

Student experiments in object-oriented modeling

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Abstract

Exploration modules (EMs) and structures of knowledge as essential components of the author's concept "Didactic system for object-oriented modelling (OOM)" for improving the OOM education are introduced as new learning aids for student-centered learning. The didactic criteria "Basic concepts on different abstraction levels" and "Synchronization, transformation and evaluation of views" for the design of EMs are developed. A methodology for designing a "didactic map" of object-oriented basic concepts as a process oriented learning aid is described. The activities of learners when using EMs with the solution of complex problems, e.g. modelling a library system, are illustrated. The strategy for inclusion in the Informatics teacher education is connected with some words on the concepts' efficiency.

1. MOTIVATION

Good career prospects in the Informatics field led to an enormous increase in the number of Informatics study beginners at German universities from the middle of the nineties. According to the German Federal Office of Statistics, the total number of Informatics study beginners (first university semester) has risen steadily from 4611 in 1995/96 to 11496 in 1999/2000. The Informatics faculties can hardly cope with this crowd. For example, in the semester 2000/01 the University of Dortmund had to schedule lectures repeatedly per week due to the entry of about 1100 beginners. The load on students and lecturers was enormous. According to information from the German "Fakultätentag Informatik" (steering committee of all accepted German Informatics faculties) the ratio of graduates in relation to study beginners has fallen from 50% in 1999 to 45% in 2002. This reflects an

increase in the number of university dropouts and also in the study length of students. There is a need for a change in the study processes. In the year 2001, the German Ministry of Education and Research started to support about 100 university collaborative research projects in the field "New Media in Higher Education". About a fourth of these projects were Informatics projects. Multimedia e-learning materials were developed to support student-centered learning and to relieve overburdened Informatics faculties. The work of consortia like the "European Consortium of Innovative Universities" [4] extends this approach to an international level.

Besides the development and distribution of e-learning materials, the Informatics study must be developed further by including new learning forms and learning aids so that student-centered learning, self-paced learning, and the preparation for lifelong learning become essential structuring elements of the learning process. Learning concepts, which should be taken into account in this context more strongly, include active and explorative learning [5, p. 150]. Traditional learning scenarios in higher Informatics education do not include enough such natural learning forms. An auditorium is a difficult environment for learning by discovery. Within the approach of "discovery learning" the teacher should design the learning process as a sequence of problem situations, each involving a learning task, which stimulate the learners' research interest. Suitable result-oriented learning aids are necessary to support learners in their explorative learning process.

Brinda and Schubert developed a concept called "Didactic system for object-oriented modelling" as a combination of traditional and new studying concepts [2, 3, 7]. The concept addresses beginners in object-oriented modeling (OOM), selected for the study because of its relevance in a variety of Informatics areas such as software engineering and object-oriented databases. The main goal of the didactic system is to bring a new quality of learning to the OOM field. The didactic system makes it possible for learners to navigate in structures of knowledge, to construct solutions for exercises from exercise classes, and to learn by discovery with exploration modules (EMs). In the context of this paper, EMs can be thought of as software modules (small applets, applications and animations). In a wider sense, learning texts and other media are included to form more complex EMs. Here the main emphasis lies on structures of knowledge and the embedding of EMs in the social process of Informatics study. Exercise classes are discussed in [2].

2. EXPLORATION MODULES AS NEW LEARNING AIDS

Discovery learning strategies are often applied by Informatics students as a work reduction strategy. They discover and then reuse standard algorithms from textbooks. The same strategy is used with software libraries. Available solution parts are adapted and integrated in the solution of new problems to avoid repeated development. This intrinsic motivation, which lies within the subject, led to the concept of the EMs. Learners explore EMs in suitable learning scenarios and in that way learn about basic object-oriented concepts and object-oriented models.

Within the design of EMs, manipulative and perceptive ways of exploration have to be considered. Manipulative exploration allows the exploring person to change something and get immediate feedback. The EM has to provide specific manipulation and observation components, combined with check mechanisms. Perceptive exploration requires structures that can be discovered. Therefore, the EM has to offer multiple cognitive approaches, which show the explored object in different ways and combine or even synchronize different views to visualize complex structures. By didactic analysis of the OOM field indicates that beginners should get to know and design structures (static basic concepts) and understand and control processes (dynamic basic concepts). Starting from an application they should analyze, modify, construct, and assess object-oriented models in the stages of structure element, structure, and model. This results in the exploration promoting features of EMs shown in table 1.

Table 1. Exploration promoting features of EMs

| Feature | Description |
|---|--|
| Basic concepts on different abstraction levels | Structures, their elements and models must be explorable on different abstraction levels to give learners with various pre-knowledge a cognitively demanding entry to object-orientation, i.e. the complexity of views ought to be adjustable. It has to be possible to switch on or off selected views. For beginners as a minimum of one static view (class diagram) and one dynamic view (interaction diagram) are necessary to describe the structure and the time change of an object-oriented model. |
| Synchronization, transformation and evaluation of views | Synchronization represents a "didactic bridge" between different diagrams. This makes it possible to bring the single views together to a picture of the complete system and to overcome a known cognitive barrier. For some educational purposes, it should be possible to synchronize different views automatically. If learners do this manually, model check functions must be provided to prove the model's consistency. |

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