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# In search of common ground: A task conceptualization to facilitate the design of (e)learning environments with design patterns

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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 have proposed the introduction of a task conceptualization as an abstract view of the concept chosen as central: the task. The choice of the constituting elements of the task conceptualization 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 has added a focus on objects facilitating the coordination, alignment and integration of collaborative activities. The presented task conceptualization is deliberately generic in nature, to ease the portability between schools of thought and make it suitable for a wide target audience. The conceptualization and the accompanying graphical and textual representations have shown 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.



## 1. Introduction

### 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 Merrienboer, & Koper, 2004). Different concepts have been introduced to analyze 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 emphasizes 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 et al., 1977 cited in Goodyear et al., 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).

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Before carrying out the two case studies described in this paper, 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.

### 1.2. Introducing a task conceptualization

To overcome the above mentioned and experienced difficulties with design patterns, we propose the introduction of a task conceptualization (see also Table 6, Appendix 'Structure of the task conceptualization and the accompanying representations'). This conceptualization 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 conceptualization is meant to help with the interpretation and integration of the data collected through literature and field studies. Furthermore, the conceptualization has a number of accompanying representations, both graphical and textual, to facilitate analysis and (re)design activities. The task conceptualization 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 conceptualization, a firm basis will become available for working with design patterns. Retalis, Georgiakakis, and 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 conceptualization 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 et al., 2007).

Above, we mentioned (e)learning environments, which have many different meanings in the educational domain. In this paper, 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 paper is: *which task conceptualization will facilitate the (re)design of (e)learning environments in higher education with the help of design patterns?* The rest of this paper is organized 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 conceptualization, which was based on the results of a literature study, is introduced. This version of the task conceptualization was used to carry out an initial data analysis. Consequently, the task conceptualization 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 conceptualization was used for detailed data analysis and construction of the pattern. Finally, the discussion, including thoughts on future research, concludes this paper. In the Appendix, Table 6, an overview of the task conceptualization and the accompanying representations including brief explanations of each representation can be found.

## 2. Constructing a task conceptualization through literature and field studies

### 2.1. Research design: Field studies and literature study

This paper is underpinned by data collected from two successive field studies and a literature study (see Fig. 1). 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 conceptualization we aim to introduce.

Both field studies can be considered as two, successive case studies, in which the task as central unit of analysis has been 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[1] 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.

### 2.2. Data collection

The data collection consists of educational material, observations of events organized 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 organized for students, while monitoring the CSCL/W-environment has been used to gain insight into the student activities outside of the organized 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 conceptualization to focus the observations. Besides the field notes, throughout the observations, photos and audio recordings were made. In Table 1 an overview of the collected data is presented.

### 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 Seven project teams worked in parallel on the same assignment, for the same client. In the first field study, there were six external

[1] Design patterns in this paper.

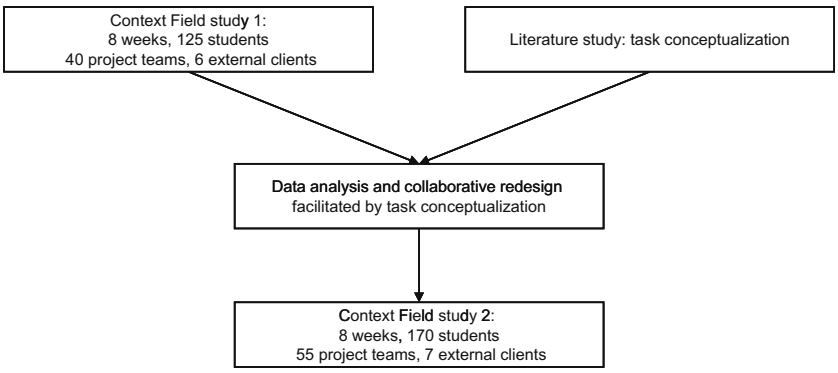


**Fig. 1.** Research design.

**Table 1**
Overview data collection field studies.

| Data collection | First field study | Second field study |
|---|---|---|
| Educational material | All educational material | All educational material |
| Observations of events organized for students: notes, photos and audio recordings | 6 h a week, 8 weeks, 48 h observations in total | 6 h a week, 8 weeks, 48 h observations in total |
| Observations of teacher meetings: notes, photos and audio recordings | 7 meetings, 1 h each, 7 h in total | 5 meetings, 1 h each, 5 h 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% |

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.).

### 2.4. A task conceptualization as result of literature study

#### 2.4.1. 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 conceptualization. The main concept we have chosen, is that of a *task*. Ten Berge, Ramaekers, and 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 (4 C/ID) method (van Merriënboer, Clark, & de Croock, 2002) in which the learning tasks are 'concrete, authentic, whole task experiences'. Kirschner, Martens, and Strijbos (2004) characterize 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 paper 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 and 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 have been studying literature to conceptualize the task in more detail. We have adopted elements from different theories and models to assemble the task conceptualization. The following criteria have guided the selection process of the elements we have adopted for the task conceptualization. Foremost, we have aimed to keep the task conceptualization as generic as possible. The task conceptualization should facilitate designing with design patterns, instead of imposing a specific school of thought. Also, the task conceptualization 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 conceptualization, to appeal to a wide target audience. The former two guidelines have as a consequence that the task conceptualization could also be suitable for *re*designing. 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 conceptualization. Lastly, the task conceptualization has to be prescriptive in nature, each element should be within the scope of design, in other words, each element should be 'designable'.

*2.4.2. Boundary object*

The first theory we have considered for the task conceptualization was Activity theory. Therefore, the primary unit of analysis of the task conceptualization 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 realized in goal-oriented individual and group actions' (Center for Activity Theory, n.d.). Activity theory is descriptive in character, while we were looking for input for a prescriptive conceptualization to facilitate (re)designing with design patterns. Therefore, we have 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. Furthermore, the most important notion we have 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 have chosen to adopt the concept of 'boundary object', first introduced by Star and Griesemer (1989): 'They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation'. 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 and Harper (2002) and Schmidt and Wagner (2002), Schmidt and Wagner (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 has represented an analytical perspective, which has 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.

*2.4.3. Role and 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 & Olivier, 2004; Koper, Spoelstra, & Burgos, 2004; Unfold project, 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 conceptualization, we have adopted the *role* and merged it with person. This choice complies with the criteria mentioned before: to keep the task conceptualization as simple as possible and focus on elements that are 'designable'. A type of person is outside the scope of design, therefore we have conceptualized a type of person that can carry out role as a feature of the role, instead of as a separate element. We have also adopted the notion of 'method' modeling: which role carries out, which activities, at what moment in the process. At this point, it has been 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 have chosen 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 organizing different types of events. The term 'environment' of IMS-LD, has been represented the concept of boundary object.

*2.4.4. Collaboration scripts and the task conceptualization*

Collaboration scripts have become fairly popular especially in the domain of computer-supported collaborative learning (Kobbe et al., 2007; Kollar, Fischer, & Hesse, 2006). 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 conceptualization. Furthermore, from the components of the framework, we have adopted the concepts of participants, roles and groups, and merged them into one element, namely role, as already explained before. We have also adopted the concept of 'resources', though we have used the broader term of 'boundary objects' as explained before. Next, we have used the concept of 'activities', which we have named 'events', as explained above. From the mechanisms of the framework we have 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.

*2.4.5. Scaffolding and the task conceptualization*

The last concept we have adopted for the task conceptualization 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 have adopted the notion of scaffolding since each element of the task conceptualization should be designable. In sum, each element of the task conceptualization is to be considered as a scaffold, which is to be designed to assist students performing a task.

### 2.5. Representations of the task conceptualization

To visualize 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 task ontology of Van Welie (2001). We have decided to use a similar visualization (see Fig. 2). It should be noted that in the Appendix, Table 6, an overview of the structure of the task conceptualization and the accompanying representations is to be found.

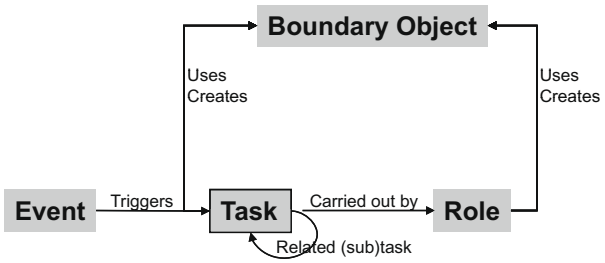


**Fig. 2.** Graphical representation of task conceptualization.

### 2.6. Task conceptualization adapted to reflect initial data analysis

This section starts with a general description of the data analysis. In the following two sections about the design patterns, specific aspects of the analysis are presented. Qualitative analysis was carried out as main method of the data analysis. Initially, the task conceptualization was used as a coding scheme to analyze the educational material or the intended curriculum. Next, the implemented curriculum was studied. On the basis of this initial analysis, the task conceptualization as presented in the previous section was adapted. The adapted task conceptualization, which reflected the initial analysis, is presented in a tabular representation (see Table 2 and Appendix, Table 6).

Then, the data were analyzed in detail, to construct design patterns. The adapted conceptualization was used as main coding scheme. 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.

### 2.7. Design patterns

In the next sections, we present two examples of design patterns, which were made with the help of the adapted task conceptualization. After the description of each pattern, we clarify how the task conceptualization has helped to construct it. For the data analysis and the construction of the design patterns, we have made use of the representations derived from the task conceptualization. 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 visualization, a prototype, or in some other way'. With these representations, different views on the learning environment could be

**Table 2**
Tabular representation of adapted task conceptualization.

| | |
|---|---|
| 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 dialog |
| Output specification | Make professional prototypes which capture the preliminary analysis in a creative way, engage the client in dialog, 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, n.d.). |
| *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. The team roles were played by first-year students<br>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 |

made. Since the representations are derivates of the task conceptualization, 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 conceptualization (see also Appendix, Table 6):

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 has been based on the description format of the E-LEN project (n.d.). To directly connect this chosen format with the presented task conceptualization, we have 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 conceptualization (tasks, boundary objects, roles and events) have been used to make the brief scenario descriptions (see also Appendix, Table 6).

### 2.8. Design pattern: Introduce primary boundary objects at the start of a project

#### 2.8.1. Analysis of the problem

The adapted task conceptualization has been used to identify and analyze the problem as presented in this pattern. We started by analyzing the *events* organized for students and the *roles* involved in these events. As representation for the events, we have used event flows, which give a condensed overview of the organized events. To make the event flows, the events have been plotted on a timeline (see Fig. 3 and Appendix, Table 6). For the roles, a graphical and a tabular representation have been made (see Fig. 4, Table 4 and Appendix, Table 6). In the table, only a few roles are described as an example.

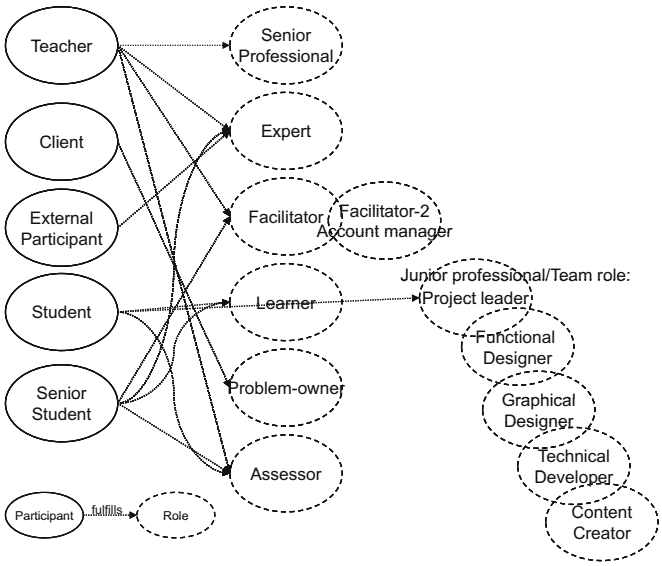


**Fig. 4.** Graphical representation of roles (first field study).

Next, the observations of the events were analyzed. 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 have confirmed that they felt overwhelmed at the start. Observations of later work events have shown students working much more independently. Also, the students were able to engage the client into interactive dialog in a much more professional way.

Consequently, we focused on the *boundary objects* in the above events (see Fig. 3). At the start of the project, students were re-

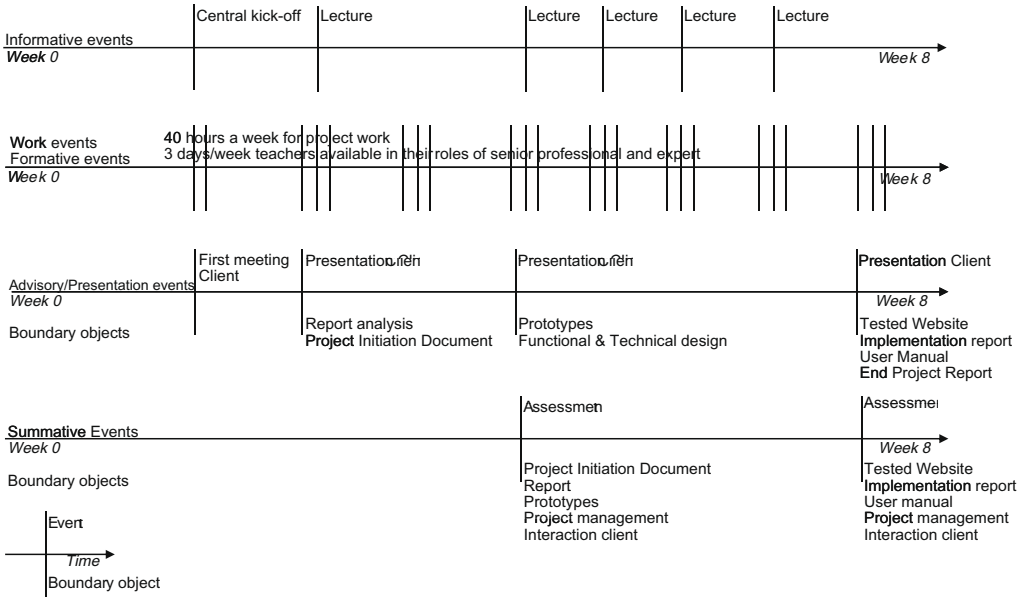


**Fig. 3.** Graphical representation of events & boundary objects (first field study).

**Table 3**
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 the start of a project<br>Initial meetings with external client (or representative of the client domain) |
| Roles | Student in the role of junior professional at the start of a new project<br>External participant in role of problem owner (or end-user) |
| Objects | Little (or no) early, primary boundary objects, e.g. mood board, early prototypes.<br>Many (or focus on) secondary boundary objects, e.g. 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 (team) 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. Furthermore, 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 (1984); Mood boards: McDonagh and Denton (2004). Primary and secondary objects: Garrety and Badham (2000). Project management: PRINCE2 (n.d.)

**Table 4**
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 |

quired 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 downloads, 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.

### 2.8.2. 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

**Table 5**
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 |
| | One-on-one tutoring |
| | Unguided work sessions, often of an individual nature |
| Roles | Student in role of junior professional dealing with precision (sub)task |
| | Teacher in role of expert |
| | Outside expert |
| Objects | (Online) resources |
| | Professional tools, often software-tools, to support precision work |
| *Problem: description of the problem area* | |
| Students often get stuck when working on detailed, precise 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 organized 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 familiarize them with the outside, online community | |
| *References* | |
| Example open source tool: Joomla! http://www.joomla.org/ | |

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 has been 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 organized events has resulted in an overview of all the tasks and sub-tasks. The overview of the second field study is presented in Fig. 5. The tasks and sub-tasks are presented in a hierarchical representation (see also Appendix, Table 6).

### 2.9. Design pattern: Connect to an outside online community

#### 2.9.1. Analysis of the problem

This pattern has 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.

#### 2.9.2. 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-organized online community, which turned out to provide adequate support to the students. In the second field study, Joomla! was more emphasized as a suitable tool, and was made less permissive. Also, one teacher with much Joomla! expertise organized 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-organized online community, students in their roles of learner and junior profes-

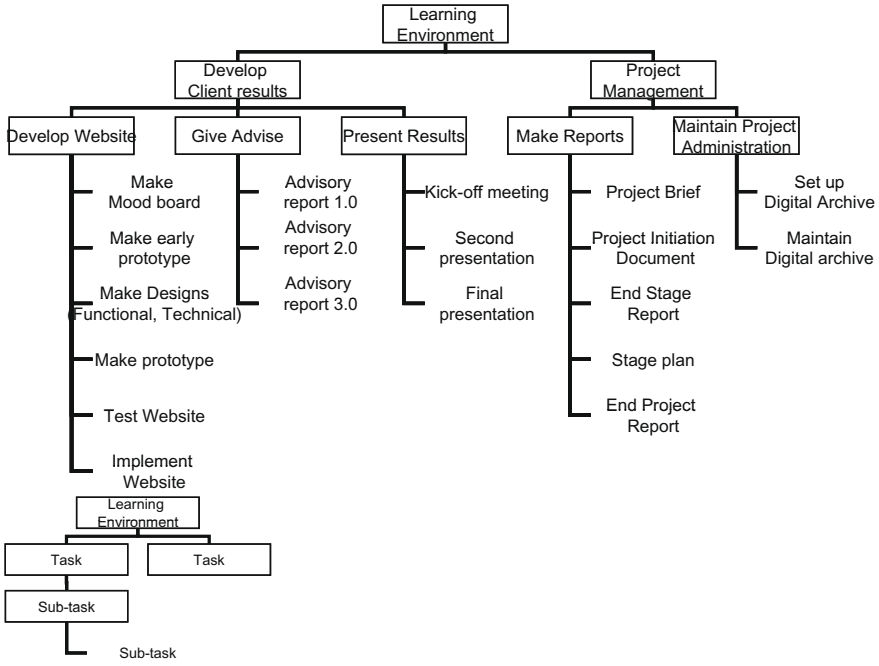


**Fig. 5.** Graphical representation of tasks & sub-tasks (second field study).

sional 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. Discussion

### 3.1. Research question

The answer to our question can now be formulated as follows: a task conceptualization 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* has been 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* has been adopted to focus on the concrete and pragmatic aspects of organizing meetings and sessions for learners. Besides, we have chosen the concept of *boundary object* to add a specific analytical perspective. Finally, we have 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 paper shows that the task conceptualization helped to construct valuable design patterns. Especially when *re*designing, in which case there are usually theories and approaches in place, the task conceptualization has turned out to be generic enough to handle the concepts which were already in use.

### 3.2. 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, and 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 conceptualization presented in this paper 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 conceptualization deals with the *content* of design patterns, it focuses on the constituting elements of a pattern. To enable focusing on the content, it has been necessary to adopt generic concepts, which have helped to keep the task conceptualization portable.

### 3.3. Task conceptualization versus IMS-LD and collaboration scripts

In this paper, we advocate the use of a task conceptualization 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 conceptualization. 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 et al., 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 have aimed to introduce a conceptual tool to facilitate the design process without the need for authoring tools. Therefore, the task conceptualization has been kept

as economic as possible, since we think that a simple and at the same time expressive conceptualization 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 have chosen 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 have adopted elements from activity theory and boundary objects, to add focus to the generic task conceptualization.

### 3.4. Future research

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

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

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## Appendix A

Structure of the task conceptualization and the accompanying representations.

**Table 6**
Structure of the task conceptualization and the accompanying representations.

| *Task conceptualization*<br>Concepts and relationships | | *Accompanying representations*<br>Derivates of the conceptualization, help to provide coherent view of a learning environment |
|---|---|---|
| Key elements of the task conceptualization, 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 conceptualization, representing the key elements and the mutual relationships. See Fig. 2 |
| Adapted task conceptualization reflecting the field studies | Tasks, related tasks and 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 conceptualization, to describe, analyze or (re)design (sub)tasks. For example Table 2 |
| Separate elements of task conceptualization | 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, analyze or (re)design the overall task-structure. For example Fig. 5 |
| | 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, analyze or (re)design the sequence of events and boundary objects. For example Fig. 3 |
| | Participants can fulfill single or multiple roles | Graphical representation of participants and which roles they can fulfill, for an overview of roles. For example Fig. 4<br>Tabular representation of roles to describe, analyze or (re)design roles in more detail. For example Table 4 |
| Design pattern:<br>– is based on analysis with task conceptualization & accompanying representations<br>– others could implement design pattern with the help of the task conceptualization & 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 conceptualization 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 conceptualization and the accompanying representations. For example part of the design patterns in Tables 3 and 5 |
| | 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 Tables 3 and 5 |

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