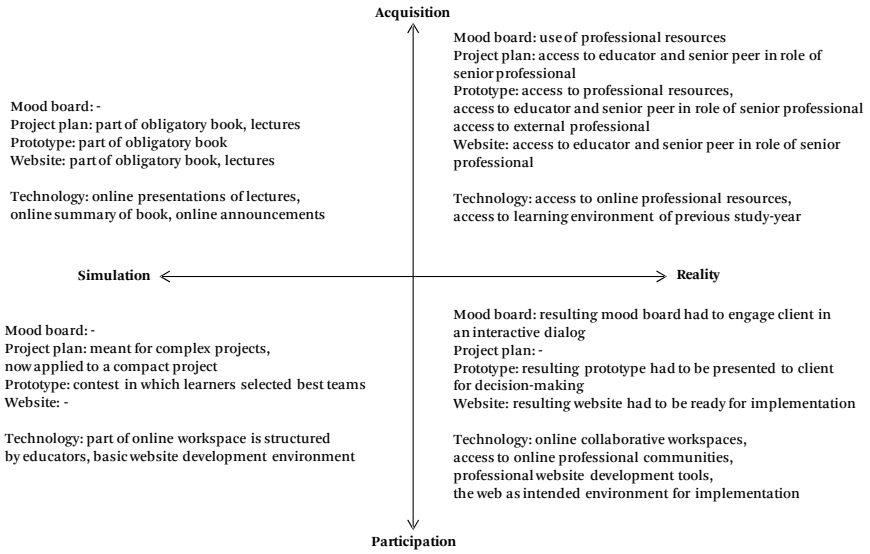
### 5.3 RESULTS

In the results describing the role professional objects played in activating the authentic mechanisms, the way technology was used has been incorporated.

#### *5.3.1 Positioning the objects*

Positioning the objects in our descriptive model shows that the selected objects were instrumental in all four quadrants of the model [see figure 15]. They functioned as boundary objects throughout the learning environment.

Figure 15: Positioning the objects



Technology was used differently in each of the quadrants. Towards the dimension of acquisition, technology facilitated one-way interaction: educational material was published online by educators and learners had access to professional sources. Towards the dimension of participation, technology facilitated collaborative interaction in the form of online collaborative workspaces. Towards the dimension of simulation, technology was more restricted by the educators, while towards reality, the use of technology was left more open.

*5.3.2 Feature analysis*

The results of the feature analysis are presented in the table below [table 17]. The rationale behind the connections made between the features and the authentic mechanisms is explained afterwards.

Table 17: Results feature analysis

| Mechanism | Feature | MB | PP | PT | WS |
|---|---|---|---|---|---|
| Use expert performances and modelling of processes | | | | | |
| | [R] Educator in role of senior professional | X | X | X | X |
| | [R] Senior peer in role of professional | | | X | X |
| | [R] External professional | | | X | |
| | [S] Web: online professional sources | X | X | X | X |
| | [S] Web: online professional communities | | | | X |
| | [T] Long-term perspective | | | | X |
| Enact multiple roles & apply multiple perspectives | | | | | |
| | [R] Learners in different project-roles | X | X | X | X |
| | [R] External client in role problem-owner | X | | X | X |
| | [R] External client in role of representative of potential users | | | | X |
| Collaboratively construct knowledge | | | | | |
| | [R] Educator in role of assessor | X | X | X | X |
| | [S] Digital versions of results in online, collaborative workspace | | X | | |
| | [R] Peers of same sub-group in role of peer-assessors | | | X | |
| Articulate to enable tacit knowledge to be made explicit | | | | | |
| | [R] Learners in different project-roles | X | X | X | X |
| | [R] Educator in role of senior professional | X | X | X | X |
| | [R] Educator in role of assessor | X | X | X | X |
| | [R] Senior peer in role of professional | | | X | X |
| | [R] External client in role problem-owner | X | | X | X |
| | [R] External client in role client of client | | | | X |
| | [R] External professional | | | X | |
| | [R] Peers of the same sub-group | | | X | X |
| | [R] Peers of other sub-groups | | | X | |
| | [S] Face-to-face interaction at school | X | X | X | X |
| | [S] Digital presentation of result | X | | X | X |
| | [S] Digital versions of results in online, collaborative workspace | | X | | |
| | [S] Development environment | | | | X |
| | [S] Web as future space of implementation | | | | X |

MB = mood board, PP = project plan, PT = prototype, WS = website
[R] Role (agency), [S] Space (spatial), [T] Timeframe (temporal).

*Use expert performances and modelling of processes.* Interaction with the roles of (senior) professional (enacted by educators and second-year learners as senior peers) or an external professional was considered as an indicator for the mechanism of 'using expert performances and the modelling of processes'. The use of online professional sources or professional communities was also considered as an indicator of this mechanism.

When the timeframe involved was to be more long-term, this was taken as an indicator of expert performance, since this would involve overseeing long-term consequences and is something experts should be able to do.
*Enact multiple roles and use multiple perspectives.* Agents and roles with different perspectives, namely, learners in different project-roles and the external client in the roles of problem-owner and representative of potential users (clients of client) were considered as an indicator of the mechanism of 'enacting multiple roles and using multiple perspectives'.

*Collaboratively construct knowledge.* Interaction required with another team member, with another project role was considered to be an indicator for the mechanism of collaborative construction of knowledge. Besides, when multiple versions of the results were to be handled in the online collaborative workspace, this was also an indicator.

*Reflect to enable abstractions to be formed.* When the result is assessed by the educator in the role of assessor, this was considered as an indicator for the mechanism of reflection. Besides, when versions of the results were to be handled in the online collaborative workspace, this was also seen as an indicator.

*Articulate to enable tacit knowledge to be made explicit.* Different agents and roles involved in producing the result with the help of the boundary object was considered as an indicator for the need to articulate tacit knowledge. Usually, articulation was necessary to be able to interact with another agent with a different role. The different spaces which could be identified were also considered as an indicator for this mechanism, since each identified space required a different form of articulation.

The four columns of the selected objects as presented in the table above [table 16] were analysed in the task analysis. The results of the task analysis are presented in the next section.

*5.3.3 Task analysis*
The results of the task analysis are presented in the next sections. For each of the four selected objects, two photos are presented (2006 and 2007) and an in-depth description is given [figures 16-19].

Figure 16: Mood board in 2006 and 2007

First meeting external client 2006, without Mood board


Agency perspective:
R1: External client in role of problem-owner
(in front of group, not shown)
R2: Learners in role of junior professional

Spatial perspective:
S1: Regular classroom, tables arranged for central presentation

Instrumental perspective:
No boundary objects were specified for this learning task.

Temporal perspective:
Short term

Mood board 2007


Agency perspective:
R1: External client in role of problem-owner
R2: Learners in role of junior professional
R3: Educators in role of assessor
R4: Senior learner in role of account manager

Spatial perspective:
S2: Regular classroom, tables arranged for meeting

Instrumental perspective:
B1: Mood board in digital form, to visualize
early look & feel of the website

Temporal perspective:
Short term

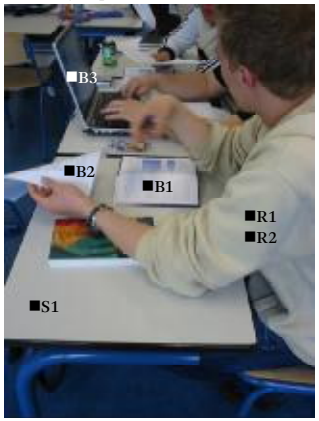
At the start of the project the external client (R1) was invited to the educational institute for the first meeting (S1). In 2006 no specific boundary object was specified to be instrumental in this task. The learners (R2) were expected to prepare questions. The client gave a central presentation and learners had the opportunity to ask the prepared questions. Observations showed that only one or two learners asked questions, while the rest remained passive.

In 2007 the first meeting was postponed slightly. Learners were to acquaint themselves with each other and with the project and prepare a mood board (B1) to explicitly articulate the initial ideas of their team. In their first meeting, each project team (R2) had a short meeting with the external client. All project teams chose to make a digital mood board and brought a laptop to present it. Observations showed highly interactive meetings in which much discussion took place between the project teams and the external client. During these meetings, the educators (R3) and senior student (R4) were present.

When we compare 2006 with 2007, the mechanisms which should be activated by the learning environment were more prominent. To make the mood board, the project teams had to articulate their initial ideas and discuss them explicitly with the external client in the role of problem-owner. Most project teams discussed the mood board in advance or afterwards with the educator in the role of senior professional. While making the mood board, learners visited different online professional sources, for instance, websites with professional examples of mood boards. Making the mood board required a collaborative effort, making collaborative construction of knowledge more likely. Besides, the educators and senior peer assessed the mood board and provided feedback, making 'reflection to enable abstractions to be formed' more likely.

Figure 17: Project plan in 2006 and 2007

Project plan 2006




Agency perspective:
R1: Learners in role of junior professionals
R2: A project team consists of 3 learners, each learner fulfilled two team roles (project leader, functional designer, graphical designer, content creator, developer)

Spatial perspective:
S1: Regular classrooms, learners sit together with project team

Instrumental perspective:
B1: Obligatory book about project management method
B2: Briefing about website from external client
B3: Digital version of project plan

Temporal perspective:
Long term

Project plan 2007


Agency perspective:
R1: Learners in role of junior professionals
R2: A project team consisted of 3 learners, each student fulfilled a team role (project leader, functional designer, graphical designer)
R3: Educators in the role of assessor
R4: Senior learner in role of account manager

Spatial perspective:
S2: Regular classroom, participants sit together for meeting

Instrumental perspective:
B4: All results have to be handed in through SharePoint, the accompanying digital workspace.
One of the educators made prints (paper).

Temporal perspective:
Long term

Prince2 (2003) was the obligatory project management method, giving directions on how to plan and manage a project. In this method, a project is globally defined in a project brief. The project brief is consequently expanded into a project plan. In the project plan the learners were expected to articulate the requirements, risks, restrictions and planning of the project.

The selected moment of 2006 shows learners of one project team (R1, R2) sitting together in a classroom functioning as workspace (S1) to make the project plan (B3). Observations showed learners collaborating while working on this intermediary result, usually iterative collaboration took place on subsequent digital versions of the project plan. They were typing while they were using the obligatory book (B1) about the project management method and they used the briefing made by the external client (B2, Word-document). The learner enacting the role of project leader would usually take the lead in writing the project plan and ask for input and feedback from team-members with a different role (designer or developer). The obligatory project management method included a format for the project plan, which was made available through the digital environment. The obligatory project management method is also used in professional practice and helped learners to model an expert performance. It also helped to find suitable additional, professional sources online.

In a project plan, a project team is expected to oversee the longer term consequences. However, the educators in the role of senior professional remarked that the long-term scope of the project plans was limited.
The selected moment of 2007 shows a feedback meeting in the middle of a classroom (S2) with two educators (R3), one senior peer (R4) and a project team (R1, R2). During these meetings the learners reflected on their intermediary results together with the educators and the senior peer. The project plans had to be handed in through the digital workspace. In this the workspace of each project-team there was a specific area for final results, which were to be assessed. One of the educators made paper print-outs of the project plans (B4).

Figure 18: Prototype in 2006 and 2007

Presenting the prototype 2006


Agency perspective:
R1: Learners in role of junior professionals
R2: A project team consists of 3 learners,
each learner fulfilled two team roles
(project leader, functional designer, graphical designer,
content creator, developer)
R3: External clients in role of problem-owner

Spatial perspective:
S1: Small meeting room at the educational institute

Instrumental perspective:
B1: Screenshots of the prototype in PowerPoint-presentation. Some teams also delivered the prototype on CD to the external client.

Temporal perspective:
Short term

The prototypes on YouTube 2007


Agency perspective:
R4: Learner of a winning team, in role of colleague junior professional
R5: Profile of a learner on YouTube

Spatial perspective:
S2: Public space on YouTube

Instrumental perspective:
B2: Movies of presentations of the prototypes of the 7 winning teams.

Temporal perspective:
Short term

In both years learners were expected to make a prototype (B1) representing how the final website would function. In this prototype it was expected to explicitly articulate for an external client what she could expect as final result. In 2006, the learners (R1) in their team roles (R2) presented the prototype to the external clients (R3) in a small meeting room at the educational institute (S1). The prototypes were assessed by the educator in the role of assessor.

In 2007 the learners were asked to select the best prototype of their sub-group. While in 2006 the presentations of the prototype were held in a meeting room with only one project team present at the same time; in 2007 the presentations took place in front of all of the teams of the same sub-group. In the parallel sub-groups, working for other external clients, the best prototypes were also selected. The winning project teams with the best prototypes presented their prototypes in the large lecture hall to all of the participating students. This was the only occasion in which learners articulated intermediary results for peers of other sub-groups. The selection process helped learners to reflect explicitly on the intermediary results, since they had to actively decide which prototype was considered as the best in their role of peer-assessor.

During the central presentation, one learner (R5) took the initiative to make short movies of the presentations. He placed the short movies online (R4, R5, B2) on his YouTube-space (S2). One of the coordinators sent an e-mail with the link to the online movies to all the participating learners.
Observations in both years showed that learners worked hard and in joint interaction on the prototype, they came more often to the educational institute and stayed longer. Each week, six hours were scheduled in advance. During these hours, there was a classroom available as workspace and the educators were available in the role of senior professional. In the beginning of the project, learners were only present during these hours (or less). They would then divide the work and continue work elsewhere. When they started working on the prototype, learners also worked outside of these hours at the educational institute.

While working on the prototype, learners could ask for help from the educator or senior peer enacting the role of (senior) professional; many users used this opportunity. They also made frequent use of various online professional sources, for example, for input on how best use and edit graphical material for the web. The more graphically oriented team member would collaborate with the technical member, to make sure his/her ideas would be technically feasible.

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[1] YouTube is a website where videos are exchanged worldwide. For more information see www.youtube.com

Figure 19: Website in 2006 and 2007

Winning website 2006


Spatial perspective:
S1: This website was not online, it is in the basic development environment of the educational institute available to the project-teams.

Instrumental perspective:
B1: Screenshots of one of the winning websites.
The external client selected two winning websites in this year.

Temporal perspective:
Long term

Online website 2007


Spatial perspective:
S2: This website was implemented. It is now online on the web.

Instrumental perspective:
B2: Screenshot of the winning website.

Temporal perspective:
Long term

The websites in both years were made for external clients of the small and medium sized enterprises domain. The websites have as feature from the agency-perspective that they are meant for clients of the client, the potential visitors and users of the website. During the design and development process, the website helped to learn to think as a user. The website functioned as boundary object since it was necessary for the project-teams to explicitly apply the user-perspective. When the websites had to be tested, many project-teams involved people with a similar profile as the potential users in the user-test. The users would test the website and give feedback. This feedback would then be used to improve the website.

Though a prototype is meant to be a working model of the final result, demonstrating the way it is intended to work, it did not invoke the user-perspective as the website did. During de design and development of the prototype, the project-teams were primarily working from the perspective of the external client.

While making the website, the learners consulted frequently with the educator or the senior peer in the role of (senior) professional. They also used many online professional sources, particularly of a technical nature. Many learners also interacted with online professional communities. The website was to made with Joomla![1]. Joomla! has an extensive online community, which learners frequently consulted.

In 2006, the external client chose two winning websites. In her opinion, one would strongly appeal to the potential users of the website. The other appealed to her as future webmaster, since it was much easier to maintain and keep up-to-date. In 2006, these two perspectives were not merged into one result by the project-teams. In 2007, the external chose one winning website that also went online. This website did include both the user-perspective and the maintenance-perspective. The client thought the website would appeal to her target-group and was positive about the offered maintenance-facilities. The attention for future maintenance showed that the project teams used a long term perspective, with a longer time horizon than just the development-process.

[1] Joomla! An open source development environment for websites. For more information see www.joomla.org

## 5.4 Conclusions and Discussion

### *5.4.1 Positioning the objects*

Our analyses showed that the selected professional objects and technology played across the dimensions of acquisition-participation and simulation-reality, throughout the project-based, technology enhanced learning environment. Towards the acquisitional dimension, the technology was used for one-way information about the more conceptual aspects of the objects. For example, the presentations about project management and making project plans were published online in the digital learning environments and learners used different online professional sources. Towards the participative dimension, the technology was used to facilitate collaboration in the form of online workspaces and access to online professional communities. Also, the objects facilitated the collaborative interaction, both between members of a project team and participants outside of the team.

Towards the simulation dimension, technology was used more top-down by the educators: they made announcements online, published information and so on. The objects were used as guiding instruments by the educators, in the form of obligatory books and fixed formats for the project plan. Towards the reality dimension, the use of technology was left more open. The learners were given professional tools to work with and could use the online workspaces to their own convenience. The professional objects could also be characterised as more realistic, especially the website, since it had to be developed for real web-users.

### *5.4.2 Feature and task analysis*

To make the abstract concept of professional objects functioning as boundary objects in learning environments more concrete, the features of the objects were identified. Consequently, they were connected with the authentic mechanisms. The in-depth task analysis substantiated the connections. The analyses showed that there were many features that helped to activate the mechanisms of ‘articulate’ and ‘use expert performances’. Few features were connected with the mechanisms of ‘enact multiple roles and use multiple perspectives’, ‘collaboratively construct knowledge’ and ‘reflect’. When educators want to activate these mechanisms, careful selection of professional objects which can function as boundary objects is needed.

### *5.4.3 Addition to current literature*

The intervention studied in this chapter is a project-based, technology-enhanced learning environment that can be characterised as authentic, in the context of higher education. We chose to focus on the instrumental perspective of these learning environments. Others also include this perspective in their studies. Van den Akker (2003) identifies 'materials & resources' as one of the ten curriculum components. The definition of a learning environment from Goodyear (2001) includes 'tools, documents and other artifacts'. Helle et al. (2006) discuss the importance of 'constructing a concrete artefact' in forms of work-based learning.

In our studies we chose to further explore the role of concrete instruments or professional objects in learning environments to add to the insights in current educational literature. We studied how they functioned as boundary objects and helped to activate authentic mechanisms, which should lead to the intended learning outcomes of transferable knowledge and learning-, thinking, collaboration- and regulation-skills (Simons et al., 2000).

Minimal guidance during instruction such as discovery learning, problem-based learning, inquiry learning and experiential learning is still controversial (Kirschner, Sweller & Clark, 2006). With our studies into professional objects as instruments to help learners produce results, we showed that such objects offered guidance to learners.

### *5.4.4 Practical implications*

By using the perspectives to analyse the role of the professional objects, educators can influence the mechanisms which need to be activated to reach the intended learning outcomes. The analyses showed that activating the mechanism of articulation was connected to many of the features of the objects, while the mechanisms of enact multiple roles and use multiple perspectives, collaboratively construct knowledge and reflect were connected to much less features. When educators feel there is more need to activate these mechanisms, they should explicitly take advantage of the few features that help to activate these mechanisms.

### *5.4.5 Future research*

We carried out in-depth, qualitative research into the instrumental perspective of learning environments. Broader research is needed to complement our research. Future research is needed to further develop the insights presented here. To start with, a broader variety of professional objects should be examined. Also, the activated mechanisms need to be systematically studied. These studies could lead to a typology of objects in relation to the mechanisms they activate. Next, the typology could be validated in a systematic way, by using it in quasi-experimental research. This research would include different interventions, for example, with no explicit attention to objects and interventions with different objects. Measuring instruments would have to be developed or taken from current literature to measure whether and to what intensity the authentic mechanisms would be activated. Besides, the overall learning outcomes would have to measured, to ensure that the overall outcomes are also reached. Such research would lead to solid, concrete evidence about the relation between types of objects and activated mechanisms and be highly useful for daily educational practice.

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# Chapter 6
# The assessment process and effectiveness of hybrid learning environments in higher education[*]

**Abstract**

Higher education has increasingly adopted competence-based learning. In this type of learning, learners are educated towards flexible professionals able to respond to a rapidly changing business environment and in possession of integrated competencies instead of isolated knowledge and skills. We have introduced a model of hybrid learning environments to study competence-based learning, made up of related learning tasks that are positioned along the dimensions of acquisition-participation and simulation-reality. With a set of quality criteria for competency assessment (authenticity, cognitive complexity, meaningfulness, fairness, transparency, educational consequences, directness, reproducibility of decisions, comparability and costs and efficiency) we have assessed the quality of the assessment process of a hybrid learning environment. The quality of the assessment process was relatively high. The high quality assessment process indeed facilitated the development of the intended learning outcomes, as evidenced by different sources of assessment data. It was concluded that there is a fair indication that hybrid learning environments can be effective and can result in the development of complex competencies, integrating knowledge, skills and attitudes.

[*]Previous/Unrevised version of Zitter, I., De Bruijn, E., Simons, P.R.J. & Ten Cate, Th.J. (2009). The quality of the assessment process in hybrid learning environments in higher education. *Assessment and Evaluation in Higher Education [Under revision]*

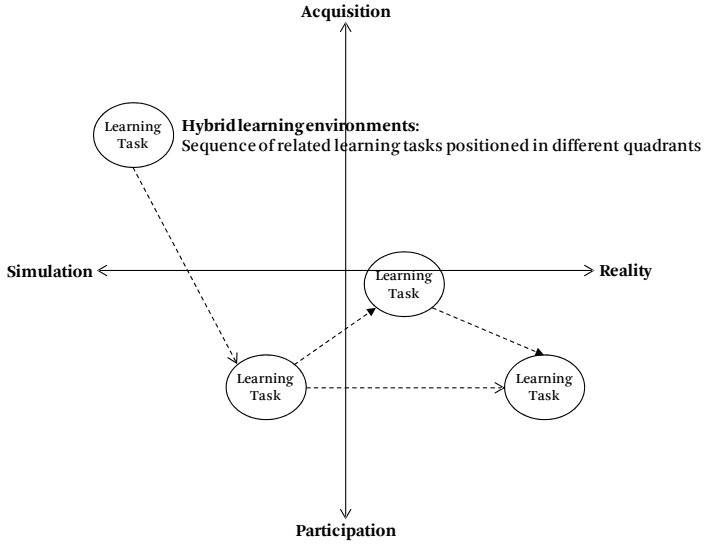
## 6.1 Introduction

Higher education has increasingly adopted competency-based learning in which learners are educated towards flexible, adaptive professionals. Professionals able to respond to a rapidly changing business environment and in possession of integrated competencies, instead of isolated knowledge and skills (Baartman, Bastiaens, Kirschner & Van der Vleuten, 2007). A competency can be characterised as a complex integration of knowledge, skills and attitudes (Van Merriënboer, Van der Klink, & Hendriks, 2002). Competence-based learning is the response to the many changes and challenges current higher education is confronted with, such as, economic globalisation, the massification and diversification of the higher education system, and a shift from strictly traditional, teacher centred education towards more learner centred education (Van Weert & Pilot, 2003; Tynjäla, Välimaa & Sarja, 2003; Brennan, 2008).

To study learning environments in competence-based higher education we have introduced a model of hybrid learning environments (Zitter, Kinkhorst, Simons & Ten Cate, 2009; Zitter, De Bruijn, Simons & Ten Cate, submitted). A hybrid learning environment is made up of related, sequenced learning tasks that are positioned along the dimensions of acquisition-participation (Sfard, 1998) and simulation-reality (Herrington, Reeves & Oliver, 2007). The first dimension has on one side the knowledge acquisition metaphor in which knowledge is seen as a commodity that can be acquired, transferred and shared with others. On the other side is the participation metaphor, characterising learning as a situated, ongoing, participatory activity which is never considered separately from its context. The second dimension has simulation on one side and reality on the other. This dimension characterises how closely a learning environment resembles professional practice. A simulated learning environment can be considered as classroom learning. This type of learning is structured by educators and diverges from real professional settings. Realistic aspects of learning environments, on the other hand, closely resemble the professional context [see figure 20].

In the model of hybrid learning environments two perspectives on learning are included: the cognitive perspective and the socio-cultural perspective. The more traditional cognitive perspective with an emphasis on conceptual and procedural knowledge (Akkerman, Van den Bossche, Admiraal, Gijselaers, Segers, Simons & Kirschner, 2007) is an established perspective in educational institutes. It is complemented with the socio-cultural perspective which emphasises social activity and situatedness (Akkerman et al., 2007). By incorporating these two perspectives in the model, both perspectives can be used to study learning environments in higher education.

Figure 20: Model of hybrid learning environments




There is a strong relationship between learning and assessment (Baartman, Bastiaens, Kirschner & Van der Vleuten, 2006). Therefore, we studied the assessment process of hybrid learning environments in higher education. We determined the quality of the assessment process and consequently determined the effectiveness of hybrid learning environments. Two research questions were addressed in this article:

- How can the assessment process of a hybrid learning environment be characterised?
- How effective is a hybrid learning environment?

### 6.2 Method

The method we chose to answer the research questions is the case study. The strength of the case study method is its ability to examine, in-depth, a "case" within its "real-life" context (Yin, 2005).

#### *6.2.1 Selected case study*

The studied educational context was situated in a large Dutch University of Applied Sciences. The institute consists of six independent faculties. The research presented here took place at the faculty of Communication and Journalism, at the department of Digital Communication. The studied learning environments were two subsequent study years of the final, obligatory course for first year students with as topic 'system development'. During an eight-week course students worked in small project teams (three to four students) on the design and development of a website for an external client. In 2006, 125 learners, 12 educators and six external clients participated; in 2007, 170 learners, 14 educators and seven external clients. The external clients were of the small and medium sized business domain or of the non-profit sector. The learners were divided into sub-groups, one sub-group for each client (six in 2006; seven in 2007). In each sub-group, about eight project-teams worked in parallel for the same external client.

The competencies, defined above as an integration of knowledge, skills and attitudes (Van Merriënboer et al., 2002) were described in the educational material as followed.

- You will design and develop a dynamic website for an external client.
- In your future profession you will be confronted with the core tasks of advising, designing and developing. These three core tasks will be dealt with in a specific setting.
- It was explicitly chosen to develop a website, since there is a strong chance that you will participate in projects to design and develop websites in your future professional practice.

The above case was selected for a number of reasons. The first reason was that the educational institute and the context in question explicitly had competence-based learning as underlying educational rational. The selected context represented a good example of a learning environment based on competence-based learning. It was designed fifteen years ago and has evolved and improved since. Lastly, the learning environment involved a large number of learners and was divided into several sub-groups. Such a large-scale environment would help to gather relatively much data from one case. Two subsequent study-years were studied. The learning environment and the assessment process remained the same in both years and were considered to be a single case. The learners differed in the subsequent years, data from the learner experiences and the learner outcomes of both years were studied.

### *6.2.2 Data collection*

*Educational material.* To characterise the learning environment and determine the quality of the assessment process, the educational material was collected. All documents and material specifying the learning environment were collected, both paper and digital material. The documents and material consisted of student manuals, hand-outs, obligatory resources (e.g. books, links to online material), formats, examples, announcements in the accompanying online learning environment and so on.

*Questionnaire: experiences and learning outcomes.* A questionnaire was used to evaluate the learning environment. The questionnaire consisted of seven, separate topics with statements. For each statement, learners were asked to score to what degree they thought the statement applied to the learning environment in question. A Likert-scale from 1-5 was used, with on one end 'not at all' and on the other end 'completely'. It was based on the standard evaluation questionnaire used in the educational institute in question. The institute has a standard evaluation procedure to monitor the quality of learning environments. The evaluation questionnaire was part of that quality process. The questionnaire was distributed to all participating students through the online learning environment accompanying the physical environment. The response to the questionnaire was 26% in 2006 and there was a response of 48% in 2007.

The following data were used from the questionnaire:

- From one topic ('Feedback, Assessment & Reflection') two statements about the assessment process were used to assess the quality of the assessment process.
- From another, separate topic ('System development') three statements to gather data about the learning outcomes as experienced by the learners were used.

- Furthermore, the answers to the final open questions were used.

*Effect measures - Self-reported learning outcomes*. The above mentioned three statements and answers to the open questions about the learning outcomes as experienced by learners.

*Effect measures - Online websites*. After the presentation of the final websites, the external clients selected the project-team with the best website. The clients could request the winning project-team to implement the website to go online. The number of websites that went online was used as an indicator of the level of competence and thus of the overall effectiveness of the learning environment.

*Effect measures - Formal grades*. All the learners were summatively assessed twice, after the first phase and after the second, final phase of the project. Learners were graded on a scale of 1-10. Grades of six and higher are passing grades, grades of five and lower are fail grades. The formal assessment criteria were established by the educators beforehand and were available to the learners in the educational material. The formal assessment criteria are representative of the final level of first-year students of a University of Applied Sciences.

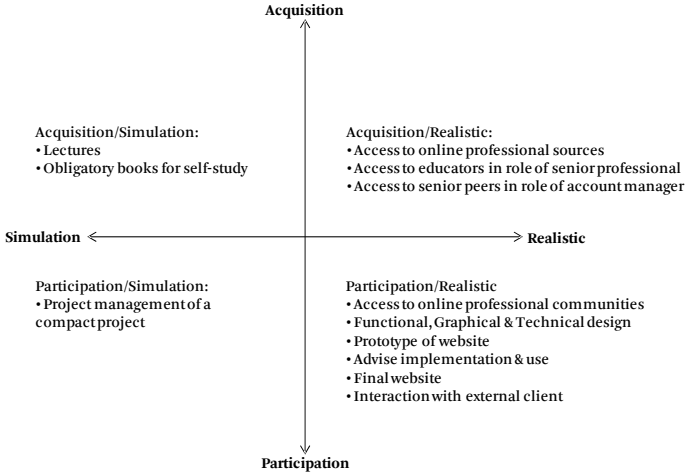
### 6.3 Results

Before determining the effectiveness of the hybrid learning environments with different sources of authentic assessment data, the quality of the assessment process was assessed. We expected to find a relation between the quality of the assessment process and the learning outcomes. The presented data confirmed these expectations.

#### *6.3.1 Characterisation of hybrid learning environment and assessment process*

The learning environment was characterised with the model of hybrid learning environments by positioning the different elements of the learning environment in the four quadrants. These elements are described, including the assessment process taking place in each quadrant [see figure 21].

Figure 21: Characterisation of the hybrid learning environment.



*Acquisition/Simulation.* In this quadrant, we could find elements with an emphasis on conceptual and procedural knowledge, combined with a context that did not resemble professional practice. The lectures and obligatory books for website development and project management can be positioned here. These elements were not assessed separately, for example in the form of a knowledge test. Learners were expected to use the conceptual and procedural knowledge from the lectures and books to produce the results in the participation/simulation and participation/reality quadrants.

*Acquisition/Reality.* In this quadrant, we could find elements with an emphasis on conceptual and procedural knowledge, combined with a realistic setting which resembled professional practice. In the studied learning environments, the access to online professional sources, educators and senior peers (second-year learners) in the role of (senior) professional, could be positioned in this quadrant. This interaction was not assessed separately. However, the educators and senior peers also enacted the role of assessor. The whole group of students was divided into sub-groups (six in 2006, seven in 2007). A duo of educators and a senior-peer provided the guidance, expertise and assessment for each sub-group. In the role of assessor during the assessment of the results in the participation/simulation and the participation/reality quadrant, they would take their interaction with the learners into account.

*Participation/Simulation.* In this quadrant, learning could be characterised as a situated, ongoing, participatory activity in a classroom setting that slightly resembled professional practice. The project management activities, which were to result in project management documents, could be positioned here. Though these activities and results could be characterised as participatory, the context had a simulation character. The context was not as complex as in a real professional setting.

A selection and the order of project management documents which had to be produced were specified by the educators. The required project management documents, namely, a global project plan and a detailed project plan, were assessed by the assessors. The assessors would assess the results and discuss them to reach consensus. Consequently, each project team had a meeting with the assessors. A combination of a project management document, the project management process and results from the participation/reality quadrant would be discussed during such a meeting. When necessary, the project teams were given the opportunity to improve their results. They would then have to hand in the final versions shortly afterwards.

Above, the formative aspects of the assessment process in this quadrant are described. The two project management documents and the overall project management process were also part of the summative assessment as described in the participation/reality-section.

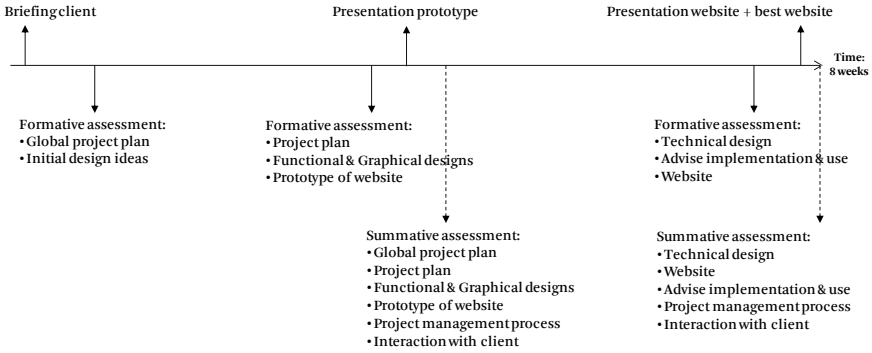
*Participation/Reality.* Most of the elements of the studied learning environments could be positioned in the participation/reality quadrant. The project teams were expected to make a functional, graphical and technical design of a website. They also had to develop a prototype of the website and the final website, and gave advice about the implementation and use of the website. The learners were expected to use concepts and theory from the other quadrants in this quadrant. Besides, learners interacted with online professional communities in particular about the technical

aspects of the website development. The learners worked in classrooms which were used as collaborative workspaces for the project teams.

The educators scheduled three meetings between the client and the teams at the educational institute. In the first meeting, the client briefed the project teams. The teams presented their prototypes in the second meeting and the final website during the third meeting. A senior-peer enacted the role of account manager. S/he was responsible for managing the contact between the project teams and the client in between these three scheduled meetings (by telephone and e-mail).

The assessment process in this quadrant was similar to the process of the participation/simulation quadrant. Formative meetings were carried out three times during the project and summative assessments took place twice [see figure 22]. The formative meetings took place before the meetings with the client, which gave the project teams the chance to improve the client-results. After the presentation of the prototype and the website, the summative assessments took place. After the presentations of the final websites, the external client selected which website s/he considered best.

Figure 22: Assessment process




*6.3.2 Assessment of the quality of the assessment process*
The quality of the assessment process was assessed with a set of quality criteria, besides, data from the questionnaire about the assessment process as experienced by the learners was used.

*Assessment as experienced by learners*. The data from the questionnaire show that learners were quite satisfied with the assessment process. They felt that the process reflected the content of the learning environment and that the assessment was based on clear criteria [see table 18].

Table 18: Assessment as experienced by learners

| Statement evaluation questionnaire, Likert-scale 1-5 | 2006 n = 125 response 26% | 2007 n = 170 response 48% |
|---|---|---|
| To what extent does the assessment fit the content of this learning environment? | 3.8 | 3.3 |
| To what extent is the assessment based on clear assessment criteria? | 3.3 | 3.2 |

The answers to the final open question of the questionnaire (Which suggestions for improvement do you have?) did include some critical remarks.

One learner remarked that the assessment in his/her sub-group was relatively severe in comparison to other sub-groups. S/he stated that some educators are much more lenient than others.

Other learners stated that they felt that more technically skilled learners had an advantage over less skilled learners: they would produce better prototypes and websites and this would affect their overall grades favourably. It should be noted that the learning environments did not intend to favour more technically advanced prototypes and websites. The project management process, project management documents, functional, graphical and technical designs, the advice on implementation and use, and the interaction with the client, were to outweigh the technical aspects.

*6.3.3 Assessment with Quality criteria*

We used a set of ten quality criteria for competency assessment: authenticity, cognitive complexity, meaningfulness, fairness, transparency, educational consequences, directness, reproducibility of decisions, comparability and costs and efficiency (Baartman et al., 2006; Baartman et al., 2007). The assessment process was assessed by one researcher and an external assessment expert. To start with, they assessed the assessment process independently. They scored each of the ten quality criteria on a scale of 1-5. Next, the quality criteria that scored differently were discussed until consensus was reached. The final, consensus scores are presented here [see table 19].

Table 19. Assessment of the assessment process with quality criteria.

| Quality criteria | Description | Score on Scale 1-5 |
|---|---|---|
| Authenticity | Degree of resemblance to the future professional life | 5 |
| Cognitive complexity | Assessment tasks reflect the presence of higher cognitive skills, it should elicit thinking process used by experts to solve problems in their field. | 3 |
| Meaningfulness | Has significant value for both teachers and learners, e.g. by linking assessment with personal interests. | 5 |
| Fairness | Show no bias to certain groups of learners and reflect the knowledge, skills and | 4 |

| | | |
|---|---|---|
| | attitudes of the competency at stake. | |
| Transparency | Is clear and understandable to all participants. Learners should know scoring criteria, who assessors are, and what purpose of the assessment is. | 3 |
| Educational consequences | Evidence is needed about the intended and unintended, positive and negative effects of the assessment on how teachers and learners view the goals of the education and adjust their learning activities accordingly. | 1 |
| Directness | Degree to which teachers and assessors can immediately interpret the assessment results, without translating them from theory into practice. | 5 |
| Reproducibility of decisions | Decisions made on the basis of the assessment must be objective. The decisions are made accurately and do not depend on the assessor or the specific assessment situation. | 3 |
| Comparability | Assessment should be conducted in a consistent and responsible way. | 3 |
| Costs and efficiency | The time and resources needed to develop and carry out the assessment, compared to the benefits. | 4 |

The *authenticity and meaningfulness of the assessment process* scored high. The emphasis of the assessment process was on the elements positioned in the participation/reality quadrant. The context of this quadrant closely resembled professional practice and was therefore highly authentic. Most of the results had to be produced directly for real external clients of the small and medium sized business domain or the non-profit sector and was considered to have significant value for both educators and learners.

The *fairness* was considered high. The assessment process as described in the educational material did not include any indication that it would lead to bias. The data from the questionnaire show that learners were of the opinion that more technically skilled learners had an advantage. However, the educational material showed that assessment of non-technical skills outweighed the technical skills.

The *transparency, reproducibility of results and comparability* were considered sufficient. Though the learners were of the opinion that assessment took place on the basis of clear criteria, the educational material did not offer a transparent list of clear assessment criteria. Within a sub-group, the reproducibility of results was considered sufficient: the different sub-groups were assessed by different duos of assessors, the assessors were known to the learners and the purpose of the assessment was specified in the educational material. The two assessors would discuss till they reached consensus, while they also took the opinion of the participating senior-peer into account. Furthermore, three formative and two summative assessments took place. These multiple assessments were considered to increase the transparency and reproducibility. However, the reproducibility between the sub-groups was less clear from the educational material, confirming the findings from the questionnaire.

The *cognitive complexity* scored sufficient. The learners worked on open and complex problems from real clients of which it was to be expected that it required cognitive effort. Also, the learners were expected to incorporate concepts and theory from the lectures, obligatory books and other sources in all the results. However, no explicit, individual assessment took place of these aspects. Also, most of the results had to be understandable for external clients without domain-expertise. This was taken as an indication of less need to include concepts and theory in the results.

The *educational consequences* were a point of discussion. Much emphasis was placed on the role of the external client. S/he would be present at two presentations, providing key-information for the two summative assessments. Besides, the clients selected the best websites. As a result, it could be expected that learners would give priority to all client-related activities. Though this was highly realistic, it does have educational consequences. Whether these consequences were all positive was not completely clarified in the educational material, therefore, this aspect scored low.

The *directness* was considered to be high, since the assessors were able to interpret the assessment results directly. The results reflected professional standards from professional practice and were to include concepts from theory offered in the lectures, obligatory books and other professional sources. The results had to be understandable for external clients without domain-expertise. As a result, no translation from theory to practice was necessary.

The *costs and efficiency* scored favourably, mostly because the educators were present during the key presentations of the project teams to the external client. No separate assessment situations had to be organised; the assessment process was integrated into the project activities.

*6.3.4 Self-reported learning outcomes*

There were three statements in the evaluation questionnaire about the learning outcomes as experienced by the learners [see table 20].

Table 20: Self-reported learning outcomes

| Statement evaluation questionnaire, Likert-scale 1-5 | 2006 n = 125 response 26% | 2007 n = 170 response 48% |
|---|---|---|
| To what extent do you think this course has added value for the profession towards which you are educated? | 4.5 | 4.1 |
| To what extent did you gain insight into the overall process of system development? | 3.9 | 3.8 |
| To what extent did you learn how to effectively and efficiently develop systems? | 3.9 | 3.7 |

From the above data may be concluded that in both years the overall learning environment was considered effective by the learners themselves.

In 2007, one of the open questions was altered to 'What did you learn from the learning environment System Development?' This question was added to gain qualitative insight into the learning outcomes as experienced by learners. The following quotes are representative of the answers.

- ‘You learn how to apply your knowledge in a way that has added value for yourself and helps the client solve the problem’
- ‘Good and a valuable experience. Now all the things you learned during the year have to be applied’
- ‘Very good. It makes a world of difference whether the client is real or not. The possibility that the site will really be used is a big incentive’.

The above answers substantiate that the learners valued the learning outcomes that integrated knowledge, skills and attitudes and which were developed in a hybrid learning environment involving real external clients.

*6.3.5 Online websites*
In 2006, none of the external clients requested their winning project team to implement the website to go online. In 2007, three of the seven websites went online. The quality of these three websites can be considered equal to the quality of professionals working in professional practice. The three websites that went online deal with diverse topics and target-audiences:
- An interactive website for participants of pony-camps of a commercial riding school. The target group consists mainly of young girls.
- The online presentation, including an online shop, of a small, commercial business in decorative painting. The target group consists of parents and grand-parents.
- A website with an online campaign to attract new members for a charity organisation and appeal for donations. The target group consists of potential youth members.

There were two main reasons why the other websites did not go online. The first reason was that the client organisation did not want the website after all for different reasons, such as, they were not ready for maintaining an online website or they did not really need it and had only collaborated with the educational institute since it did not involve any costs. Working with real clients had as a consequence that clients could decide not to follow through.

The second reason was that the project teams of learners did not follow through to implement the websites. Often, some finishing touches had to be made or the client had additional requirements. The learning environment took place just before the summer holiday. The final or additional work would be postponed till after the holiday and consequently abandoned. This last reason was connected to the logistical aspects of a learning environment situated at an educational institute. The learning environments took place before the holiday. After the holiday, other educators were to take over, which meant that there was no continuity for external clients.

*6.3.6 Formal grades*
In the table below, the results of the formal assessments made by educators of all the participating learners are presented [see table 21].

Table 21: Formal grades

| Percentage of learners (%) | | 2006 n = 125 | 2007 n = 170 |
|---|---|---|---|
| Summative assessment 1 | | | |
| | Grade 9 | 0 | 0 |
| | Grade 8 | 13.5 | 17.1 |
| | Grade 7 | 46.5 | 51.2 |
| | Grade 6 | 31.8 | 29.5 |
| | Grade 5 and below (fail) | 8.2 | 2.3 |
| Summative assessment 2 | | | |
| | Grade 9 | 3.5 | 4.7 |
| | Grade 8 | 25.9 | 29.5 |
| | Grade 7 | 33.5 | 33.3 |
| | Grade 6 | 24.7 | 25.6 |
| | Grade 5 and below (fail) | 5.3 | 3.9 |
| | Drop-outs | 7.1 | 3.9 |

The above data show that 87.6% of the learners in 2006 and 93.1% of the learners in 2007 passed the final level of a first-year student of a University of Applied Sciences as accredited by the NVAO (2003-2009)[1]. In 2006, 12.4% of the learners were unsuccessful; they either failed (5.3%) or dropped out all together (7.1%). In 2007, 7.8% of the learners were unsuccessful.

It is our conclusion that the relatively high quality of the assessment process resulted in the intended learning outcomes and that there is a fair indication that the hybrid learning environment was effective.

## 6.4 Discussion

In this article we studied the assessment process and effectiveness of hybrid learning environments in competency-based higher education. We will now discuss the main outcomes of this study.

### *6.4.1 Effectiveness of hybrid learning environment*

From the self-reported learning outcomes, the number of online websites and the formal grades it was concluded that there is a fair indication that hybrid learning environments in higher education can be effective. The learners reported favourably on the learning outcomes, external clients were satisfied with the results, and a substantial majority of learners reached the required level of competency.

### *6.4.2 Characterise learning environment and assessment process*

We used a model of hybrid learning environments in which learning tasks are positioned along two dimensions: acquisition-participation (Sfard, 1998) and simulation-reality (Herrington et al., 2007). A salient aspect of applying this model to characterise the studied assessment process was that most of the learning tasks and the assessment of these tasks could be positioned in the participation quadrants of the model, in which learning is characterised as a situated, ongoing participatory activity, leading to the development of competencies. Assessment of competencies is a complex endeavour due to the fact that they consist of a complex integration of knowledge, skills and attitudes. In contrast, the learning tasks and the assessment of

[1] NVAO (2003-2009). *About NVAO*. Retrieved 4 June 2009, from http:// http://www.nvao.net/about-nvao.

these tasks in the acquisition quadrants of this model deal with explicit conceptual and procedural knowledge. Testing for such knowledge has a longstanding tradition in higher education. So even though assessment towards the participation quadrant is much more complex than towards acquisition, the emphasis was on these more intricate forms of assessment.

*6.4.3 Quality of the assessment process*
The assessment process was experienced as satisfactory by the learners. When we assessed the assessment process with ten quality criteria: authenticity, cognitive complexity, meaningfulness, fairness, transparency, educational consequences, directness, reproducibility of decisions, comparability and costs and efficiency, we found that the assessment process was of relatively high quality.

Notably, the criterion of 'costs and efficiency' scored favourably, since gathering key input for the assessment process was integrated into the presentations given to the external client. Educators in schools are concerned that assessing competencies will be too expensive and too time-consuming (Baartman et al., 2007). Our study showed that competency assessment can be carried efficiently and effectively in a large-scale learning environment.

During the process of using the quality criteria, it was found that the quality criteria were applicable and easy to use. The set of quality criteria complemented the descriptive model of hybrid learning environments to position different elements of the assessment process very well.

*6.4.4 Suggestions for educational practice*
We have the following suggestions to improve the assessment process and therefore the related learning outcomes of hybrid learning environments. The transparency of the assessment could be increased by providing clear criteria in the educational material. These criteria could include explicit criteria for the application of conceptual knowledge, which would also help to strengthen the aspect of cognitive complexity. The quality of the reproducibility could be increased by involving an outside assessor. If this assessor would have specific domain-expertise, the assessment meetings could include assessing conceptual and theoretical aspects. Alternatively, indirect methods such as a knowledge test could be included, following the suggestion of Baartman et al. (2006) to integrate different assessment methods.

*6.4.5 Future research*
Though the conclusions presented in this article were based on data collected from a large-scale educational setting involving many learners, the data came from one case-study. More thorough research is needed into the assessment processes and effectiveness of hybrid learning environments in competency-based higher education. The model of hybrid learning environments as applied in this study proved to be complementary to the set of quality criteria. It helped to further differentiate the different elements of the assessment process by positioning them on the dimensions of acquisition-participation and simulation-reality. The complementary model could therefore play a role in future, broader research.

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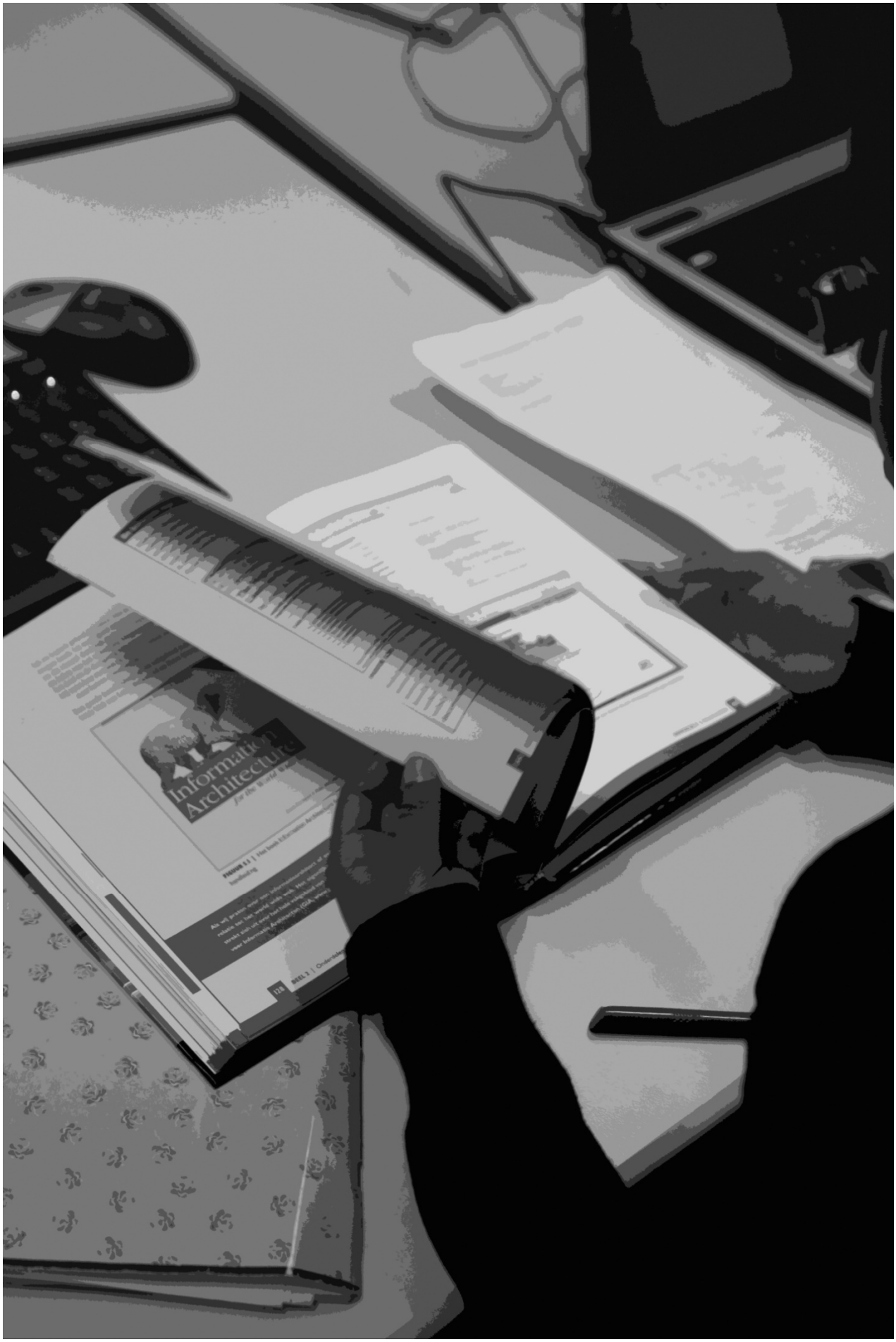
Information
Architecture

# Chapter 7
# Discussion

## 7.1 Introduction

> 2006 - It was the first time the external client came to institute for higher professional education. She has a small business enterprise and prepared a presentation to brief the learners. The learners were expected to prepare questions for the client. The teacher introduced the client and she briefed the learners about her problem. She wanted to start a new business and needed a website to attract customers. Then it was time for the learners to ask their questions. Only one or two questions were asked. The silence was slightly awkward.
>
> 2007 – It was the first time the external client came to the educational institute. She has a small business enterprise for which she would like to attract more customers with a professional website. The teacher introduced the client. Each project-team had prepared a mood board. A mood board is a professional object to articulate initial design ideas. Each project team presented their mood board to the client, which helped engage the client in a dialogue and to gain insight into the client's perspective. Two teachers and a senior peer, a second-year learner, attended the meetings. Afterwards, they gave feedback to each project-team.

The above scenarios sketched the focus of our research: learning environments in higher professional education situated in schools that are project-based and in which learners have to work on real problems. In the 2006-scenario, learners were expected to prepare questions for the first meeting with the external client. Observations showed that learners had trouble to engage the client in dialogue. In the 2007-scenario, an object from professional practice was introduced to facilitate the interaction between learners and the client. Collaborative articulation of the ideas in a concrete object helped learners to cross the boundary to the client domain. Learners were able to merge their own perspective with the perspective of the client like a true professional. How did we study the above learning environments? Which perspectives did we use? What results did we find? In this final chapter, we present our conclusions and discuss the research we carried out. We discuss the theoretical approach, the methodological approach, future research, and the practical implications.

## 7.2 Conclusions

Designing authentic, project-based learning environments is far from clear-cut yet and can be a difficult task for teachers. The research question driving our research was: How can we design and improve project-based, ICT-supported learning environments in higher professional education? It was our aim to find valuable pieces of the design-puzzle in current literature and integrate these pieces. We intended to complement current insights with inventive insights from an explicit design perspective by carrying out empirical studies.

We now summarise our conclusions by reintroducing the CIMO-logic (Denyer, Tranfield & Van Aken, 2008) as explained in the first chapter: a tool to structure applied knowledge that can be used to solve a problem. The CIMO-logic consists of the following elements. There is a *context* in which a *problem* can be identified. An

*intervention* is the proposed solution to the identified problem. This intervention triggers processes or *mechanisms*, like for example, different behaviour of the participants involved. Through these mechanisms, the desired *outcomes* or goals are produced.

At the start of our research, we formulated a broad description of the problematic context we intended to study, the proposed solution, the mechanisms and the intended outcomes. The context we intended to study was higher professional education facing various challenges, such as, a larger and more diverse learner population and appeals from society and industry to educate learners towards becoming suitable professionals. The intervention or proposed solution was a hybrid learning environment: a project-based, ICT-supported learning environment situated in a school with characteristics of workplace learning. The five mechanisms or processes this intervention should activate were identified from current literature: (1) use expert performances; (2) enact multiple roles and apply multiple perspectives; (3) collaboratively construct knowledge; (4) reflect to enable abstractions; and (5) articulate to enable tacit knowledge to be made explicit. The intended learning outcomes were learners developing competencies which contribute towards becoming an employable professional with suitable competencies. As defined in the first chapter we focused our research on the intervention and the mechanisms.

The above CIMO-logic functioned as the broad working hypothesis formulated from a design perspective. We will now present the conclusions of our research, structured according to the same CIMO-logic.

### *7.1.1 Problematic Context*

The following research questions were relevant in relation to the context:

- How can we characterise the designs of learning environments in current higher education, consisting of spaces, artifacts and events, on a dimension with on the one end 'specified' and on the other end 'open'.
- What problems can be identified when a learning environment is carried out?

We answered the above questions in a generic way, by studying three different contexts in higher professional education. These contexts were all problematic in the way described above. Besides, in each context, contextual problems were identified. These contextual problems were identified from two perspectives: the domain perspective and the educational perspective.

The first context was positioned in the healthcare domain, and specifically, those areas of the healthcare domain that need the collaborative effort of healthcare professionals from different professions to achieve suitable treatment and care of patients. In this case, doctors, nurses, physiotherapists and speech therapists were involved in the treatment and care of patients suffering from a stroke. From an educational perspective, we were dealing with a relatively small number of learners (approximately 30) from four different educational programs, from different study years. The course in question was an elective course with a duration of eight weeks. The combination of the aspects of the healthcare domain and the educational aspects determined the available room to manoeuvre. When designing a hybrid learning environment to suit this particular context, a number of restrictions had to be taken into account: costs, technical limitations, avoidance of danger, ethics, psychometric requirements and time constraints. Involving real patients was not

possible in this context, since there was limited budget, limited time and danger had to be avoided to offer the learners involved a safe learning environment.

The second context was positioned in the digital communication domain and specifically the design, development and implementation of a website. From an educational perspective, we were dealing with a large number of learners (approximately 145) from one educational program. The course was an obligatory course for first-year learners. In this domain, there were less restrictions in comparison to the healthcare domain. Offering real problems to learners was possible in this context. The teachers had access to a large pool of potential external clients willing to collaborate. From an educational perspective, this context also faced challenges. While in the previous context, four different educational programs provided the main challenge, in this context, accommodating the large learner population was the main challenge.

The third context was positioned in the domain of urban development. From an educational perspective, we were dealing with a relatively small number or learners (approximately 25). The learners were from various educational programs. The course was an elective minor with a duration of six month for third-year learners. They could choose this course as an alternative to a trainee assignment. The learning environment in this context had to be equivalent to a trainee assignment in professional practice. In this context, the variety of educational domains, the relatively long period of six months and providing a learning experience equivalent to a work placement, were the main challenges.

Besides the above general and contextual problems, we also identified three specific problems. These specific problems are related to the *hybrid* nature of the learning environment in different ways. The first problem was to match the open, realistic problems with the specified learning goals that learners expected to achieve. For learners it was difficult to take the initiative to adjust either their goals or the learning environment to suit their own learning requirements. For teachers it was difficult to acquire external projects that would be a better match with the learning goals or make clear that learners could take the initiative to adjust a project to suit their own learning goals. The second problem is closely related to the previous problem. Learners experienced problems with the reality of open elements, which in their opinion collided with the stricter, specified elements. In the second case, for example, the deadlines for handing in (intermediary) results were specified in advance by the teachers and were very strict. At the same time, project teams had to deal with an external client, who often took her time to react and give feedback. The third problem we identified is that learners experienced problems with connecting what was learned in specified elements, such as, lectures or the self-study of obligatory books, and apply it in open elements, e.g. the delivery of an intermediary result for an external client. The fourth problem is that learners experienced difficulties in switching from the guided role enacted in the specified parts of the environment, to an initiating role required in the open parts of the environment.

In the next section, the intervention, namely, the studied hybrid learning environments that had to respond to the above contextual challenges will be discussed.

*7.1.2 Intervention*
We started our research with a broad proposed solution, namely, a hybrid learning environment: a project-based, ICT-supported learning environment situated in a school with characteristics of workplace learning. To characterise the above intervention, we formulated the following research questions:

1. How can we characterise the designs of learning environments in current higher education, consisting of spaces, artifacts and events, on a dimension with on the one end 'specified' and on the other end 'open'? [chapter 2]
2. Which task conceptualisation will facilitate the (re)design of (e)learning environments in higher education with the help of design patterns? [chapter 3]
3. How to design hybrid interprofessional education? [chapter 4].

The research has resulted in a compact design model to make generic concepts of the intervention explicit [see chapters 3-6]. We will first discuss the different elements of this design model. The intervention was also studied at a more detailed level, focusing on the instrumental perspective. The conclusions from the instrumental perspective are presented next.

*Design model of the intervention.* This design model of a hybrid learning environment consists of the following elements:

1. Designable elements positioned on the dimension of specified-open.
2. Learning tasks as basic building blocks of a learning environment.
3. Four quadrants to position learning tasks.
4. Four analytical perspectives.

*1. Designable elements*. A hybrid learning environment consists of designable elements, namely, spaces, artifacts and events. These designable elements can be specified by teachers or they can be less specified in advance and left open [chapter 2].

*2. Four quadrants*. Learning tasks are seen as the basic building blocks of a learning environment [chapter 3]. Learning tasks can be positioned across two dimensions: acquisition-participation (Sfard, 1998) and simulation-reality (Herrington, Reeves & Oliver, 2007). The first dimension has on one side the knowledge acquisition metaphor, in which knowledge is considered as commodity that can be acquired, transferred and shared with others. On the other side is the participation metaphor, characterising learning as becoming a member of a professional community. The second dimension is simulation-reality. This dimension characterises how realistic learning tasks are. Simulated settings are characterised as a low-fidelity. They are situated in educational settings and the rich reality of professional practice is reproduced. Moving towards the reality-side of this dimension, simulations can become much more advanced and high-fidelity, for example, involving immersive technology or a patient simulator closely resembling a real patient. Realistic settings closely mirror the real professional context. In such settings, learners are immersed in real problems from actual professional practice. These two aspects have resulted in four quadrants: acquisition/simulation (e.g. lectures applicable to realistic problems), acquisition/reality (e.g. access to professionals or professional practice), participation/simulation (e.g. group assignments) and participation/reality (e.g. work on a result for an external client) [chapter 4].

*3. Four analytical perspectives.* To start with, we studied the designable elements at the level of the learning environment [chapter 2]. Next, we studied these elements more closely at the level of learning tasks [chapter 3]. Finally, they were reinterpreted as four analytical perspectives [chapter 4]. These perspectives are: (1) the agency perspective to study the roles enacted by participants; (2) the spatial perspective to study the physical and digital spaces; (3) the temporal perspective to study the timeframe; and (4) the instrumental perspective to study professional objects functioning as boundary objects.

*Focus on instrumental perspective: professional objects.* After studying the intervention at the level of the learning environment, we focused on the instrumental perspective. From an instrumental perspective, we studied the professional objects which had been introduced into the hybrid learning environment. From our studies we have concluded that this point of view could add relevant insights to current literature. More importantly, the activities in the practice stream of our research [chapter 1, figure 1] showed that focusing on these objects offered feasible opportunities for quick wins to improve existing learning environments, which were within the scope of the teachers involved. We therefore also focused on these objects in the research stream [chapter 5]. Professional objects that facilitate the interaction between actors with different roles and help to join dissimilar information, function as boundary objects. We identified the features of such objects, namely, the three remaining analytical perspectives (agency, spatial and temporal). We connected these features to the five authentic mechanisms identified from literature.

We now turn to the mechanisms that are expected to be activated by the studied intervention, the hybrid learning environment which was characterised in detail in the above section.

### *7.1.3 Mechanisms*

From literature, we identified five authentic mechanisms from literature (Herrington & Herrington, 2006) that might play a role in hybrid learning environments. In our studies, we focused on how professional objects within hybrid learning environments are connected to activating the mentioned mechanisms. For studying the mechanisms, the following research questions were formulated [chapter 5]:

1. How do professional objects function as boundary objects and which role do they play in activating authentic mechanisms?
2. How was the technology enhancing the learning environment used in relation to these objects?

Our data showed that the studied professional objects were instrumental in all four quadrants of the learning environment. It is therefore our conclusion that professional objects indeed have the potential to connect learning tasks from different quadrants, thereby addressing some of the specific problems as described in section 7.1.2.

We carried out a feature analysis, to identify the features or attributes of professional objects in hybrid learning environments. These objects themselves represent the instrumental perspective, the three remaining perspectives (agency, spatial and temporal) were used to identify the features. The objects were handled in nine different spaces (spatial perspective), and we were able to identify two different time-frames (temporal perspective). We were able to identify eighteen roles which were

involved in handling the studied professional objects (agency perspective). These roles were enacted in the professional community, the client domain and in the educational community. We therefore concluded that professional objects have the potential to function as boundary objects, since they can facilitate the interaction between actors enacting different roles, from different communities.

The above features were consequently connected to the five authentic mechanisms. These connections between the features and the authentic mechanisms were substantiated by our research. It is our conclusion that there are many features that helped to activate the mechanism of 'articulate Articulate to enable tacit knowledge to be made explicit' and 'use expert performances and the modelling of processes'. Our research showed that few features are connected with the mechanisms of 'enact multiple roles and apply multiple perspectives'; 'collaboratively construct knowledge'; and 'Reflect to enable abstractions to be formed'. It was our conclusion that the professional objects helped learners to produce results and offered guidance to learners. Furthermore, the data showed that the professional objects helped to contextualise the learning environments situated at schools. In summary, the studied professional objects activated the following mechanisms:

- The five authentic mechanisms identified from literature.
- Potential independence of learners by offering guidance.
- Contextualising learning environments situated at schools.

The implications of the above for educational practice will be discussed in the last section of this chapter. In the last phase of our research, we turned to the intended outcomes of hybrid learning environments, namely the learning outcomes [chapter 6]. The conclusions related to the outcomes are discussed in the next section.

*7.1.4 Outcomes*

There is a strong relationship between learning, learning outcomes and assessment. We therefore also studied the assessment process of hybrid learning environments. The research questions formulated in relation to the outcomes were:

1. How can the assessment process of a hybrid learning environment be characterised?
2. How effective is a hybrid learning environment?

We determined the quality of the assessment process and used a number of effect measures to get an indication of the effectiveness of hybrid learning environments.

We used ten quality criteria to determine the quality of the assessment process (Baartman, Bastiaens, Kirschner & Van Vleuten ,2006): (1) Authenticity, (2) Cognitive complexity, (3) Meaningfulness, (4) Fairness, (5) Transparency, (6) educational consequences, (7) Directness, (8) Reproducibility of decisions, (9) Comparability and (10) Costs and efficiency.

The quality of the assessment process as measured is considered as relatively high. The assessment process scored medium to high on all but one criteria (scores 3-5). The criterion of 'educational consequences' scored low (score 1). The external client played a key-role in the assessment process. As a result, it could be expected that learners would give priority to all client-related activities. Though this is highly realistic, it does have educational consequences. This aspect is at the heart of the hybrid learning environments we studied. It was our conclusion that educators need

to stay alert to these consequences for the assessment process and compensate for them when necessary.

To get an indication of the effectiveness, a number of effect measures was used; self-reported learning outcomes, the amount of websites that went online and the formal grades. The learners reported favourably on the learning outcomes, external clients were satisfied with the results and a substantial majority of learners reached the required level of competency. From these data sources we can conclude that there is a fair indication that hybrid learning environments might be effective.

### *7.1.5 Design guidance*

The above presented conclusions have been based on the broad CIMO-logic used as the working hypothesis at the start of our research. Conclusions for each aspect of the studied CIMO-logic were presented in the previous sections. We also generated design guidance from our analyses. This design guidance can also be structured according to the CIMO-logic, only at a lower, more detailed level. The generated design guidance formulated as detailed CIMO-logic will be presented in the section 'practical implications of the research'.

## 7.2 Discussion of the theoretical approach

### *7.2.1 Integrated view on learning*

The focus of this research was on the role professional objects play in learning environments. In the socio-cultural approach to learning, learners do not just accumulate knowledge, but rather participate in activities that are distributed among the individuals, tools and artifacts of a community. The socio-cultural perspective helped to enrich our analyses, which would otherwise be inclined to remain superficial studies of tools and instruments. Closely related to the socio-cultural approach to learning is the concept of authentic learning which we adopted. Simons, Van der Linden & Duffy (2000) state that many instances of school learning are not authentic enough since they are too decontextualised and that many improvements can and should be made as to the contextualisation of school learning. This perspective offered a view on how the objects we studied could contribute towards contextualising learning environments situated at schools.

The downside of choosing a socio-cultural perspective on learning is that one almost automatically ignores more cognitive approaches, in which learning is seen as a more individual form of knowledge construction. Therefore, it was important to stay alert and not only perceive learning as a social phenomenon which should occur in rich social and physical environments, but also keep taking the individual cognition into account. We explicitly took an integrated point of view, bridging cognitive and socio-cultural approaches instead of dichotomising them. This integrated view is demonstrated by the nature of our model. In this model, we deliberately included the dimension of acquisition-participation. This dimension corresponds to cognitive and socio-cultural approaches to learning, which we think both play a role in current higher education. As such, the integrated view provided us with a multifaceted perspective on the intricate process of learning.

*7.2.2 Studying the concept of 'context'*

A learning environment is seen as the context of the studied learning activities. But what do we study when we say 'context'? Dourish (2004) states that context can be seen as more delineable and stable or it can be seen as interactional. In the interactional perspective, whether something is context or not, depends if it is contextually relevant to a specific activity. Also, context is not just present, it has to be actively produced, maintained and enacted. In our research, we operationalised the interactional perspective.

We identified the contextual features of the objects we studied, namely, role, physical and digital spaces, and timeframe. Though these contextual features can be designed in advance, they are considered as dynamic in nature. It is expected that they change and develop when a learning environment is in action. The relativity of the interactional perspective is difficult to match with the perspective of explicitly designing a learning environment as a context for intended activities. We do think that the above operationalisation contributes to making this match. Additionally, acknowledging that an intervention is not directly connected to outcomes, but that outcomes have to be reached through the activation of mechanisms, also helps. Designing an intervention is within one's span of control, full control of mechanisms is outside of one's control. The mechanisms as studied by us include the above interactional perspective. Part of a mechanism can be seen as participants perceiving contextual relevance or actively producing, maintaining and enacting a specific context.

The operationalisation of the contextual features of the objects we studied in combination with the concept of the mechanisms, provides a concrete way to study context from the interactional perspective, which could also be useful contextual research.

*7.2.3 Studying the concept of 'boundary objects'*

At the start of our research we chose for the concept of 'mediating artifacts': all types of artifacts that were instrumental during interaction between the participants. However, when designing, making the design object as specific as possible made designing easier. That is also why the intervention-part of the CIMO-logic in section 7.1 was so elaborate. We therefore started by focusing on professional objects instead of all artifacts. These objects have a more specific function during interaction, since they function as tools and (intermediary) deliverables and reflect professional standards of the domain in question. What's more, we focused on the function of boundary object: objects that facilitate coordination, alignment and integration of the various activities of participants with different roles and viewpoints. In hybrid learning environments, multiple roles and viewpoints are present, such as, senior professional and junior professional, inside the school and the outside professional practice, the professional domain and the client domain, domain-expert and domain-novice. Boundary objects help to cross the boundaries as experienced by participants with these different roles and can be instrumental in integrating multiple viewpoints. As such, the concept of boundary objects provided a focal point in our research, which could also be promising for other studies.

## 7.3 Discussion of the methodological approach

### *7.3.1 Balancing three perspectives[*]*

In the introduction, we introduced two interwoven streams of inquiry (Andriessen, 2007, the practice stream and the knowledge stream in which our case studies have been positioned [chapter 1]. During our research, we identified three perspectives, which we found needed careful balancing: (1) research perspective, (2) design perspective, and (3) change perspective. Recognising these perspectives, allows to pinpoint to their mutually enriching, but more so to their conflicting nature.

Tension may arise because of the different main focus of each of the three perspectives, namely, a research question (research perspective), the design problem (design perspective) and the local educational setting (change perspective). Traditionally, researchers tend to study single aspects at the time, while educational settings form a systemic whole. The main focus of the change process, the local educational setting, is a rich and complex setting. There is a trade-off between the rich reality and the experimental control that might be preferred from a research perspective. We faced this type of tension in our research as demonstrated by the following example. The concept of the 'authentic task' was a crucial concept in the research process, from a research perspective. However, in the educational setting, there were also problems with the self-reflection activities of learners and with the currently used, main book. Therefore, to account for the experienced problems, redesigned self-reflection tasks were introduced in the second design iteration, and the current book was replaced with a new book. From both the design and change perspective, the latter actions made sense. The actions were intended to respond to the local educational setting, but were interfering with the research perspective.

Tension may also arise from the differences in methods and tools of the three perspectives. The research process is mediated by systematic research methods, while design processes often show chaotic design activities. This tension also occurred in our research. Some crucial decisions were taken much too fast by the collaborating practitioners in the design process, making it hard to verify the consequences thoroughly from a research perspective.

The perspectives also turned out to have added value for each other. To increase the quality of the data that was collected, the design and change perspective were used to their advantage. We aimed to study a specific type of design of a learning environment. When searching for cases, we looked for best-practice examples of such designs. We were able to compare enacted designs with a theoretical design in the form of our model. The enacted designs provided rich, inspirational additional information to feed the theoretical design. The design perspective helped to enrich the research perspective. To help insure that a design would be enacted properly,

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∗ This section is based on: Zitter, I. (2007, June). *Educational Design Research, A bridge to far? A crossover scenario to bridge the gap between applied research and design research.* Symposium at the Onderwijs Research Dagen (ORD), Groningen, The Netherlands; Zitter, I., Akkerman, S.F., & De Bruijn, E. (2008, June). *The quest for usable knowledge: the delicate balance between research, design and change*. Fire hose presentation at the International Conference for the Learning Sciences (ICLS), Utrecht, The Netherlands.

much effort had to be invested from the change perspective. The educational contexts were carefully selected and consequently deliberately nurtured to ease the enactment of the changes which were made to the existing learning environment. Relations with key participating teachers were developed and maintained, while also fostering commitment of the other teachers. These aspects were part of the change perspective and helped to ensure that a design was properly enacted in the real-life context. These extensive investments from the change perspective lead to properly enacted designs. These properly enacted designs yielded high quality data. In this way, the change perspective helped to increase the quality from a research perspective.

The three perspectives we identified add more detail and depth to the distinction between research and practice which is usually made. The research perspective is in line with the research aspects of current literature. For practice, we identified two distinct perspectives: design and change. Experience with our research showed that clarifying these three distinctive perspectives and using them to identify potential tension and enrichment, enabled us to anticipate and plan accordingly. Additionally, in the separate phases of the research, a single perspective was taken as focus. For example, in the first phase, an explorative research perspective, while in the subsequent phase, the design perspective was more dominant. By planning and working explicitly from the three different perspectives, the understanding between us and the other participants developed. We were able to actively pursue compromises and advantages, which in the end resulted in a delicate balance in our quest to find usable scientific knowledge for educational practice.

*7.3.2 CIMO-logic and domain-independent model of design processes*
At the start of this research, we introduced the CIMO-logic (Denyer et al., 2008) and a domain-independent model of design processes (Reyman, 2001; Reymen, Hammer, Kroes, Van Aken, Drost, Bax & Basten, 2006). Both models are from the design science research domain and were introduced to make the different aspects of our design perspective explicit.

In the course of the research, especially during the extensive peer debriefings, it became clear that the terminology of the domain-independent model did not facilitate interaction. The various design-terms turned out to be too foreign in the educational domain. The CIMO-logic, on the other hand, did facilitate to communicate the design perspective taken in this research. The concepts of the CIMO-logic did come across the boundary of the design sciences. The concepts of the CIMO-logic could easily be translated into concepts of the educational domain, like the curriculum perspectives of Van den Akker (2003), as explained in section 1.3.

Though the CIMO-logic helped to make the design perspective explicit, it does have a drawback. The domain-independent model explicitly includes a dynamic view and conceptualises the iterative nature of design activities. This iterative nature is also acknowledged in the educational domain, for example, by The Design-Based Research Collective (2003) and Van den Akker, Gravemeijer, McKenney, & Nieveen (2006). The clear conceptualisation in the domain-independent model could therefore be useful for systematic educational design research.

Another model which could in our opinion be highly useful is the process model of theory-practice linkages of Tenkasi & Hay (2004). This model formalizes the links

which have to be made between the knowledge and the practice streams introduced in section 1.6. We used the concepts from the domain-independent model and the process-model of theory-practice linkages throughout our research, though they were kept implicit in the written texts. We do however advocate the use of formal design models when conducting educational research from a design perspective.

*7.3.3 Quality and limitations of the research*
We conducted the research from a naturalistic paradigm (Guba, 1981). In this paradigm it is assumed that there are multiple, interrelated realities, in which variables cannot be singled out for study or control. Also, this paradigm acknowledges that the inquirer and the respondents are interrelated, with each influencing the other. Lastly, this 'paradigm rests on the assumption that generalisations are not possible, that at best what one can hope for "working hypotheses" that relate to a particular context'. These working hypotheses are similar to the CIMO-logic we have used throughout this research.

*Measures to increase the trustworthiness.* To increase the quality of our research, we used a number of measures: triangulation, prolonged engagement at a site, persistent observation, peer debriefing and reflexivity, member checks, and collect thick descriptive data and develop thick descriptions. These measures can be related to the three main stages of the research process: data collection, data analysis and data interpretation.

The researcher collected all the data alone, since it was not feasible to include other researchers in the prolonged presence at sites and the rich data that was collected. As countermeasures we used triangulation, prolonged engagement, persistent observations and the collection of thick descriptive data. These measures can be considered as complementary to the extensive investments from the change perspective, which were taken to lead to properly enacted designs, in turn yielding high quality data (see previous section). A salient aspect of the collected data is that making photos played a crucial role. By systematically taking photos, rich data was collected about how objects were used within a specific context. These photos can be considered as an example of the thick descriptive data we collected throughout this research. The use of a wide range of measures to increase the trustworthiness, in combination with the investments from the change perspective, are an indication that the quality of the data collection is satisfactory.

The quality of the data analysis was increased by the measures of peer debriefing, reflexivity and member checks. The open communication with practitioners, educational experts and researchers throughout the process of data analysis was combined with systematically applying the CIMO-logic. These two aspects helped with the credibility of our research.

The development of thick descriptions and the use of the CIMO-logic are related to the process of data interpretation. It is up to the target audience to judge whether the results are applicable to their problematic context. There was ample confirmation from the target audience that the results are potentially very useful. So, though the presented results may be highly ecologically valid, the overall generalisability of the results is modest.

*Limitations of the research*. Though we have strictly adhered to a variety of measures to increase the trustworthiness of this naturalistic inquiry and have increased the quality of the collected data by taking advantage of the design and change perspective, the presented research has specific limitations. We studied three educational contexts which are a limited representation of educational reality. Focusing on the intervention and the mechanisms involved collecting a huge amount of qualitative data, which meant that we collected limited data about the outcomes of the studied interventions. Therefore, we are unable to draw solid conclusions about the effectiveness of the studied interventions.

## 7.4 Future research

We carried out in-depth, qualitative research with a design perspective into project-based, ICT-supported learning environments in higher education. Future research is needed to further develop the insights we presented. A broader variety of professional objects should be examined. Also, the activated mechanisms need to be systematically studied. Measuring instruments would have to be developed or taken from current literature to measure whether and to what intensity the authentic mechanisms would be activated. These studies could lead to a typology of objects in relation to the mechanisms they activate. Next, the typology could be validated in a systematic way, for example, by applying a quasi-experimental research method. Such research would include different interventions, for example, interventions with no explicit attention to objects versus interventions with different objects. Such research could lead to solid, concrete evidence about the relation between types of objects and activated mechanisms and be highly useful for daily educational practice.

Furthermore, future research is needed about the intended outcomes of the studied interventions. Though the results we presented gave an indication about the outcomes, more solid research is necessary. An important feature of the intended outcomes is that they should be transferable, learners should be able to display the developed competencies in different contexts. Future research could be aimed at finding out whether competencies developed in hybrid learning environments are indeed applicable in multiple contexts.

## 7.5 Practical implications of the research

In the last section of this chapter we discuss the practical implications of our research.

### *7.5.1 Hybrid nature of studied learning environments*

We planned to study a hybrid form of learning in which learning takes place at school and is intentionally planned and at the same time has many characteristics of learning in the workplace. The real problems learners were working on in the studied hybrid learning environments, were supplied by professional practice. However, there was no automatic match between these real problems and the learning goals [chapter 2]. Also, learners tended to give priority to working on results of the external clients over other results, which resulted in unforeseen educational consequences in the assessment process [chapter 6].

Learners also experienced difficulties in switching from an acquisitional and simulated mode, in which they were expected to follow directions more strictly, to a

participative and realistic mode, in which the initiative was in their own hands [chapter 4]. In learning environments which are not hybrid and only have characteristics of learning at school or learning in the workplace, there is no need to deal with the difficulties of integrating different elements of a hybrid nature. A practical implication is that teachers have to be alert to the fact that learning in the workplace is very different from purely learning in schools. When introducing workplace characteristics into a learning environment situated at school, suitable translation is necessary and explicit connections need to be made. Otherwise, no real hybrid learning environment will be created, but will only confusion from the workplace be introduced into a learning environment at school.

*7.5.2 Design guidance structured with CIMO-logic*

We generated design guidance from our analyses. This design guidance can also be structured according to the CIMO-logic. We now present four specific design guidelines: Adaptive designable elements [chapter 2], Introduce primary boundary objects at the start of a project [chapter 3], Connect to an outside online community [chapter 3], Resist two opposite forces in a hybrid learning environment [chapter 4].

Table 22: Design guidance structured with CIMO-logic

| Adaptive designable elements | |
|---|---|
| Context | Hybrid learning environments with specific problems are related to the hybrid nature of the learning environment: difficulties with matching open problems with specified learning goals; collisions between reality of open elements with intentional specified elements; difficulties with switching roles and difficulties with connecting what is learned in specified in open elements. |
| Intervention | Design adaptive designable elements: these elements differ from specified and open elements. Specified elements are specified in advance and are expected to be used as specified. Open elements are deliberately left open and are expected to be jointly developed by learners during interaction. Adaptive elements allow all participants, not just the teachers, to specify them when needed and to the level of specificity that is needed. |
| Mechanisms | Adaptive designable elements can be adapted by participants. Educators, (senior) learners and external participants can adapt elements by specifying them for to become suitable for their own use or for the use of others. |
| Outcomes | The intended learning outcomes were learners developing competencies which contribute towards becoming an employable professional with transferable knowledge and learning-, thinking-, collaboration- and regulation-skills. |

Table 23: Design guidance structured with CIMO-logic

| Introduce primary boundary objects at the start of a project | |
|---|---|
| Context | At the start of a project, learners often experience difficulties in getting started and growing into their (team) roles. |
| Intervention | Try to capture the advantages of primary boundary objects, which are often planned later in a projects, and move them to the start of a project. A primary objects is a (technological) artifact which has the focus of a project, for example, a website developed for an external client. |
| Mechanisms | 1. Learners tend to like working on more concrete primary objects, which helps them to get started<br>2. Learners experience primary objects as easier to work on, which helps learners to work independently, also at the start of a project<br>3. Primary objects tend to elicit collaborative effort, which helps learners to grow into their (team) roles<br>4. Primary objects tend to ease interaction with external clients, which may lead to more lively and productive interaction at the start of a project |
| Outcomes | Same as in table 22. |

Table 24: Design guidance structured with CIMO-logic

| Connect to an outside online community | |
|---|---|
| Context | Students often get stuck when working on detailed, precise or specific aspects of a project, e.g, the technical aspects of developing a website. Teachers are not always able to keep up with the latest developments. Teachers experience that their authority is negatively affected, since they are not able to provide adequate support. |
| Intervention | Explicitly connect to an outside, online community. A well organised online community is required. Such communities can be located by making an explicit choice for a tool to support the working process. For example, an open source tool could be made obligatory as a working tool, since these tools tend to have a well established online community. Accompanying informative events need to guide learners to high quality online resources and familiarise them with the outside, online community. |
| Mechanisms | Both to facilitate the working and learning process of learners and to relieve teachers of having to be(come) experts on everything. Learners tend to be quite capable of tapping into online resources. By focusing such effort on interaction with a professional online community, learners can find support to help them solve detailed problems. They could also interact with more and different role models besides their teachers enacting the role of senior professional. |
| Outcomes | Same as in table 22. |

Table 25: Design guidance structured with CIMO-logic

| Resist two opposite forces in a hybrid learning environment | |
|---|---|
| Context | Two forces can be distinguished in hybrid learning environments. One force is pulling towards the simulated/acquisitional quadrant, with comfortable, more traditional roles and easy to organise learning tasks. The other force pulls towards the realistic/participative quadrant, towards learning outcomes needed by employable professionals. |
| Intervention | Design clear and consistent tasks:<br>▪ Make transitions between acquisitional and participative roles clear.<br>▪ Since hybrid learning environments are situated at schools, they miss the rich reality of professional practice. The contextual and temporal clues which are needed to solve the realistic problem, need to be compensated or simulated clearly.<br>▪ Connect acquisitional and participative learning tasks by selecting objects from professional practice that can function as boundary objects. |
| Mechanisms | Clear and consistent tasks:<br>▪ Help learners to adjust to the role they are expected to enact.<br>▪ Use compensated or simulated contextual and temporal clues to facilitate interaction.<br>▪ Use the selected professional objects as powerful tools to facilitate interaction. |
| Outcomes | Same as in table 22. |

*7.5.3 Applying the research results*

The research presented in this thesis already had many practical implications in different forms. The research was carried out in close collaboration with teachers from different educational contexts. The interaction with these teachers during the research provided them with new insights and incited them to make improvements to their learning environments. During the research process, presentations and workshops were given of intermediary results. It should be noted, that there was certainly not just one-way interaction. Interaction with educational practice provided crucial input for our research.

The research results can be used in different ways. The rich descriptions can be used to compare existing learning environments with the studied environments. They can be used to gain new insights and maybe inspire feasible changes. The model we introduced, is complementary to established educational models. It can be used to systematically analyse existing learning environments. By positioning learning tasks, including the assessment processes, in the four quadrants, efforts can be focused on those areas that need extra attention.

The different elements of the CIMO-logic and the more detailed design guidelines in CIMO-logic help to decide whether the presented results are suitable for a specific educational context.

The identified features of the objects and their connections with authentic mechanisms can also be useful. Teachers can identify the objects they have chosen

from professional practice and determine whether they have the potential to function as boundary objects, activate the authentic mechanisms, provide guidance and contribute to contextualisation. Choosing and deploying different objects from professional practice is highly feasible in any educational context. This process takes place at the level of a single learning environment and is within the scope of single teachers. The process of choosing suitable objects from professional practice might also be instrumental in the interaction between teachers and professionals. Our focus on objects which may function as boundary objects provides a very concrete starting point for teachers to make feasible improvements to existing learning environments. Since the objects are instrumental towards reaching (intermediary) results, they will also be closely monitored and formatively and summatively assessed. Determining whether the chosen objects were indeed effective is therefore integrated into the process of guiding and assessing learners.

### *7.5.4 Closing remarks*

The research questions and methodology chosen for this research project were explicitly meant to develop knowledge that would be relevant and applicable in educational practice. The presented research results indicate that this goal has been met. At the same time, the current form is not optimal for practitioners. The results are presented in terms of scientific articles. A translation for practitioners, with more concrete and explanatory examples, would be more suitable for educational practice. Interactive presentation of the results, preferably in the form of workshops during which the teachers can discuss their own cases, could potentially be even more effective. Nevertheless, the design perspective we used, including the use of models, textual and graphical representations and the CIMO-logic, make this research solution driven. Therefore, after translation, this research certainly has the potential to be applied by practitioners.

## 7.6 References


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# Nederlandse Samenvatting

## 1.1 Inleiding

Dit proefschrift bestaat uit zeven hoofstukken: een introductie- en een discussiehoofdstuk en vijf hoofdstukken in de vorm van wetenschappelijke artikelen. In dit hoofdstuk is een korte Nederlandse samenvatting te vinden van de hoofdstukken. De leeromgevingen die hebben geparticipeerd in dit onderzoek worden éénmalig samengevat in een tabel, als onderdeel van paragraaf 1.2.

## 1.2 Samenvatting van Introductie [H1]

Er wordt van het hoger (beroeps)onderwijs verwacht dat er competente en levenslang lerende beroepsbeoefenaren worden opgeleid. Van het (beroeps)onderwijs wordt verwacht lerenden te helpen om flexibele, direct inzetbare professionals te worden (Baartman, Bastiaens, Kirschner & Van Vleuten, 2007). Professionals die beschikken over duurzame, flexibele, functionele, betekenisvolle, generaliseerbare en toepassingsgerichte kennis. Daarnaast wordt naar vaardigheden gestreefd die een algemener karakter en een bredere reikwijdte hebben: vaardigheden rond leren leren, denkstrategieën, samenwerkingsvaardigheden en regulatievaardigheden (Simons, Van der Linden & Duffy, 2000). Deze verwachtingen stellen hoge eisen aan de leeromgevingen in het hoger (beroeps)onderwijs. Onderwijsonderzoek moet een bijdrage leveren aan de onderwijspraktijk in de vorm van systematische ontwerpkennis waarmee de praktijk uit de voeten kan. Met een ontwerpbril hebben we gezocht naar ontwerpmodellen en ontwerplogica, waarmee leeromgevingen in het hoger (beroeps)onderwijs kunnen worden vorm gegeven.

In dit onderzoek is ervoor gekozen om gebruik te maken van de Contexten-Interventies-Mechanismen-Outcomes-logica, ofwel, CIMO-logica (Denyer, Tranfield & Van Aken, 2008). De CIMO-logica bestaat uit de volgende vier gerelateerde onderdelen. Er is een bepaald type van problematische *Contexten*, waarvoor oplossingen moeten worden ontwikkeld. De *Interventie* is een type oplossing(srichting) die past in de betreffende soort contexten. Passende oplossingen brengen processen teweeg: ze lokken *Mechanismen* uit. Via deze mechanismen worden de gewenste uitkomsten of *Outcomes* bereikt.

De CIMO-logica is een krachtig instrument voor het systematisch ontwikkelen van ontwerpkennis en is gebruikt voor het selecteren van geschikte leeromgevingen om te onderzoeken. Daarnaast is deze ontwerplogica ingezet voor het systematische proces van dataverzameling, analyse en beschrijven van de bevindingen, op basis waarvan ontwerpmodellen en de bijbehorende ontwerplogica zijn gegenereerd. De CIMO-logica kan aan de start van dit onderzoek als volgt worden ingevuld.

Tabel 1: CIMO-logica aan de start van onderzoek

| | |
|---|---|
| Type problematische Context | Hoger (beroeps)onderwijs in respons op veranderingen zoals nieuwe vormen van kennisontwikkeling, een diverse studentenpopulatie en de vraag naar flexibele, direct inzetbare professionals. Een probleem dat kan worden onderkend in dit type context is hoe er passende leeromgevingen kunnen worden ontworpen, waarmee het hoger (beroeps)onderwijs aan deze hoge verwachtingen kan voldoen. |
| Type Interventie | Een hybride leeromgeving wordt als een passende interventie gezien voor bovenstaand type context.<br><br>Een hybride leeromgeving is gesitueerd in een onderwijsinstelling en heeft tegelijkertijd kenmerken van leren op een werkplek. Het gaat om project- of opdrachtgeoriënteerde, ICT-ondersteunde leeromgevingen die kunnen worden gekarakteriseerd als 'authentiek'.<br><br>Een leeromgeving wordt gevormd door de fysieke en digitale setting waarin lerenden hun werk uitvoeren en omvat alle instrumenten, documenten en andere artefacten die in een dergelijke omgeving te vinden zijn. Behalve een fysieke en digitale setting, is het ook de sociaal-culturele setting (Goodyear, 2001). |
| Mechanismen | Bovenstaande hybride leeromgeving lokt uiteenlopende mechanismen uit. Voor dit onderzoek zijn de volgende vijf mechanismen uit de literatuur ontleend. Deze mechanismen zijn gerelateerd aan het genoemde authentieke karakter (Herrington & Herrington, 2006) van een hybride leeromgeving:<br>▪ Het (re)produceren van een expert aanpak en het overnemen van expert processen.<br>▪ Het vervullen van meervoudige rollen en het gebruiken van meervoudige perspectieven.<br>▪ Het ontwikkelen van kennis in samenwerking.<br>▪ Het reflecteren om abstraheren mogelijk te maken.<br>▪ Het articuleren om het expliciteren van impliciete kennis mogelijk te maken. |
| Gewenste Outcomes | Via de bovenstaande authentieke mechanismen is het de verwachting dat hybride leeromgevingen helpen om lerenden te ontwikkelen richting flexibele, direct inzetbare professionals. Het gaat om lerenden met duurzame, flexibele, functionele, betekenisvolle, generaliseerbare en toepassingsgerichte kennis. Daarnaast wordt naar vaardigheden gestreefd die een algemener karakter en een bredere reikwijdte hebben: vaardigheden rond leren leren, denkstrategieën, samenwerkingsvaardigheden en regulatievaardigheden. |

In dit onderzoek is empirisch onderzoek gedaan in drie onderwijscontexten waarin de leeromgevingen waren gesitueerd die hebben geparticipeerd. De onderwijscontexten waren van het bovenbeschreven type problematische context en de leeromgevingen hadden de genoemde kenmerken. Er is gebruik gemaakt van de case study-methode (Yin, 1989; 2005) waarbij een expliciet ontwerpperspectief is gehanteerd. In onderstaande tabel zijn de onderwijscontexten en leeromgevingen

samengevat die betrokken waren in dit onderzoek [zie ook figuur 2, Hoofdstuk 1; tabel 2, Hoofdstuk 2].

Tabel 2: Samenvatting betrokken onderwijscontexten en leeromgevingen

| | Case-1 (2005)<br>Case-1 (2006) | Case-2 (2006)<br>Case-2 (2007) | Case-3<br>(2006/2007) |
|---|---|---|---|
| Faculteiten | Faculteit Gezondheidszorg (hbo)<br>Faculteit Geneeskunde (universitair) | Faculteit Communicatie & Journalistiek (hbo) | Faculteit Natuur & Techniek (hbo) |
| Opleidingen | Fysiotherapie, Verpleegkunde & Logopedie; Geneeskunde | Digitale Communicatie | Open voor studenten van deze en andere faculteiten |
| Onderwerp | Multiprofessionele samenwerking rond patiënten die een beroerte hebben gehad | Systeemontwikkeling | Regie Stedelijke Vernieuwing |
| Aantal studenten | 32<br>12 | 125<br>170 | 26 |
| Tijdsduur | 8 weken, 4 ECTS[*] | 8 weken 14 ECTS | 6 maanden, 30 ECTS |
| Positie in totale curriculum | Facultatieve module derde-jaars hbo-studenten<br>Verplicht onderdeel eerstejaars Geneeskunde | Afsluitende module eerstejaars studenten | Facultatieve minor voor derdejaars studenten |

### 1.3 Samenvatting van De toegevoegde waarde van het hanteren van een ontwerpperspectief voor het onderzoeken van leeromgevingen in het hoger (beroeps) onderwijs: drie case studies [H2]

Er is nog geen consensus over hoe project- of opdrachtgeoriënteerde leeromgevingen in het hoger (beroeps)onderwijs optimaal kunnen worden vorm gegeven. In dit hoofdstuk wordt daarom antwoord gezocht op de vraag: Welke ontwerpkenmerken hebben project- of opdrachtgeoriënteerde leeromgevingen in het huidige hoger (beroeps)onderwijs?

In het onderwijsonderzoek en de onderwijspraktijk komen we verschillende tweedelingen tegen. Dichotomieën met schijnbaar tegengestelde polen, bijvoorbeeld, kennis als product vs leren door te participeren; en sturing vs zelf-sturing. Complementair aan de bestaande tweedelingen, introduceren wij een ontwerpmodel dat is gebaseerd op een dichotomie met aan de ene kant 'specifieke ontwerpkenmerken' en aan de andere kant 'open ontwerpkenmerken'. Echter, om

[*]European Credit Transfer and Accumulation System. De werkbelasting van een student van een voltijds opleiding in Europa is gemiddeld 1500-1800 uur per jaar en dan staat één credit voor 25 tot 30 werkuren (European Commission, Directorate-General for Education and Culture, 2007).

de dualiteit van een tweedeling te vermijden, beschouwen we deze dichotomie als een *dimensie* waarop alle schakeringen tussen specifiek en open ook mogelijk zijn.

Vraag: Wat kunnen we nu positioneren op deze dimensie? Antwoord: Alle onderdelen van een leeromgeving die te ontwerpen zijn. In dit hoofdstuk modelleren we drie soorten ontwerpbare onderdelen: ruimtes, instrumenten en gebeurtenissen. Deze drie onderdelen hebben ontwerpkenmerken die geschakeerd zijn van 'speciek' tot 'open'.

Het ontwerpmodel in dit hoofdstuk bestaat dus uit drie soorten ontwerpbare elementen en een dimensie waarop deze kunnen worden gepositioneerd. Met dit model zijn drie verschillende onderwijscontexten geanalyseerd: de ontwerpbare elementen zijn geïdentificeerd en beschreven. Er is in dit hoofdstuk gewerkt met Case-1 (2005), Case-2 (2006) en Case-3 (2006/2007). Hierbij zijn ook de problemen onderkend die kunnen worden geassocieerd met hoe specifiek of open de geïdentificeerde ruimtes, instrumenten en gebeurtenissen waren.

Uit de analyse van de betrokken leeromgevingen blijkt dat er vooral problemen worden ervaren wanneer het *contrast* tussen elementen met specifieke en open kenmerken groot is. Studenten hebben bijvoorbeeld moeite om te schakelen tussen ruimtes, instrumenten en gebeurtenissen die volledig zijn gespecificeerd, naar ruimtes, instrumenten en gebeurtenissen die juist open zijn gelaten.

In de discussie van dit hoofdstuk presenteren we een potiëntele ontwerpoplossing, namelijk, *adaptiviteit* als ontwerpkenmerk. Adaptieve ruimtes, instrumenten of gebeurtenissen worden niet vooraf nauwkeurig gespecificeerd of juist open gelaten. Adaptieve elementen worden zodanig ontworpen dat alle participanten -docenten, (senior) studenten en externen- nog *tijdens* de uitvoering kunnen bepalen welke mate van specificatie of openheid op dat moment noodzakelijk en wenselijk is.

Tot slot onderkennen we de tweevoudige basisfunctie die ruimtes, instrumenten en gebeurtenissen van een project-georiënteerde leeromgeving in het hoger (beroeps)onderwijs volgens ons heeft: het bieden van (adaptieve) ondersteuning, en in het verlengde daarvan, het bieden van contextuele aanwijzingen.

### 1.4 Samentvatting van Op zoek naar gemeenschappelijk begrip: een taak conceptualisatie voor het faciliteren van het ontwerpen van (ICT-ondersteunde) leeromgevingen met ontwerppatronen [H3]

Zoals eerder kort is geschetst, worden er aan het hoger (beroeps)onderwijs hoge eisen gesteld. Het onderwijsonderzoek zou hier een bijdrage aan moeten leveren in de vorm van systematische ontwerpkennis waarmee de praktijk uit de voeten kan. Systematische ontwerpkennis kan in verschillende vormen worden gegoten. Ontwerpkennis in de vorm van zogenaamde 'ontwerppatronen' wordt gezien als kansrijk (Goodyear, Avgeriou, Baggetun, Bartoluzzi, Retalis, Ronteltap & Rusman, 2004). Ontwerppatronen kunnen door hun structuur houvast bieden als een gemeenschappelijk kader en de basis vormen voor gemeenschappelijk begrip.

Ook in dit hoofdstuk wordt eerst een ontwerpmodel gepresenteerd waarmee leeromgevingen in het hoger (beroeps)onderwijs kunnen worden bezien vanuit een expliciet ontwerpperspectief. Het ontwerpmodel dat in dit hoofdstuk is gebruikt, is een nadere uitwerking van het model uit het voorgaande hoofdstuk. Het centrale

ontwerpbare element in dit model is een hele *taak (*Van Merriënboer, De Clark & De Croock, 2002). Taken worden getriggerd door *gebeurtenissen* en uitgevoerd vanuit bepaalde *rollen,* waarbij *grensoverschrijdende instrumenten* (Star & Griesemer, 1989) worden gebruikt en gemaakt [zie figuur 5, Hoofdstuk 3]. Een voorbeeld van een taak in de onderzochte context is het ontwikkelen van een prototype [*grensoverschrijdend instrument*] om te presenteren aan [*gebeurtenis*] een externe klant, door studenten die samenwerken als junior professionals [*rollen*].

Vervolgens is dit model gebruikt om een leeromgeving in twee opvolgende leerjaren systematisch te analyseren. Het model is gebruikt om de ontwerpbare elementen te identificeren en te beschrijven. Er is in dit hoofdstuk gebruik gemaakt van Case-2 (2006 en 2007). Hierbij zijn tevens problemen onderkend. Op basis van deze systematische ontwerpanalyse is ontwerpkennis gegenereerd in de vorm van ontwerppatronen [zie ook sectie 1.8 van deze samenvatting].

### 1.5 Samenvatting van Het analyseren van interprofessioneel onderwijs vanuit een ontwerpperspectief [H4]

In dit artikel gaat het om medisch, paramedisch en verpleegkundig onderwijs waaraan door de gezondheidszorg hoge eisen worden gesteld. De bekwaamheid om adequaat te kunnen samenwerken met professionals van andere beroepsgroepen wordt zowel nationaal als internationaal als noodzakelijk beschouwd. Hoe hieraan door het onderwijs vorm kan worden gegeven is nog niet uitgekristalliseerd.

Vanuit een ontwerpperspectief is gekeken naar de vormgeving van een interprofessionele, ICT-ondersteunde leeromgeving voor studenten Fysiotherapie, Verpleegkunde en Logopedie van een hbo-instelling en studenten van een versnelde, universitaire opleiding Geneeskunde. Er is in dit hoofdstuk gebruik gemaakt van Case-1 (2005).

Ook in dit hoofdstuk wordt eerst een ontwerpmodel gepresenteerd waarmee interprofessionele leeromgevingen kunnen worden bezien vanuit een expliciet ontwerpperspectief. Dit ontwerpmodel combineert aspecten van de ontwerpmodellen uit de voorgaande hoofdstukken en is verder uitgewerkt. Het model bestaat uit: [A] vier perspectieven voor het vormgeven van de ontwerpbare onderdelen. De ontwerpbare onderdelen van de leeromgeving kunnen worden gepositioneerd langs [B] twee haaks op elkaar staande dimensies, die [C] vier kwadranten vormen, [zie ook figuur 9 en 10 in Hoofdstuk 4].

[A] De vier ontwerpperspectieven waarmee hybride leertaken en omgevingen kunnen worden vorm gegeven:
1. Actor perspectief: patiënt, professionele rollen en onderwijsrollen.
2. Ruimtelijke perspectief: de fysieke en digitale ruimtes.
3. Instrumentele perspectief: de grensoverschrijdende of perifere instrumenten.
4. Tijdsperspectief: beschikbare tijd, tempo en temporisatie.

[B] De twee dimensies waarlangs ontwerpbare onderdelen kunnen worden gepositioneerd:
1. Aquisitie-Participatie (Sfard, 1998). Dit ontwerpkenmerk geeft aan of het accent ligt op de meer klassieke acquisitie-benadering van kennis die kan worden overgedragen en meer individueel is georiënteerd. Of dat het accent ligt op de

meer socio-culturele, participatieve benaderingen, waarbij leren wordt gezien als het leren functioneren in een (professionele) gemeenschap.
2. Simulatie-Realiteit. Dit ontwerpkenmerkt geeft aan of er is gekozen voor een meer gereduceerde en gecontroleerde versie van de werkelijkheid (simulatie) of voor de realiteit in haar volle complexiteit (realistisch).

[C] Bovenstaande twee dimensies staan haaks op elkaar en vormen vier kwaddranten met eigen ontwerpkenmerken:
1. Simulatie-Acquisitie
2. Realistische-Acquisitie
3. Simulatie-Participatie
4. Realistische-Participatie.

Vervolgens is dit model gebruikt om een interprofessionele, ICT-ondersteunde leeromgeving systematisch te analyseren, te beschrijven, de problemen te onderkennen en ontwerpoplossingen te genereren. Op basis van deze ontwerpanalyse presenteren we generieke en specifieke ontwerprichtlijnen [zie ook sectie 1.8 van deze samenvatting].

### 1.6 Samenvatting van De rol van professionele instrumenten in technologisch versterkte leeromgevingen in het hoger (beroeps)onderwijs [H5]

In dit hoofdstuk ligt de focus op het instrumentele perspectief waarmee leeromgevingen in het hoger beroepsonderwijs kunnen worden vorm gegeven. Er is ingezoomd op instrumenten uit de professionele beroepspraktijk die in leeromgevingen kunnen functioneren als grensoverschrijdende instrumenten. Ook is er in dit hoofdstuk meer ingezoomd op de rol die technologie kan spelen ter versterking van een leeromgeving.

Voor het structureren van deze diepte-analyse hebben we in dit hoofdstuk de zogenaamde Contexten-Interventies-Mechanismen-Outcomes-, ofwel, CIMO-logica gebruikt. Met deze logica kunnen ontwerpproblemen en –oplossingen systematisch worden ontwikkeld, geanalyseerd en beschreven. Er is in dit hoofdstuk gebruik gemaakt van Case-2 (2006 en 2007). In dit hoofdstuk gaat het om een versie van het ontwerpmodel dat hetzelfde is als in het voorgaande hoofdstuk.

Er is binnen deze case studie een nadere selectie gemaakt van vier professionele instrumenten[*]: mood board, project plan, prototype en website. Hierbij is het van belang om op te merken dat deze instrumenten een duale functie hebben. Het zijn eerst generieke instrumenten voor alle individuele lerenden en project-teams en worden ontwikkelenderwijs de specifieke (tussen)resultaten van specifieke teams.

De diepte-analyse bestond uit drie stappen. De eerste stap was het positioneren van de geselecteerde instrumenten in de vier kwadranten (simulatie-acquisitie; realistische-acquisitie; simulatie-participatie; realistische-participatie). De tweede stap bestond uit een analyse van de eigenschappen (ofwel de ontwerpkenmerken) van de geselecteerde instrumenten. De instrumenten zelf vertegenwoordigden het

[*]Voor de relatie van de geselecteerde instrumenten met andere instrumenten in de leeromgeving zie figuur 8, Hoofdstuk 3

instrumentele perspectief. De overige drie perspectieven (actor-, ruimtelijk- en tijdsperspectief) zijn gebruikt voor het identificeren van de ontwerpkenmerken. Deze ontwerpkenmerken zijn gerelateerd aan de vijf authentieke mechanismen die aan de literatuur zijn ontleend en kenmerkend zijn voor hyrbide leeromgevingen.

De derde en laatste stap bestond uit een taakanalyse (Jonassen, Tessmer & Hannum, 1998), waarbij is geanalyseerd hoe de geselecteerde instrumenten (inclusief de geïdentificeerde eigenschappen) werden gehanteerd door de betrokken actoren[*], in de verschillende fysieke en digitale ruimtes, en met welk tijdsperspectief[*]. Hierbij is gebruik gemaakt van foto's die kenmerkend waren voor de geselecteerde instrumenten-in-actie [zie figuren 16 t/m 19, Hoofdstuk 5]; [zie ook sectie 1.8 van deze samenvatting].

### 1.7 Samenvatting van Het beoordelingsproces en de effectiviteit van hybride leeromgevingen in het hoger (beroeps)onderwijs [H6]

In de voorgaande hoofdstukken is naar de leeromgeving als geheel gekeken, in dit hoofdstuk is gezocht naar een indicatie van de effectiviteit van de onderzochte leeromgevingen in meer klassieke zin.

Hiervoor hebben we naar de leeruitkomsten gekeken van Case-2 (2006 en 2007) en naar het beoordelingsproces. Het beoordelingsproces hebben we beschouwd als de ontwerpbare elementen van de leeromgeving die te maken hebben met het aspect 'beoordeling'. We hebben de ontwerpmodellen uit de voorgaande hoofdstukken gebruikt voor het systematisch analyseren en beschrijven van het beoordelingsproces. Vervolgens hebben we het beoordelingsproces geëvalueerd met een set van tien kwaliteitscriteria voor competentie assessment programma's (Baartman, Bastiaens, Kirschner & Van Vleuten, 2007).

Onze conclusie is dat de kwaliteit van het ontworpen beoordelingsproces relatief hoog scoorde op de set kwaliteitscriteria. Daarnaast werd het beoordelingsproces door de studenten positief beoordeeld op twee indicatoren: geschiktheid en transparantie van de beoordelingscriteria.

Wat betreft de leeruitkomsten laat de data zien dat: [a] de lerenden zelf positief zijn over hun eigen leeruitkomsten; [b] in 2006 geen van de websites online is gegaan en in 2007 drie van de zeven websites online is gegaan; en dat [c] 88% van de studenten in 2006 en 93% in 2007 het gewenste c.q. geaccrediteerde niveau heeft behaald.

Er kunnen twee opvallende punten worden geconstateerd. Ten eerste viel ons op dat het grootste deel van het ontworpen beoordelingsproces is te positioneren in het realistische-participatie kwadrant, terwijl beoordelen in dit kwadrant juist ook het meest complex is. Ten tweede viel ons dat wanneer een beoordelingsproces handig wordt ontworpen, dat het criterium 'kosten en efficiency' gunstig kan scoren. Terwijl het toch om een vrij grootschalige leeromgeving ging (125 studenten in 2006 en 170 in 2007) en dit criterium vaak als een plausibel tegenargument rond het inzetten van competentie assessment wordt gebruikt.

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[*]Voor een analyse van de betrokken actoren, zie figuur 7, Hoofdstuk 3.

[*]Voor een analsye van de instrumenten door de tijd heen, zie figuur 6, Hoofdstuk 3.

Onze eindconclusie was dat de door ons geïntroduceerde ontwerpmodellen helpen om het ontwerp van een beoordelingsproces verder uiteen te rafelen en complementair is aan de set kwaliteitscriteria. Tezamen kunnen ze bijdragen aan nader onderwijsonderzoek en verdere onderwijsverbetering.

### 1.8 Samenvatting van Discussie [H7]

Het ontwerpen van project- of opdrachtgeoriënteerde leeromgevingen die kunnen worden gekarakteriseerd als 'authentiek' is geen rechtlijnig en afgetekend proces en is daarmee een complexe taak voor docenten. De drijvende onderzoeksvraag achter dit onderzoek is als volgt:
*Hoe kunnen we project- of opdrachtgeoriënteerde, ICT-ondersteunde leeromgevingen in het hoger (beroeps)onderwijs helpen te ontwerpen en te verbeteren?*

De door ons gevonden antwoorden kunnen worden samengevat met behulp van de eerder geïntroduceerde Contexten-Interventies-Mechanismen-Outcomes-logica, ofwel, de CIMO-logica.

#### *1.8.1 Problematische context*

In de drie geselecteerde contexten zijn meer algemene ontwerpproblemen te onderkennen vanuit een inhoudelijk of domeinperspectief en vanuit een onderwijskundig perspectief. In de eerste context was het ontwerpprobleem vanuit een gecombineerd perspectief met name dat het ging om patiënten met een beroerte en het niet haalbaar en wenselijk was om echte patiënten in de leeromgeving te betrekken. In de tweede context was het ontwerpprobleem met name dat het ging om een relatief groot aantal studenten, terwijl er wel toegang was tot passende opdrachten van echte, externe opdrachtgevers. In de derde context was het onwerpprobleem met name dat het ging om een facultatieve minor voor studenten van verschillende opleidingen en opleidingsrichtingen voor een periode van zes maanden, die een leerervaring moest bieden die equivalent was aan een externe stage in de toekomstige beroepspraktijk.

Daarnaast is er een algemeen probleem onderkend dat specifiek is voor hybride leeromgevingen. Er is gebleken dat er vooral problemen worden ervaren wanneer het *contrast* tussen elementen met specifieke en open kenmerken groot is. Het verbinden van ontwerpbare elementen die in de verschillende vier kwadranten (simulatie-acquisitie; realistische-acquisitie; simulatie-particpatie en realistische-participatie) zijn gepositioneerd, kan als een kernprobleem van dit type leeromgevingen worden onderkend.

#### *1.8.2 Interventies*

Op basis van de empirische data en de ontwerpanalyses is er een compact ontwerpmodel gegenereerd waarin de generieke concepten van een passende interventie, de hybride leeromgeving, zijn ondergebracht. De laatste versie van het ontwerpmodel bestaat uit de volgende elementen:

1. Ontwerpbare elementen met ontwerpkenmerken die geschakeerd zijn van specifiek tot open.
2. Leertaken als de bouwstenen van hybride leeromgevingen.
3. Vier kwadranten om leertaken in te kunnen positioneren: simulatie-acquisitie; realistische-acquisitie; simulatie-particpatie en realistische-participatie

4. Vier analytische perspectieven om leertaken mee te kunnen ontwerpen: actorperspectief, instrumentele perspectief, ruimtelijke perspectief en tijdsperspectief.

Behalve bovenstaand compacte, generieke ontwerpmodel, is er ook meer gedetailleerde ontwerplogica geformuleerd, waarvan we in het bestek van deze samenvatting alleen de korte, beschrijvende namen geven [zie verder tabellen 22 t/m 25, Hoofdstuk 7):

- Ontwerpbare elementen met adaptiviteit als ontwerpkenmerk.
- Het introduceren van vroege, primaire grensoverschrijdende instrumenten aan de start van een project/opdracht.
- Het leggen van verbindingen met externe, online professionele communities.
- Het bieden van weerstand tegen de twee tegengestelde krachten in een hyrbide leeromgeving.

*1.8.3 Mechanismen*

Uit de literatuur hebben we vijf mechanismen onderkend die zijn gerelateerd aan het authentieke karakter van hybride leeromgevingen:

- Het (re)produceren van een expert aanpak en het overnemen van expert processen.
- Het vervullen van meervoudige rollen en het gebruiken van meervoudige perspectieven.
- Het ontwikkelen van kennis in samenwerking.
- Het reflecteren om abstraheren mogelijk te maken.
- Het articuleren om het expliciteren van impliciete kennis mogelijk te maken.

Deze mechanismen zijn in een verdiepende ontwerp- en taakanalyse gerelateerd aan de ontwerpkenmerken van professionele instrumenten die een grensoverschrijdend karakter hebben. De onderzochte instrumenten bleken de vijf mechanismen te activeren, waarbij de meeste ontwerpkenmerken hielpen bij het activeren van het articulatie-mechanisme en het (re)productie van expert aanpak-mechanisme. Weinig ontwerpkenmerken waren direct gerelateerd aan het activeren van de andere drie mechanismen. Daarnaast hebben we twee andere mechanismen onderkend: het onafhankelijk maken van lerenden en het contextualiseren van leeromgevingen die zijn gesitueerd in een schoolse setting.

*1.8.4 Outcomes*

Wat betreft de gewenste uitkomsten van een hybride leeromgeving hebben we gekeken naar de ontwerpbare elementen van het beoordelinsgproces in een hyrbide leeromgeving en de leeruitkomsten zelf.

Onze conclusie is dat de kwaliteit van het ontworpen beoordelingsproces in een hybride leeromgeving relatief hoog scoorde op de set kwaliteitscriteria. Daarnaast werd het beoordelingsproces door de studenten positief beoordeeld.

Wat betreft de leeruitkomsten van een hybride leeromgeving liet de data zien dat: [a] de lerenden zelf positief zijn over hun eigen leeruitkomsten; [b] in 2006 geen van de websites online is gegaan en in 2007, drie van de zeven websites online is gegaan; en dat [c] 88% van de studenten in 2006 en 93% in 2007 het gewenste c.q. geaccrediteerde niveau heeft behaald.

*1.8.5 Methodologie*
In deze samenvatting van het discussie-hoofdstuk besteden we kort aandacht aan de methodologische aanpak van dit onderzoek. Dit onderzoek kent twee verweven stromen: de praktijkstroom en de kennisstroom (Andriessen, 2007). Deze twee stromen kunnen vanuit drie verweven perspectieven worden benaderd: het onderzoeksperspectief, het ontwerpperspectief en het veranderkundige perspectief. Het onderkennen van de verweven stromen en perspectieven maakt het mogelijk om de onderlinge toegevoegde waarde te onderkennen en tegelijktijd bewust te zijn van hun conflicterende karakter (Zitter, 2007; Zitter, Akkerman & De Bruijn, 2008).

Er zijn potentiële spanningsvelden doordat de drie perspectieven zijn ontstaan vanuit verschillende activiteiten systemen (Engeström, 2008). Het onderzoeksproces is met name gericht op het beantwoorden van onderzoeksvragen. Het ontwerpproces is voornamelijk gericht op het vinden van optimale oplossingen en het veranderproces op het bereiken van een duurzame verandering in de dagelijkse, lokale onderwijspraktijk.

De door ons gekozen onderzoeksaanpak gaat ervan uit dat deze drie processen voorwaardelijk zijn voor elkaar en dat deze daarom alle drie expliciete inspanning vereisen. Het continu in balans houden van deze drie processen, waarbij actief is gezocht naar compromissen en wederzijdse versterking, heeft uiteindelijk geleid tot een delicate balans in onze zoektocht naar bruikbare, wetenschappelijke ontwerpkennis voor de onderwijspraktijk.

*1.8.6 Toekomstig onderzoek*
Er is in dit onderzoek vooral een kwalitatieve diepte-strategie ingezet. Deze heeft geleid tot rijke ontwerpmodellen, ontwerplogica, specifieke ontwerprichtlijnen en een uitgebalanceerde onderzoeksaanpak.

Om de ontwerpmodellen en ontwerplogica robuuster te maken is er ook breedte-onderzoek nodig. Voor het verbreden van de ontwerplogica en het nader valideren van de logica in combinatie met de specifieke ontwerp richtlijnen, is ook nader onderzoek nodig. Nader onderzoek zou bijvoorbeeld kunnen leiden tot een typologie van interventies en mechanismen met bijbehorende indicatoren en meetinstrumenten, die geschikt zijn voor het soort problematische contexten die het onderwerp waren van deze studie.

Met een dergelijke typologie en passende meetinstrumenten zou vervolgens breder, quasi-experimenteel onderzoek kunnen worden uitgevoerd, waarmee ook de Outcomes een meer solide onderbouwing zouden kunnen krijgen.

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## Curriculum vitae

Ilya Zitter was born in 1970 in Wageningen (The Netherlands) and completed her secondary schooling in 1989 at the Lorentz comprehensive school in Arnhem. She studied Knowledge Based Systems at the Higher School of Economics (Amsterdam) and graduated with a bachelor degree in 1994. She followed the master program Information and Knowledge Engineering at Knowledge Centre CIBIT (Utrecht) and Middlesex University. She graduated with distinction in 1995.

From 1995 till 2001 she worked as consultant ICT and organisational change for various large-scale projects in knowledge intensive organisations, such as, the Dutch Parliament (Tweede Kamer) and the Government Employment Offices (Arbeidsvoorziening). During this time, she also worked as program manager for a knowledge and demonstration centre of new technology. In her last job as consultant, she worked as consultant information management on financial, business-to-business processes.

From 2001-2003 she followed a two year salaried traineeship at the Post-Master User-System Interaction program of the Technical University Eindhoven. The last year of this program was devoted to an e-learning research project at the Educational Department of the University Medical Centre Utrecht. This was the start of her career in the educational domain.

From 2003-2009 she worked for IVLOS Institute of Education of Utrecht University and Cetis, centre for educational innovation and ICT/Department Education and Research of Hogeschool Utrecht University of Applied Sciences. In this double-appointment, she worked as a PhD-candidate. Besides, she participated in various projects, teams and networks of Hogeschool Utrecht University of Applied Sciences, for example, the Knowledge Platform Education and ICT and the Internal audit-team for the internal quality process for the accreditation of the Accreditation Organisation of the Netherlands and Flanders (NVAO). She was affiliated with the Research Group Vocational Education of Hogeschool Utrecht University of Applied Sciences (Lectoraat Beroepsonderwijs).

She currently works as researcher for the National centre of expertise for vocational education (Expertisecentrum Beroepsonderwijs, ecbo). Working for ecbo will bring the opportunity to combine her experience as consultant ICT and organisational change in knowledge intensive organisations, the design research perspective of the post-master program, and the experience of carrying out applied, participative research in the educational domain.

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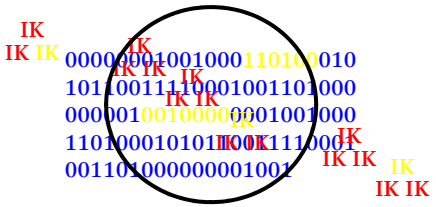
Formative audit Bachelor of Small Business and Retail Management, Faculty of Economics & Management

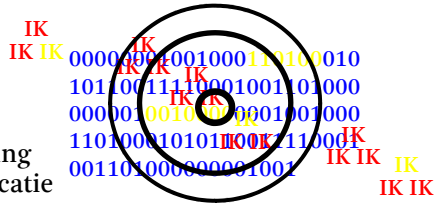
# Designing for Learning
# Ilya Zitter, Academiegebouw, Utrecht, Nederland, 4 februari 2010

## Primaire ingrediënten bereiden volgens de CIMO-logica

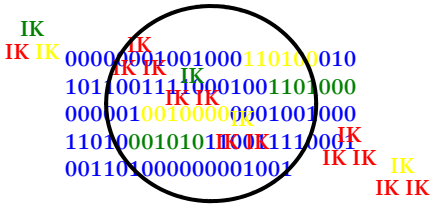
**Context**
= Problematische context van een bepaald type
→ Leeromgevingen in het hoger (beroeps) onderwijs



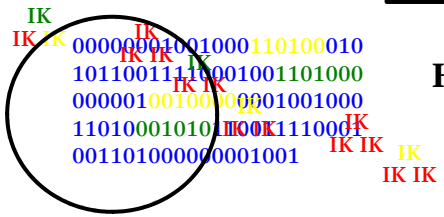
**Interventie**
= Hybride leeromgeving met passende boundary objecten
→ Voorbeeld: Mood Board in de leeromgeving Systeemontwikkeling van opleiding Digitale Communicatie



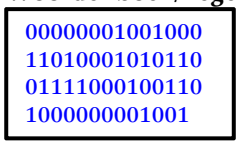
**Mechanismen**
= Mechanismen die geactiveerd kunnen worden in hybride leeromgevingen en bijdragen om doel te bereiken
→ Voorbeeld: articuleren om het expliciteren van impliciete kennis mogelijk te maken



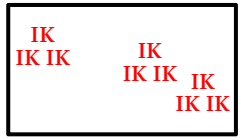
**Outcomes**
= Gewenste uitkomsten, Hogere doel
→ Gediplomeerde, levenslang lerende Professionals



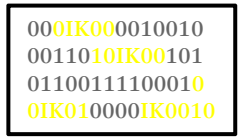
**Woordenboek/Legenda Primaire Ingrediënten**



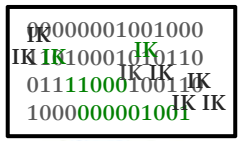
Bits & Atoms: de ontwerpbare werkelijkheid
Heeft twee toestanden: Het is er of Het is er niet
Ruimtelijke en Instrumentele perspectief
Voorbeelden: gebouw, Web, document, Website etc.



Ik & Ik & Ik &... [I-positions]: de niet-ontwerpbare werkelijkheid
Ontwikkeling tussen Ik ben er niet en Ik ben er
Actor perspectief
Voorbeelden: expert, junior professional, klant, gediplomeerd student



Boundary object: kan in beide werkelijkheden zijn
Wordt gebruikt & ontwikkeld of Niet gebruikt & ontwikkeld
Instrumentele perspectief
Voorbeeld: mobiele telefoon



Bits & Atoms zijn er (niet)
Ik&Ik&Ik &... ben/zijn er (niet)
Boundary objecten worden (niet) gebruikt & ontwikkeld
Mechanismen die geactiveerd kunnen worden met perspectief: dragen ze bij aan bereiken van het doel?

Magische ingrediënt: Relativi-Tijd
Kan Ik plannen en Hoef Ik niet te ontwerpen (gaat vanzelf)
Tijdsperspectief
Voorbeelden: real-time, versnellen, vertragen, interrumperen

**Dit is een gereedschap om een doel te bereiken:**
**Het is een kijkwijzer voor het organiseren van doelen & middelen**
**'Ceci n'est pas une Boundary object'**