Educational Technology Expertise Center
Open University of the Netherlands

Research project proposal

This project falls in the following research topic(s):

Design
- Competency analysis / domain modeling
- Learning tasks & learner support

Delivery
- Composing instructional messages
- Computer-mediated communication

Diagnosis
- Performance-based assessment
- Quality control & assurance

1 Project chair
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2 Project name
English: The role of design strategies for designing and developing electronic, competency based learning environments.
Dutch: De rol van ontwerpstrategieën voor het ontwerpen en ontwikkelen van op competenties gebaseerde elektronische leeromgevingen.

3 Place in organization
Design theme in the OTEC research program

4 Synopsis of the research problem
English
The Open University of the Netherlands spends much time, effort and financial resources designing and developing high quality educational materials for use in lifelong learning settings. One of the most time consuming and labor-intensive elements is the development of electronic material in the courses. In the past (in the age of ‘simple’ COO) - when electronic material was primarily intended for acquiring knowledge and procedural skills - designers and developers could fall back on traditional pedagogy and psychology (instruction, drill and practice, simulation... as pedagogy and behaviorism or cognitivism as psychology). With the current emphasis on competency-based education in powerful electronic learning environments as the driving force within the organization (Instellingsplan 1998-2002) the ‘security’ that designers and developers had in the past is no longer present.

Competencies are abilities that enable learners to recognize and solve new problems in their domain of study and future work. According to Keen (1992), competencies are the ability “…to operate in ill-defined and ever-changing environments, to deal with non-routine and abstract work processes, to handle decisions and responsibilities, to work in groups, to understand dynamic
systems, and to operate within expanding geographical and time horizons”. Competency-based education at the Open University of the Netherlands is thus defined as education aimed at providing students with a range of knowledge, skills and attitudes which they can apply to efficiently and effectively solve real world (poorly defined) problems.

The design of competency-based educational environments is assumed to be based upon constructivist principles that hold that the learner builds an internal representation of knowledge based on personal interpretation of experience. This representation is constantly open to change, its structure and linkages forming the foundation to which other knowledge structures are attached. Learning is an active process in which, based upon experience, meaning is developed. Conceptual growth comes from the sharing of multiple perspectives and simultaneous changing of our internal representations in response to those perspectives as well as through cumulative personal or group experience. Consistent with this view of knowledge learning must be situated in a rich context that is - at least to a certain degree - reflective of real world contexts in order for this constructive process to occur and to transfer to environments beyond the school (Bednar, et al, 1991, p. 91-2).

Within this new field designers and developers make use of ‘authentic’ tasks in electronic environments which allow them to interact with a series of different real events (i.e., experience in differing contexts or situations) or simulations of those real events (“vicarious” experience).

Decisions on how to design the tasks and the - assumed to be necessary - support mechanisms in electronic learning environments is done on the basis of a combination of:

- tacit, intuitive or professional knowledge (“Fingerspitzengefühl”),
- modification of tried and true design techniques and methodologies, and
- an attempt to use the constructivist paradigm for the development of instructional design guidelines.

This research attempts to answer the following questions:

- What is the role of design strategies for designing and developing electronic, competency based learning environments.

This translates into the following sub-questions:

- How do educational developers actually design and develop electronic learning environments for competency acquisition?
- What is the role of (implicit) cognitive strategies and heuristics (“rules of thumb”) of designers/developers for setting up competency based learning environments?
- How can we use this knowledge for developing empirical guidelines for the design of electronic, competency based learning environments?

Dutch

De Open Universiteit Nederland (OUNL) besteedt veel tijd, moeite en geld aan het ontwerpen en ontwikkelen van hoogwaardige onderwijskundige materialen voor gebruik in afstandsonderwijs. Een van de meest tijds- en arbeidsintensieve activiteiten betreft het ontwerpen en ontwikkelen van elektronische cursusmaterialen. In het verleden (de tijd van eenvoudige COO), toen elektronische materialen nog vooral gericht waren op het verwerven van kennis en procedurele vaardigheden, konden ontwerpers en ontwikkelaars terugvallen op de traditionele pedagogiek en psychologie (instructie, drill-and-practice, simulatie etc. als pedagogiek en behaviorisme of cognitivisme als psychologische invalshoek). Nu de nadruk meer en meer komt te liggen op competentiegericht onderwijs binnen elektronische leeromgevingen als drijvende kracht binnen de OUNL-organisatie (“Instellingsplan 1998-2002”), dreigt de zekerheid die ontwerpers en ontwikkelaars in het verleden hadden verloren te gaan.

Competenties zijn vermogens die lerenden in staat stellen om nieuwe problemen in hun studie- of (toekomstige) werkgelegenheid en op te lossen. Volgens Keen (1992) verwijzen competenties naar het vermogen om te kunnen “… opereren in slecht-gedefinieerde en continu veranderende omgevingen, omgaan met niet-routine en abstracte werkprocessen, nemen van besluiten en verantwoordelijkheden, werken in groepen, begrijpen van dynamische systemen, en handelen binnen zich uitbreidende geografische en temporele grenzen”. Competentiegericht
onderwijs aan de Open Universiteit Nederland wordt derhalve gedefinieerd als onderwijs dat gericht is op het studenten bijbrengen van een scala een kennis, vaardigheden en attitudes dat nodig is om op een doelmatige en effectieve wijze (slecht-gestructureerde) problemen in hun werkveld op te lossen.

Het ontwerp van onderwijs en leeromgevingen wordt verondersteld gebaseerd te zijn op constructivistische psychologische principes die er van uitgaan dat de lerende een interne representatie opbouwt van kennis, d.w.z. een persoonlijke interpretatie van opgedane ervaringen. Deze representatie is constant onderhevig aan verandering; de structuur en relaties vormen het fundament waar andere kennisstructuren aan gekoppeld worden. Leren is een actief proces waarbinnen betekenis wordt ontwikkeld op basis van ervaring. Conceptuele groei is het resultaat van het herkennen van meerdere perspectieven en het simultaan veranderen van onze interne representaties conform deze perspectieven, en dus het resultaat van cumulatieve ervaring. Om consistent te zijn met deze kijk op kennis, dient leren gesitueerd te zijn in een rijke context die—tot op zekere hoogte—aansluiting biedt met de echte wereld. Dit faciliteert het constructieve proces en draagt bij aan de transfer van verworven competenties naar niet-schoolse omgevingen (Bednar, et al, 1991, p. 91-2).

Binnen dit nieuwe gebied maken onderwijsontwerpers en ontwikkelaars gebruik van "authentieke" taken in elektronische leeromgevingen die lerenden in staat stellen om te interacteren met een reeks verschillende "echte" gebeurtenissen (d.w.z., ervaring in verschillende contexten of situaties) of simulaties van deze echte gebeurtenissen ("vicarious" of plaatsvervangende ervaring).

Beslissingen omtrent het ontwerpen van leertaken en de nodig geachte ondersteuningsmechanismen voor lerenden worden gebaseerd op een combinatie van:

- stilzwijgende ("tacit"), intuïtieve of professionele kennis,
- modificatie van bestaande en waardevol gevonden ontwerptechnieken en methodieken, en
- een poging om constructivistische psychologische uitgangspunten te vertalen naar instructie-ontwerpprincipes.

De voorgestelde studie tracht een antwoord te geven op de volgende vragen:

- Hoofdvraag: Wat is de rol van ontwerpstrategieën bij het ontwerpen en ontwikkelen van elektronische, competentiegerichte leeromgevingen?

  Deelvragen:
  - Hoe ontwerpen en ontwikkelen onderwijsontwerpers in concreto elektronische omgevingen die gericht zijn op het verwerven van competenties?
  - Wat is de rol van impliciete strategieën en heuristieken/vuistregels van de ontwerper/ontwikkelaar binnen dit proces?
  - Hoe kan deze kennis gebruikt worden om empirische richtlijnen te ontwikkelen voor het ontwerpen van competentiegerichte leeromgevingen?

<table>
<thead>
<tr>
<th>5 Research team</th>
<th>Name and titles</th>
<th>Expertise/function</th>
<th>Department</th>
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<tr>
<td>a Project chair</td>
<td>Dr. P.A. Kirschner</td>
<td>Educational Technology/researcher</td>
<td>OTEC</td>
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<td>b Project team</td>
<td>Prof. dr. J. van Merriënboer</td>
<td>Instruction Design/researcher</td>
<td>OTEC</td>
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<td>Dr. P.B. Sloep</td>
<td>Educational Technology/researcher</td>
<td>OTEC</td>
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<td>c Other team members</td>
<td>TWOP</td>
<td>Programmer</td>
<td>OTEC/extern</td>
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<td>d Consultants</td>
<td>Drs. F.H.D. Gastkemper</td>
<td>Head of Educational Applications</td>
<td>OTEC</td>
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<tr>
<th>6 Length of the project</th>
<th>Begin date:</th>
<th>September 1, 1999</th>
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<tr>
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<td>End date:</td>
<td>February 28, 2001</td>
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<td>Total length:</td>
<td>18 months</td>
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| 7 Intended output | a Publications and conference presentations |
## Two articles:
1. on instrument and methodology for object-action based data collection / QGOMS-based data analysis,
2. on empirical study and preliminary ID model.

- Conference presentation in the United States (AECT or AERA)
- Conference presentation in Europe (EARLI)

### Instruments and procedures
- Model for design and development (including guidelines) for designing competency based learning environments
- Designer’s tool for documenting the design of competency based learning environments

### Further elaboration

<table>
<thead>
<tr>
<th>Further elaboration</th>
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<th>Further elaboration of the problem and aims of the research project, including scientific framework</th>
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<tr>
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<td><strong>Traditional Instructional Design</strong></td>
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<td>In The Systematic Design of Instruction (1996), Dick &amp; Carey describe the design process.</td>
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<td>&quot;Instructional design, which has emerged over the last twenty years, is a process used primarily to develop a wide variety of instructional materials, such as printed materials, computer-assisted instruction, and televised instruction... A formal definition of instructional design is: a systematic process for designing, developing, implementing, and evaluating instruction.&quot;</td>
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<td>According to Smith &amp; Ragan (1993), &quot;the term instructional design refers to the systematic process of transplanting principles of learning and instruction into plans for instructional materials and activities.&quot;</td>
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<td>The Association for Educational Communications and Technology (AECT) labeled the process as &quot;Instructional Systems Design&quot; and described it as &quot;an organized procedure for developing instructional materials or programs which include the steps of analysis (defining what is to be learned), designing (specifying how the learning should occur), developing (authoring or producing the material), implementing (using the materials for strategies in context), and evaluating (determining the adequacy of instruction).&quot; (Seels &amp; Richey, 1994; 129)</td>
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<td>There is no shortage of Instructional Design models developed. In general the models have the following components:</td>
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<td>1. identifying and analyzing instructional problems or need</td>
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<td>2. planning and designing a solution to an instructional problem or need</td>
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<td>3. acquiring or developing and producing the solution to the problem</td>
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<td>4. implementing the solution in the educational setting</td>
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<td>5. evaluating and revising the solution based on feedback for final integration into the curriculum.</td>
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<td><strong>Constructivism / constructivist paradigm</strong></td>
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<td>Constructivism is not an approach to or model for instructional design, but rather a paradigm of learning based on the idea that knowledge is constructed by the learner – and eventually ‘the one(s) who know(s)’ - based on his/her/their mental activity. Learners are active in seeking meaning. Consistent with this view, learning must be situated in a rich context, reflective of real world contexts, for this constructive process to occur and for transfer to environments beyond the school to be possible.</td>
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<td><strong>Components of constructivism</strong></td>
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|                     |   | Constructivism holds that in order to learn, learning needs to be situated in problem solving in real-life contexts where the environment is rich in information and where there are no right answers (embedded knowledge). The tasks must be authentic and are best learnt through cognitive apprenticeship on the part of the learner in a rich environment. Meaning is negotiated through interactions with others where multiple perspectives on reality exist. Reflexivity is essential and must be nurtured. Finally, all of this is best (and possibly only) achieved when learning takes place in ill-structured domains. Taking these one for one:
- **Situated learning and authentic tasks**: Situated learning (Brown, Collins & Duguid, 1988) is a method of ensuring that students learn to understand concepts anchored within the context of an area of study. Instead of abstracting unrelated bits of knowledge in an area of study, a student learns about a subject area by immersion in that culture. The objective is to produce a student who, if studying within a certain area or professional domain, understands how a practitioner within that domain acquires knowledge, finds information in his or her field and integrates this knowledge to solve problems in that domain. A rich context for problem solving becomes part of this component.

- **Cognitive apprenticeship**: In cognitive apprenticeship, a teacher models those thought processes that characterize an expert in a particular field. (Collins, 1988) Experiences are provided for the student that mimic the apprenticeship programs of adults in trades, or teachers in internship. Although it is not possible to submerge the student to the extent that an internship would imply, through the use of simulations and meaningful experiences, the student would learn the ways of knowing of an expert.

- **Social construction of shared perspectives - Collaborative learning**: Von Glasersfeld (1988) discusses the social construction of knowledge where concepts are developed in a process of fine-tuning involving interaction of others. Group interaction aids this process, because it exposes the learner to multiple perspectives about a theme. Collaborative learning which emphasizes the need to examine an issue from all sides gives students the understanding of various points of view.

- **Nurturing reflexivity**: Constructivists believe it is important to encourage reflexivity whereby students become aware of how their own thinking processes work. Helping students to think about how they are arriving at conclusions, or how they go about solving problems, helps form more meaningful links between knowledge and develops more elaborate cognitive schemata.

- **Ill-structured problem domains**: Spiro et al (1988) developed the Cognitive Flexibility theory that addresses knowledge acquisition in ill-structured domains. It was developed after they discovered that many learning failures resulted from cognitive oversimplification and the inability to transfer knowledge and apply it to new cases. In many cases, the design of learning involved the use of typical cases to explain a concept. The solutions to these typical cases were usually too obvious for students, so many students could not solve problems that involved more complex sets of factors. To counter these problems they suggested the need for instructional systems which allow students to revisit “the same material, at different times, in rearranged contexts, for different purposes, and from different conceptual perspectives” (p. 28). The idea is that many cross-links may occur, and conceptual richness will develop as a student spends time investigating the various connections between themes or concepts.

**Implications of this paradigm of knowledge for the design of instructional tools**

Traditional designers first attempt to analyze content and prerequisites (see above) to identify a course sequence. Constructivist course designers “know” that content cannot be pre-specified. Although a certain amount of content may be available for students to use, they are encouraged to seek out as many alternate sources of knowledge as they can find to deepen their perspective of the topic they are working on. Here, the notion of situated learning is important. Students are encouraged to consider what real life people in a particular environment would do. Traditional theory focused on the typical learner and what he or she would know when the course was completed. A constructivist learner is not described. Instead, through metacognition, all learners are encouraged to reflect on how and what they are learning and how it fits into what they already know. Traditional theory specifies objectives for knowledge acquisition in advance. Constructivism attempts to identify the culture of a knowledge domain.

The synthesis or design phase of traditional instruction involves the design of a sequence and message to achieve specified performance objectives. Pre-specified content and objectives are not congruent with a constructivist worldview. Substituted for these activities would be: learning based on situated cognition in (electronic) learning environments that more or less
mimic real world contexts; cognitive apprenticeship and modeling; and negotiation of meaning through collaborative learning emphasizing multiple perspectives of analysis. Another emphasis in constructivism is to make available an array of cognitive tools that can scaffold the learner within this rich, sometimes confusing, environment. In electronic learning environments, this refers to computer-based tools.

A beginning of an ID-model based on constructivism

Some general aspects of designing education / educational environments according to constructivist theories (Wilson, Teslow & Osman-Jouchoux, 1995) are:

• Apply a holistic/systemic design model that considers instructional factors (learner, task, setting, etc.) in increasing detail throughout the development process. Rather than doing a learner or task analysis once early in the process, return to these factors and their interactions continuously through the project cycle (e.g., Wilson, Teslow, & Osman-Jouchoux, 1993).

• Consider solutions that are closer to the performance context (job aids, just-in-time training, performance support systems, etc.). This is consistent with situated models of cognition and with the notion of distributed cognition (Perkins, 1993).

• Use objectives as heuristics to guide design. Don't always insist on operational performance descriptions that may constrain the learners' goals and achievement. The 'intent' of instruction can be made clear by examining goal statements, learning activities, and assessment methods. Goals and objectives should be specific enough to serve as inputs to the design of assessments and instructional strategies.

• Don't expect to capture the content in your goal or task analysis. Content on paper is not the expertise in a practitioner's head. The best analysis always falls short of the mark. The only remedy is to design rich learning experiences where learners can pick up on their own the content missing between the gaps of analysis.

• Give priority to problem solving and meaning-constructing learning goals. Instead of rule following, emphasize problem solving (which incorporates rule following but is not limited to it). Instead of simple recall tasks, let learners make sense out of material and demonstrate their understanding of it.

• Allow for multiple goals for different learners. Hypermedia and collaborative work learning environments almost - by definition - are designed to accommodate multiple learning goals. Even within traditional classrooms, technologies exist today for managing multiple learning goals (Collins, 1991).

• Consider teaching models based on the constructivist paradigm such as cognitive apprenticeship, minimalist training, intentional learning environments, and case- or story-based instruction. Seek out instructional strategies and systems that use authentic problems in collaborative, meaningful learning environments (see Wilson & Cole, 1991b).

• Consider strategies that provide multiple perspectives and that encourage the learner to exercise responsibility. Resist the temptation to "pre-package" everything. Let learners generate their own questions or presentation forms.

What do instructional designers actually do?

There is a clear difference between designing instruction as a practical activity and ID (Rowland, 1993). While ID models often inspire designers, their activities typically don't reflect the systematic, step-by-step approach as prescribed in traditional ID models. Systemic, zig-zag or even chaotic design activities can frequently be observed - especially for expert designers (Rowland, 1992). Krabbe (1998), in a study of what curriculum developers do, relates standardization (the use of a method), professional practice and curriculum development in a triangular way which may lead to tension and (im)possibilities. Analog to this, a similar relationship may exist with respect to design of competency-based learning environments:
For design of competency-based learning environments based on constructivist assumptions no full-fledged ID models are yet available. Especially for such design enterprises, implicit strategies and rules-of-thumb will heavily influence the design process (see, e.g., Rowland, 1995). Krabbe (1998) cites one of her subjects as follows: “Curriculum developers use creativity as an excuse not to use an instrument when carrying out their work”. We define creativity here as making use of one’s professional knowledge and skills ‘above and beyond’ the constraints of the model used to design learning environments. One of the main aims of this project is to find out what instructional designers actually do when designing competency-based learning environments. This will offer a first knowledge base that may help to develop empirical guidelines for the design of electronic, competency-based learning environments.

b Importance for the Open University of the Netherlands and the place of the research in the OTEC Research Program
The design of competency-based, electronic learning environments is central to the recently adopted educational model of the OUNL. There is a clear risk involved in this choice, because no full-fledged ID models are yet available that provide clear prescriptions for how to design such environments. In the worst case, design and development projects may become highly cost-ineffective or lead to sub-optimal learning environments. The current project is a first step towards the development of a (systemic) ID model. It will first describe the strategies and heuristics applied by expert designers, then identify commonalities in the approaches of those designers, and finally use these commonalities for offering prescriptions for the design of learning tasks and support mechanisms in electronic, competency-based learning environments.

c Design & Methods
This research makes use of a number of qualitative research methods to arrive at a preliminary instructional design model for designing and developing competency based learning environments.

Participants
The participants in this research project are expert designers and developers of instruction (Nmax=12) from institutions noted for their high quality designs of instruction. These include Educational Technologists and Technical Scientific Designers/Programmers (TWOP’s) at the OUNL and expert designers/developers at other institutions who are familiar with the ideas underlying competency-based learning (e.g., University of Twente, Arthur Anderson Consulting, Tennyson, Merrill, Jonassen, Mayer, Scandura, et cetera).

The design of the experiment entails the following steps:

Step 1. Design an instructional design task
This task will be an instructional design task for the design of - aspects of – an electronic, competency based learning environment in a particular subject matter domain. The constraints (time, money, manpower, technical facilities) will be comparable to the constraints
Step 2. Develop an electronic instrument for observation/analysis of the design process

An electronic instrument will be designed and developed for observing, analyzing and recording the instructional design process. Ideally, the instrument should not have an impact on the natural flow of the design process (cf., thinking-aloud protocols); pilot studies will be used to determine a possible impact. This instrument has four functions, namely:

- It will essentially be a tool for a multi-level representation of cognitive goals as action-object pairs, or, a layered representation of object-action matrices (Elkerton & Palmiter, 1991). This – to be designed and developed – direct manipulation instrument graphically offers a number of actions and objects to subjects (instructional designers) with which they carry out and document the completion of the design task. For example, cognitive goals at the highest level can be represented by the actions “explore”, “analyze” and “design”, and the objects “target group”, “context”, and “task”. At the second level, each cell is further specified in a lower-level action-object matrix, et cetera. In addition, subjects have the freedom, or are even encouraged to specify their own actions or objects at each level.

  This tool is based upon a variant of GOMS (Goals, Operators, Methods, Selection) a rule-based approach to the analysis of skills that takes cognitive goals into account (Kieras, 1988) called QGOMS (Quick (and dirty) GOMS). GOMS is a family of techniques initially proposed by Card, Moran, and Newell (1983), for modeling and describing human task performance and/or the knowledge necessary for a person to perform a task. Goals, Operators, Methods, and Selection Rules are the building blocks for a GOMS model. Goals represent what a user is trying to accomplish, usually specified in a hierarchical manner. Operators are the set of atomic-level operations with which a user composes a solution to a goal. Methods represent sequences of operators, grouped together to accomplish a single goal. Selection Rules are used to decide which method to use for solving a goal when several methods are applicable.

  QGOMS is a tree-like visual mental model that is very useful for comparing system designs. It reduces the number of modeling constructs necessary for a GOMS analysis, uses highly modified selection rule mechanisms, and is visualized and manipulated with a graphical tree structure and direct manipulation tool. QGOMS reduces the conceptual complexity of GOMS because users do not have to learn the subtle differences between goals, methods and operators (only task nodes are used) and the visual representation of the model allows the designer to see opportunities for design and consistency improvements.

- It will not only allow the subjects to carry out their task, but will also (1) give them information that is essential for performing the task, (2) prompt them to document and explain each chosen action and object, and (3) assign costs (time, money, manpower) to reaching particular goals. First, choosing particular goals or action-object pairs will sometimes lead to the provision of information that is essential for performing the design tasks. For instance, selecting the pair Analyze-Target Group will yield some basic information on the target group, selecting the pair Interview-Expert will yield some basic information on the to-be-learned competency as given by a content expert, etc. Second, it will prompt the subjects to explain their arguments for selecting the goal or action-object pair (e.g., Why have you chosen this action or object? How do you plan to do and/or make that? What is the effect of that action or object? et cetera). This information will take the place of active experimenter observation and thinking aloud for understanding and analyzing what the subjects do and why they do it. Third, it will assign costs in terms of time, money and manpower to reaching each of the goals specified so that the design enterprise mimics the real world and the gathered data mimic real-world instructional design, and not an idealized model of instructional design. For instance, the higher-level goal or action-object pair Analyze-Task can either be reached by the lower level goal

that are common at the OUNL.
Build-Cognitive Simulation or Interview-Expert, but it should be clear that the costs connected to the first option are much higher.

- It will log and be able to ‘play back’ the process that the subject carried out (the design trace) for later analysis and which can be used as a basis for debriefing interviews with the subjects.
- It will form the basis for an OTEC direct manipulation “design tool” for designing and developing electronic, competency based learning environments. In this stage, it is only a “basis” because it merely supports designers in their documentation of activities that take place during the design process.

Step 3. Give designers/developers a substantial task (approximately four design hours) to design instruction for achieving a competency as developed in step 1 in which they make use of the instrument developed in step 2.

Subjects will be given a short introduction to the use of the (in step 2 designed and developed) instrument. This will be followed by a practice problem (unrelated to the experimental task) to allow the subjects to practice using the instrument. After this training the subjects will be given the experimental design task and will be allowed approximately four hours to complete it. During this period one of the experimenters will be present to observe and technically assist in the use of the instrument if and when necessary.

Step 4. Carry out a preliminary analysis of the design process (goal trees based upon an analysis of the design trace in step 3) and the product of each of the subjects

The preliminary analysis will give the researchers a notion of whether or not there is a need for more explanation as to the design of the model (objects and actions) and why specific choices were made by each subject. Based upon this preliminary analysis the researchers will determine whether or not a debriefing is necessary and - if so - what the debriefing will need to entail for each individual.

Step 5. Based on the results of step 4 make use of structured interviews / debriefing to get at the underlying ID principles that the subject used (audio registration)

In a structured interview, based upon the results of step 4, the subjects can be debriefed as to the decisions they made, the actions and objects they defined, the methods they employed and the reasons why they made certain choices.

Step 6. Carry out a thorough analysis of the process (goal trees based upon step 3) and interview data (step 5)

In this step a detailed analysis of the data which has been gathered will be carried out. The analysis will be based upon the in step 2 developed variant of QGOMS. A top-down, breadth-first expansion of methods and goals (as known from the action-object matrices) will be made. High-level methods are identified that subjects used to decompose the initial task into a sequence of subtasks; intermediate methods will be identified that describe the sequence of functions necessary to complete a subtask, and - if possible - low level methods will be identified that generate the actual actions necessary to perform a function.

Step 7. Distil a model for instructional design

The basis of this study is description of actual design strategies. One possible outcome is that different designers use completely different methods to obtain identical goals. Then, it would not be possible to distil a more general model for instructional design. However, it is assumed that some methods will pop up that - a majority of - designers use to reach particular goals in the design of learning tasks and support structures in competency-based learning environments. Such methods will offer the basis for a preliminary model for constructivist instructional design.

Step 8. Revise the instrument for use within OTEC

Based upon both the model developed in step 7 and the experiences with the research instrument, the instrument will be refined for use as a developer’s documentation tool for the
design and development of competency based learning environments.

d Literature


The components of the proposed research are:
- Task and instrument design and development
- Experiment
- Analysis and debriefing
- Model development
- Instrument perfection – OTEC tool

Time planning

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<tr>
<th>Design task</th>
<th>Design and develop case</th>
<th>Design and develop instrument</th>
<th>Give task to subjects</th>
<th>Analyze task completion</th>
<th>Analyze products</th>
<th>Debrief</th>
<th>Distil model</th>
<th>Refine instrument</th>
<th>Report</th>
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</tbody>
</table>

10 External partners
None

11 Motivation for external partners
Not applicable

12 External financial support
Not applicable

13 Budget (internal and external staff)

<table>
<thead>
<tr>
<th>Person</th>
<th>To the account of</th>
<th>Hours/week</th>
<th>Period</th>
<th>Cost in kƒ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. P.A. Kirschner</td>
<td>OTEC</td>
<td>8</td>
<td>18 months</td>
<td>42</td>
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<tr>
<td>Prof. dr. J. van Merriënboer</td>
<td>OTEC</td>
<td>12</td>
<td>18 months</td>
<td>81</td>
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<tr>
<td>Dr. P.B. Sloep</td>
<td>OTEC</td>
<td>8</td>
<td>18 months</td>
<td>42</td>
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<tr>
<td>TWOP (12/99 &amp; 1/00)</td>
<td>OTEC</td>
<td>24</td>
<td>8 weeks</td>
<td>14¹</td>
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Total 179

14 Budget (material)

<table>
<thead>
<tr>
<th>Materials and apparatus</th>
<th>Cost in kƒ</th>
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<tbody>
<tr>
<td>Expert designers as subjects (OTECA)</td>
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<tr>
<td>Expert developers as subjects (OTECA-TWOP)</td>
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<tr>
<td>Expert developers as subjects ($n_{max}=6$ for 4 hours each for $100,-$ per hour) – see 15a</td>
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<tr>
<td>Notebook computer – see 15b</td>
<td>7</td>
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<tr>
<td>FreeSpeech 98® Dutch and English – see 15c</td>
<td>0.5</td>
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<tr>
<td>Travel expenses for data acquisition – see 15b</td>
<td>6</td>
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</tbody>
</table>

Total 15.9

¹ This is based upon the availability of internal programming capacity. If this is not available then the cost will be approximately 30 kƒ
15 Explanation / justification of material costs
   a  Payment of external research subjects
   b  Notebook computer is necessary for the testing of external subjects at their own place of work and/or conferences
   c  Speech recognition software in English and Dutch to simplify the production of protocols

16 Budget (travel)

<table>
<thead>
<tr>
<th>Purpose/justification</th>
<th>Cost in k£</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conference in the USA (AACE)</td>
<td>4</td>
</tr>
<tr>
<td>Conference in Europe (EARLI)</td>
<td>2</td>
</tr>
<tr>
<td>total</td>
<td>6</td>
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</tbody>
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17 Appendices attached  None