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INFORMATICS AND
STUDENT ASSESSMENT

Concepts of Empirical Research and Standardisation of
Measurement in the Area of Didactics of Informatics

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Preface

Mission Statement

The Dagstuhl-Seminar 'Concepts of Empirical Research and Standardisation of Measurement in the Area of Didactics of Informatics' is organised in order to make a contribution to the development of didactics of informatics in general and to foster empirical research in the area of informatics education particularly. It is also intended to link the discussion of national experts about standards of informatics education to the discussion of the international scientific community within this area. Connected with the development of a theory of didactics of informatics educational standards are regarded as standardized objectives of qualification in subject related learning processes. They contain educational objectives of informatics and thus also describe implicitly the contribution of informatics as a subject in schools to general education.

The history of informatics, of informatics education and of didactics of informatics is a very short one in comparison to other more traditional sciences and subjects. Due to this legal and educational framework it is necessary to establish a tradition of discussion of didactical concepts in the area of informatics education in order to develop a subject related didactical theory. Though there is a strong relation between empirical research and the development of didactical theory, we unfortunately have to register a lack of empirical studies in the area of didactics of informatics. To develop concepts of empirical analysis of learning processes in informatics education and regarding them as results of realisation of practical aspects of a didactical theory are main issues of the seminar.

Therefore, during the seminar different concepts of empirical research will be presented. Especially the process of operationalisation of test items related to educational standards will be discussed. In comparison with research concepts of class room work in other subject areas empirical research methods in informatics education must direct their attention additionally to the use of software-tools and integrated development environments. Empirical analysis of class-room work in informatics must include collaborative processes within learning groups and individual and collaborative aspects of human-computer interaction. The intention is to gain more sophisticated empirical instruments which fit in a special way with the specific demands of the subject area.

Educational Standards of Informatics

This Dagstuhl-Seminar will give reason for the use of educational standards within the area of informatics education and emphasise the importance of standards for empirical research. The intellectual techniques of informatics such as problem oriented modelling, formalisation and abstraction change research and lecture in other subject areas, including pedagogics, and support meta-knowledge in order to master complexity.

The educational value of informatics is determined by this method of cognition within other sciences even apart from informatics systems. To learn about design and construction of informatics systems as a process of balancing interests between stakeholders makes people realise that exerting influence on system design and the considered use of technical systems is an important issue of democratic societies.

Based on the fundamental educational importance of informatics there are recommendations, national and international curricula and demanding educational concepts concerning informatics education. They include mainly not approved and empirically verified educational standards, e.g. methodical skills and domain related knowledge. In a wide range of educational topics in which students' learning success is scored there is a tendency towards internationally harmonized test methods for the educational outcomes of institutional learning. At the moment such comparative data are missing for informatics, especially for the impact of informatics on general education issues. In order to formulate educational standards within informatics education comparable teaching-and-learning-materials must be developed.

The concept of „Didactic Systems" ensures such a collection of coordinated teaching-and-learning-materials, which, as part of a class scenario, may lead to different skills very flexibly according to the respective target group and enables the integration of secondary informatics education into international student assessment. Thus, educational learning processes in informatics will become more transparent and comparable. In the aftermath of that a certain level of standardisation will contribute to the quality assurance and sustainability of the general educational impacts of informatics education.

New Research Results

In the last years we observed the consolidation of a new part of informatics, the field of didactics of informatics through a row of powerful doctoral theses, e.g. from Torsten Brinda, Ira Diethelm, Berit Holl, Ludger Humbert, Eckhart Modrow, Carsten Schulte, Marco Thomas, and the postdoctoral thesis of Peter Hubwieser. Therefore, the time is ready to establish a new level of cooperation to solve open questions and pressing tasks based on such successful research designs and tools. The invited expert group of the Dagstuhl-Seminar 2004 was asked to give their experience to the task force "Educational Standards of Informatics".

The research by *Torsten Brinda* shows the way from objectives to educational standards for the field of object-oriented modelling (OOM). The key idea of this approach is the identification, structuring and testing of new exercise classes. He developed this exercise classes as part of his specific concept "Didactic System for OOM". This concept provides such exercise classes to enhance the quality of learning. The power of the research results lies in the connection of a competence level model with informatics cores, subjects and types of exercises. On this basis he deduced competence levels from cognitive and planning preparation of OOM (level 0) to the advanced OOM and assessment of models (level 4).

Volker Claus describes how to educate students to be future successful applicants of informatics with a learning and teaching method called "Basic Reciptique". This method is the core of a new kind of didactics of Informatics, the "Service Didactics" of informatics Application. As an expert of theoretical informatics he illustrates the connection between the skills and the essential knowledge for this specific target group. The new "Service Didactics" could guarantee an efficient and serious informatics application strategy for other sciences. He recommends experiments in the virtual laboratory as a technique of interdisciplinary learning of informatics and other sciences.

Ira Diethelm, Leif Geiger, Christian Schneider, Albert Zündorf present two papers concerning the problems of measuring modelling activities. The first paper 'Measurement of Modelling Abilities' discusses the difficulties of measuring modelling abilities within empirical examinations. Besides a description of diverse aspects of the subject area, especially the challenge to operationalize cognitive processes at different levels of abstraction of a model, the authors provide us with a specific solution for grading modelling abilities of 3rd term students. Their second paper 'Automatic Time Measurement for UML Modeling Activities' outlines the current state-of-the-art in automatic time measurement in CASE tools and what may be achieved in the near future. This is done with respect to empirical studies for learning and teaching processes.

Ludger Humbert, Hermann Puhlmann analysed kinds of phenomena of informatics, such with direct, such with indirect and such without connection to an informatics system but with informatical structure or informatical reasoning. They discuss the conclusions of these properties for a phenomena-driven approach in informatics education and the phenomenon-based test items. The relation between modelling skills and different techniques of formalization was described together with examples of appropriate test items. These last findings were summarized to design conclusions of test items to determine the degrees of literacy in informatics.

Dietmar Johlen's paper "Learning Process' Evaluation in Vocational Schools for the IT Sector's Training Occupations" presents the concept of learning areas for the IT sector's training occupations. The scenario-approach is introduced, which represents a methodical-didactic reference system for the development and execution of instruction. From this starting point the evaluation of learning process in vocational training, especially in regard to the advancement of competencies were discussed. The author stresses that the scenario-approach puts the concept of learning fields in precise terms and that this approach is also an appropriate research environment for the evaluation of learning processes.

The empirical studies by *Peter Micheuz* show the results of a project in informatics education of learners at the age between 10 and 12 years in comprehensive secondary schools in Carinthia/Austria. The learners are in the beginning highly motivated to master the fourth cultural technique, but the enthusiasm of all learners (girls as well as boys) decreases significantly after one year. In teamwork a minimal standard curriculum was established and a pool of exercises. The project confirms two well-known facts; first the preparations for informatics lessons are extraordinarily intensive and second the teachers prefer to work with materials they prepared themselves.

Eckhart Modrow's paper 'The Contribution of Computer Science to Technical Literacy' deals with the idea of general education and how informatics at school may foster students' appreciation of technical systems, especially informatics systems. The author stresses the importance of that issue in regard to students' occupational choice. For the discussion of educational standards and for the selection of content in the area of didactics of informatics it is also very important to analyse the contribution of informatics to technology related topics and its relation to general education. The paper also examines how the term "technical general education" may be substantiated and discusses on the basis of some examples the consequences for the class room work in informatics.

Olaf Scheel describes the use of learning objects in an interactive computer-based learning environment for Blended Learning called Informatics Learning Lab (ILL). Students should use learning objects in a self-organized learning process in this open collaborative learning environment. The paper focuses on the construction of the learning objects and examines the coding types and levels of abstraction of the learning objects' media. An empirical research design is presented that should give reason for the design of problem based learning scenarios and analyses the effects of interactive animations in order to achieve software engineering related objectives.

Markus Schneider presents a matrix of measurable quantities which connects fundamental concepts of informatics, complexity levels of the exercises (low, intermediate, high) and the test results of students (female and male separately) in higher informatics education (first academic year). He discovered important results. Various program styles should be learned in the order of increasing syntactic complexity. Lectures are not suitable for the support of the students' self-activity. Female students start their first academic year with the handicap of missing knowledge on program languages and application strategies. Adequate study scenarios are to be developed in future work.

Carsten Schulte describes how to measure the effectiveness of learning-processes in informatics that rely on the use of programming environments. The paper deals with empirical research concepts which examine the influence of media on learning processes, especially in the area of informatics. According to the thesis that media may not influence learning under any conditions, the emphasis shifts from searching the best media to the search of effective learning environments. The conclusion to be drawn from this paradigm shift is with regard to empirical studies to supplement empirical pre-post design by instruments which enable to analyse human computer interaction with the software tools.

The research by *Andreas Schwill* shows that educational standards of informatics need a clear definition of the expressions "idea" and "term". He analyses works of Plato, Descartes, Locke, Leibniz, Hume and Kant. He describes the impact of the properties of ideas for the process of education, e.g. the influence of basic ideas on more complex ideas. From this he deduces the specific role of "idea" and "term" in the process of cognition, e.g. terms are structuring the subject area of cognition and ideas are controlling the process of cognition. This article complements his publications on "Fundamental Ideas of Informatics" (e.g. algorithmizing, structured decomposition, language).

Through the publication of these new research results, we hope to intensify the dialog among the German researchers and the international community in didactics of informatics, to promote educational standards of informatics and their integration into the Programme for International Student Assessment (PISA).

We hope that many readers in the informatics community will benefit from these contributions.

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Content

Participants with not published lectures:
Götz Bieber
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