RECENT DEVELOPMENTS IN INSTRUCTIONAL DESIGN
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Summary
Traditional instructional design theories and models are developed from behavioral theories and from general models how to solve an educational problem. Based on ideas and research results of cognitive science and the development of highly interactive, technology based delivery systems it became clear that the traditional design theories and models had some limitations. The most important criticism is the analytical nature of instructional design theories. All theories start with identifying the components and subcomponents of the subject matter which then are used for designing and sequencing instructional frames. Especially in case of complex subject matter which contains several concepts, principles and procedures, the student may be unable to integrate the components in organized wholes. The analytical nature of the traditional theories also causes an economic problem, because the designer of instruction needs to compose every instruction from the basic elements, which is labor intensive. Finally, traditional instructional design theories mainly refer to tutorial instruction in which the student is supposed to be passive.

The symposium addresses the limitations and criticisms and will discuss how recently developed instructional design theories and models which are embedded in or derived from cognitive science try to solve the instructional design problems. Attention is given to inquiry teaching, to the constructivist approach, to the use of contextual knowledge and to the integration of knowledge and skills through problem solving techniques. The application of cognitive orientations in designing exams also will be addressed.

Introduction
Traditional instructional design models are developed from behavioral theories and from general models how to solve an educational problem. Based on ideas and findings of cognitive psychology in the seventies and early eighties, new models and design rules emerged, which roughly comprise four approaches: inquiry teaching (Collins, 1977, 1983), instructional design strategies for concept teaching (Tennyson and Cocchiarella, 1986), constructivism (Brown, Collins and Duguid, 1989; Jonassen, 1992) and the use of contextual knowledge (Brown, Collins and Duguid, 1989; Jonassen, 1990 & Tennyson 1992).
The purpose of the inquiry method is teaching students to reason from cases in order to develop a knowledge network. The results of experiments on human memory and reasoningsupported the supposed structure of human knowledge as a rich semantic network which comprises declarative, procedural and metaknowledge. The knowledge base consists of incomplete and inconsistent knowledge. The students use this knowledge in reasoning and in drawing conclusions. Collins, Warnock, Aiello and Miller (1975) analyzed the reasoning of students, especially the negative and functional inferences and published the first results of a method of inquiry teaching. Collins (1977, 1983) further developed the rules of inquiry teaching and presented a theory of inquiry teaching. The theory had three parts: the goals of teachers; the strategies teachers use and the control structure that governs their teaching. Themethod of inquiry teaching was described independent of the content of the subject matter, but several publications make clear that subject matter which shows causal structures is often used to illustrate the method of inquiry teaching. Tennyson and Cocchiarella (1986) presented an empirically based instructional design theory for teaching concepts. The theory was an update of the Merrill and Tennyson (1977) model which was based on the classical theory of concept learning. Evidence for this theory was mainly derived from carefully designed laboratory experiments with artificially constructed stimuli which could be categorized with certainty once the concept was learned. In the seventies the classical theory faced several problems such as the existence of disjunctive concepts, the existence of unclear cases and the failure to specify defining features for most concepts. In research attention was given to the learning of natural concepts and concepts with less "well-defined" attributes. The results indicated that the process of concept learning has two phases: the formation of conceptual knowledge (prototype formation) and the development of procedural knowledge. Conceptual knowledge is formed by the integrated storage of meaningful dimensions (defining and variable attributes) selected from known examples and by the connection of this information to a given domain of knowledge. The instructional design model which was developed by Merrill and Tennyson emphasized the instruction of the defining attributes and the instruction of an isolated concept. Tennyson and Cocchiarella however elaborate on prototype formation by defining a "best example" in their instructional design strategy. They also pay attention to attribute characteristics (constant and variable) and to the relational structure of concepts (successive and coordinate). These factors lead to attribute elaboration and to the successive and simultaneous presentation of examples as components of the instructional strategy. The importance of prerequisite knowledge is underlined for which embedded refreshment is a necessary instructional design component. Current cognitive theory emphasizes that learning is a process of knowledge construction, not knowledge absorption. Learning occurs by interpreting information and by checking whether the supposed consequences will happen. Effective learning depends on the intentions, self-monitoring and representational constructions of the learners. Thus the instructive environments should be designed in such a way that they provide information and questions for the knowledge construction processes of the students. They should support multiple perspectives of reality, knowledge construction and context-rich
experience based activities (Jonassen, 1991). The important application of the constructive view of learning is the provision of instruction in relevant contexts. Learning should occur most effectively in context. The context becomes an important part of the knowledge base associated with that learning. Brown, Collins and Duguid (1989) stressed the distinction between authentic and school activities. When authentic activities are transferred to the classroom, the context is changed and the tasks become classroom tasks instead of real tasks. As a result, they state, conceptual and problem-solving knowledge acquired in school remains largely unintegrated or inert for many students. Learning should be adjusted to the situation in which it takes place. Instruction should provide for a relevant context. The contributions of the symposium elaborate on the changes in instructional design theories and how the changes influenced the actual design of instruction. The results of the research addresses the effects of the instructive environments, both retention and transfer.

THE INSTRUCTIONAL DESIGN, STUDENT ACTIVITY, DISCOVERY LEARNING AND TEACHING TO SOLVE PROBLEMS

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Summary

Recently traditional instructional-design theories and models, which are developed from behavioral learning theories and from general educational problem-solving models, are criticized. The traditional theories and models were too analytic and unable to teach integrated wholes. The analysis of the subject matter or the target behavior of the students usually resulted in different outcomes of instruction such as facts, concepts and principles. For each of these categories a further analysis was made and the components of the outcomes were reformulated such as attributes and relations. The results of the analysis were used to design and sequence the instructive frames. The emphasis was on the presentation of information or external conditions for learning rather than on what the student should do. Therefore, traditional or first generation instructional design was only seen as a tutorial approach which supposed the students to be passive and which was insufficient to design the teaching of problem-solving activities.

This paper will try to link the knowledge of human problem solving with recent developments in instructional design. It will address the issue of the analysis of the target objective, how detailed this should be done and how the resulting components can be used to formulate questions and problems which stimulate the student's activity, enhance the formation of cognitive networks or schemata and in some situations lead to discovery of problem-solving procedures. The tutorial approach will be compared with an experiential approach that for different types of content can realize continuous transactions with subject matter. Attention will be paid to understanding and applying knowledge in solving complex problems.