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# Current Status and Prospect of Educational Informatics

at the University in Landau, Germany

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## Abstract

Achievements, results, knowledge and techniques of informatics persuade increasingly all other sciences, and of course especially traditional educational sciences. In 1993 the Institute of Educational Informatics was founded within the department of natural sciences at the University in Landau, Germany. The institute takes traverse dimension of informatics into account and makes its main objective the application of methods of informatics to educational sciences. All subjects of research are analysed in team work with multiple sciences. Doing so the institute meets the demands to integrate not only the methods and models of informatics but also those of educational sciences when applying and inforcing methods of informatics.

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## Introduction: Educational Informatics

Educational informatics studies a component of education that can be described as a three-level system made of the elements Learning, Teaching and Managing. From the specific point of view of educational informatics these constituent components are regarded as a recursive system. Therefore the main research fields are: *Representation of Knowledge, Learning Models, Planning Algorithms*, as well as *Subjective Reduction of the Complexity of Information*.

From the historical point of view educational informatics is based on the world-wide cybernetic movement of the post-war period. In the late 60's the studies of educational informatics were first established at the University of Linz, Austria. As well as the development of cybernetic pedagogics in Germany, there was a parallel process in Austria but with an independent research pattern as a result of several projects of educational cybernetics. This pattern was primarily based on the theoretical foundation of *Mathematical Pedagogics* by Milos Lánský which was formulated in the 60's in Karlsbad and Prag while he was searching for appropriate mathematical structures to define the basic concept of pedagogics more precisely (Lánský, 1993).

From 1971 to 1991 research and developing processes were intensified by the Institute of Educational Informatics in Paderborn, Germany. Numerous publications appeared on informatics as a subject of teaching and on support of teaching/learning processes by developing formal teaching and learning models. The works also included quantitative analysis of subjective information processing as well as the administration of educational institutions. At the moment these activities are being continued within the scope of the subject of educational technology at the universities of Prag (Czech Republic), Budweis (Czech Republic) and Nitra (Slovak Republic).

In 1993, after several years of conceptual preparations, the Institute of Educational Informatics was founded at the University in Landau, Germany. The main objective of the institute is the development of methods of informatics for education as well as for the support of educational processes.

The University in Landau chiefly provides courses of teacher education. The courses are characterised by the fact that the realisation of structures which have access to computer aided simulation or modelling is far away from the prevailing way of thinking. Therefore the Institute of Educational Informatics offers courses dealing with possible implementations of teaching and learning techniques by using computer aided models of informatics.

Focal point of the current studies is the interplay of knowledge based systems and human experts with regard to the development of computer aided problem-solving strategies for selected sciences. The aim is to create the best possible port between artificial intelligence referring to rule-based knowledge and human intelligence with its ability of association. The latter is particularly characterised by spontaneous intuition and the ability to exceed the limits of perceptual consciousness. The view on decision-making processes is regarded as essential and is therefore taken into account of the analysis.

The scientific approach of research in Landau is clearly distinctive from the early approach of cybernetic or mathematical pedagogics. The latter assumed that it is possible and sufficient to transfer formal scientific methods of informatics to educational sciences. The non-acceptance of early achievements of computer based training, programmed instruction and the independence of branches such as software ergonomics or didactics of informatics require a modification of the research paradigm. The aim is to emphasise the central role of each individual within the educational system.

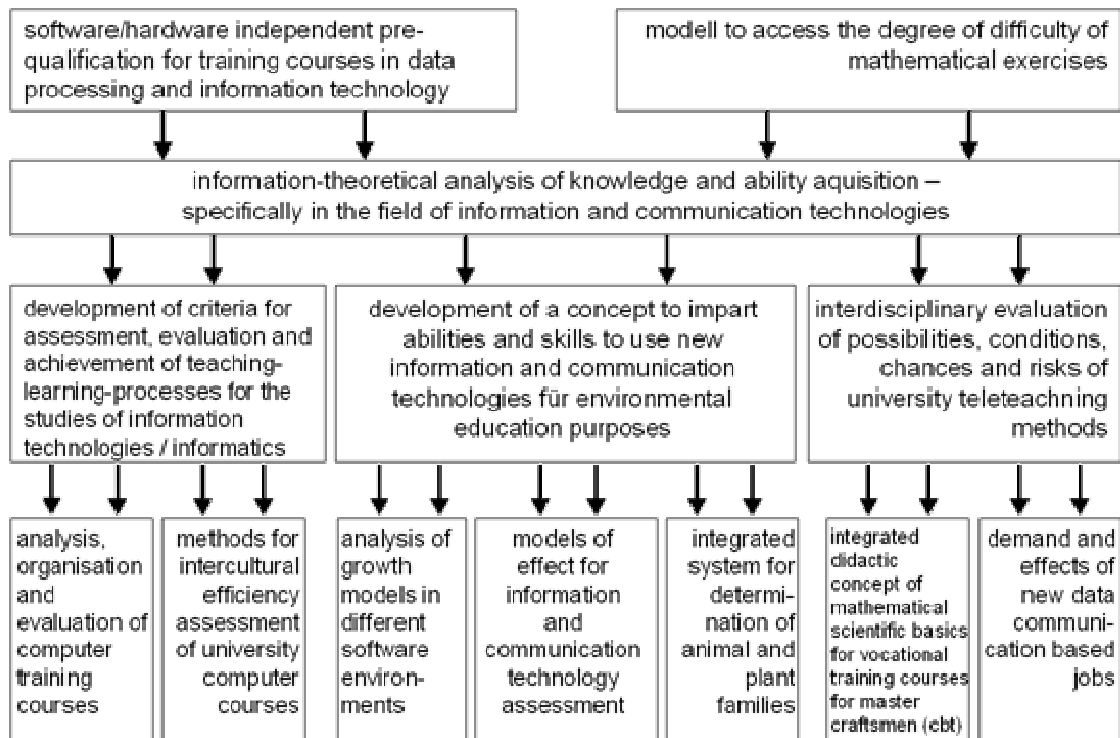
All subjects of research are analysed in team work with multiple sciences. Doing so the institute meets the demands to integrate not only the methods and models of informatics but also those of educational sciences when applying and enforcing methods of informatics. This shows that the subject of research gives an essential impetus to further development of methods. Educational informatics serves not merely as a subject of research but also as a means.

### **Reference:**

M. Lansky, *Bildungsinformatik - Milos Lanskys ausgewählte Werke*, (ed. J. Lanska), Akademie Libroservo, Prague, 1993 **Research activities** The following chart shows the research activities of the Institute of Educational Informatics in Landau of the recent years. The diagram demonstrates the temporal development and links of each project.

The following descriptions will briefly explain the intention of each project as well as the specialisation of the research activities.

## Research Activities of the Workgroup Educational Informatics at the University of Koblenz-Landau, Campus Landau in Germany



### Model to assess the degree of difficulty of mathematical exercises

A design to measure and assess a person's intellectual performance in problem-solving processes plays an increasingly important role in the analysis of the man-machine port. Therefore different points of view and various methodical approaches are used in this project. The situation can be compared to vain attempts to assess the degree of difficulty of mathematical exercises concerning the organisation of teaching processes. The project is designed to develop a scale for the difficulty of mathematical exercises following the concept of complexity of algorithms and theoretical informatics. This scale seems to be particularly suitable to solve didactic problems. (Becker and Stever, 1985)

**Cooperation:** FEoLL and DIFF

**References:** W. Becker, H. Stever, Vergleichende Analyse verschiedener Ansätze zur Bestimmung des Schwierigkeitsgrades mathematischer Aufgaben,

in: Zentralblatt für Didaktik der Mathematik, 1985, Vol. 4, pp 113-120

H. Stever, Ein Modell zur Bewertung von Aufgaben,

in: Grundlagenstudien aus Kybernetik und Geisteswissenschaften, 1986, Vol. 1, pp 13-17

### Software/Hardware independent pre-qualification for training courses in data processing and information technology

The aim of the project is to develop a concept of how to impart a qualification for computer users which is software/hardware independent. For this reason the qualification would have to

precede innovations. Know-how and vocational experience combined with comprehension of basic concepts of micro electronics, data processing and information/communication technologies form an essential part of this qualifying process. The didactic concept comprises the following steps: - Introduction of participants to data processing following their vocational or everyday experience

- Transfer of tasks from the participant's working field to data processing procedures
- Comprehension of theoretical connections, terms and ideas of models of informatics using various means also in the light of the historical development
- Transfer of acquired knowledge to vocational tasks
- Introduction of participants to special applications of the required innovation.

**Cooperation:** Institute for Economics and Economic Education, University Koblenz-Landau, Div. Landau (Prof. Dauenhauer), educational divisions of pharmaceutical industries

**Reference:** H. Stever, H. Jannasch, B. Wunder, Informationstechnik: Herstellerneutrale Vorausqualifizierung, in: Lernfeld Betrieb, 1990 Vol. 23, pp 36-38

### **Information-theoretical analysis of knowledge and ability acquisition specifically in the field of information and communication technologies**

The objective of cybernetic pedagogics is the analysis and formal description of the feedback mechanism of teaching-learning processes. In contrast educational informatics focuses on an informal description and based on that an algorithmic structure of education at all levels. Education itself represents one of the most important forms of human data processing. The analysis of educational processes, planning and administration on an information-theoretical foundation serves as a starting point for this project. Taking part in long-term studies of this subject requires a curricular and didactic concept. This concept should be aimed at subject interests of students in order to impart basic concepts and skills of information and communication technologies. The focus of interest is the analysis of the relationship between informatics, education and society. The conclusions drawn from that become part of an integrated concept of training courses and further education at schools and other institutions. Therefore the objective of the project comprises the development of components for propaedeutics of informatics and an information-technical education in the sense of basic informatics. Doing so the concept contributes to a further development of educational informatics and its paradigms.

**Reference:** H. Stever, Bewertung von Information als Problemfeld der Kybernetischen Pädagogik und Bildungsinformatik, in L. Kouba (Ed.) Fourth Prague Conference on Educational Cybernetics, Prague 1991, pp 310-314

H. Stever, Anmerkungen zur Entwicklung einer Elementar-Informatik, in: Schauer, Tauber (Ed.), Informatik in der Schule, Vienna, Munich, 1980

### **Development of criteria for assessment, evaluation and achievement of teaching-learning processes for the studies of information technology/informatics**

In Germany, Austria and Switzerland there are very different concepts of propaedeutics of informatics. The concepts that are exclusively designed for students of humanities and social sciences show considerable differences in content, methodology and didactics. What most of

them have in common though is the fact that they hardly comprise constructive suggestions for objectives concerning the development of criteria for assessment, evaluation and examination. The model that has been developed at the University in Landau to impart the basic concepts and skills of informatics and information technology (i.e. project C) in accordance with university standards also shows these deficiencies. The project concentrates on this lack and works out useful criteria for assessment, evaluation and examination which will then be applicable to other concepts too.

### **Development of a concept to impart abilities and skills to use new information and communication technologies for environmental purposes**

One of the main objectives of the Institute of Educational Informatics is to impart pragmatic competence in information and communication technologies to teacher students. Due to the fact that the university mainly offers teacher training courses for primary school (age group 6 to 10) and secondary school (age group 11-16) an integrated concept of curriculum development is needed urgently. The exemplary development of teaching-learning concepts dealing with environmental topics offers almost unlimited possibilities for an interdisciplinary exchange where corresponding research fields are bound to form a network. For this reason the institute develops a practically orientated training programme that combines the possibilities of information and communication technologies with the whole spectrum of ecological problems. Apart from teacher students the project is aimed at members of conservation groups. Selected lectures and work experiences dealing with specific environmental questions give the participants a chance to get familiar with all available media.

**Cooperation:** Institute for Biology and Institute for Mathematics, University Koblenz-Landau, Div. Landau

**Reference:** H. Stever, Einfluß technologischer Gegebenheiten auf Inhalt und Form von Unterricht - dargestellt am Beispiel Mathematik, in Schauer, Tauber (Ed.) Kommunikationstechnologie, Vienna, 1982

### **Analysis of growth models in different software environments**

So far the remarkable development of the so-called 'Chaos theory' has omitted the question if the chaotic reaction of mathematical models might be influenced by the applied calculation procedures. However, experience shows that the validity of predictions for theoretical models depends rather on means of calculation or simulation than on applied formalisms. As a consequence of that the project focuses on the analysis of growth models, for example, the Verhulst Model or Predator-Prey-Model. Besides the analysis concentrates on the reliability of these models concerning the usage of different software environments such as handmade programs, computer algebra systems, and simulation surroundings.

**Reference:** H. Stever, Regeln der unregelmäßigen Bienenvolkentwicklung - ein elementarer populationsdynamischer Ansatz mit spekulativer Interpretation für die Bienenhaltung, in Die Biene, 1991, Vol. 9, pp 476-486

### **Models of effect for information and communication technology assessment**

In recent years the public discussion has been focused increasingly on the different effects of the engineering progress of our environment. It becomes apparent that this rapid progress involves both positive and negative consequences – even bad for one’s health. Both the toxic danger of different substances and the damage of ionizing, radioactive rays and indications of unhealthy effects of non-ionizing radiation are discussed increasingly, too. The phenomenon of the non-ionizing radiation is called ‘Elektrosmog’ in part.

Whereas the mechanisms of effect of the first mentioned two topics are well-known and well-studied, substantial and experimentally proved models are missing in different fields of the ‘Elektrosmog’.

In this context, we developed a model of effect based on the learning theory of supersigns, which deals with the well known phenomenon of chunking: The extended theory of supersigns. This model describes to what extent electromagnetic fields could influence the learning process of human beings. In this context we identified honey bees (*apis mellifera*) as a bioindicator, since their brainstructure concerning learning processes is similar to that of human beings. So we interpret possible effects as a repertory change in the construction of internal models.

As a consequence it is possible to study non-thermal effects on the learning process of these insects, because honey bees could be resonantly stimulated e.g. by the frequency of GSM-mobile-phones. Therefore the influence of non-thermal effects on the brain of human beings could also be identified.

This research points out the cross-sectional dimension of Educational Informatics.

**Reference:** J. Kuhn, H. Stever, Model of Effect Relating to Non-Ionizing Radiation: A Part of the Cross-Sectional Dimension of Educational Informatics, in print

### **Integrated system for determination of animal and plant families**

Usually the determination of animals and plants requires a specialised knowledge and an extensive amount of literature. Non-specialists find it rather difficult to determine certain organisms. Therefore the objective of the project is to develop a computer aided key to make the determination of animals and plants easier. The program combines the binary key for identification with other keys, for example, habitat and colour of blooms. To show the possibilities of such a system the project deals with an exemplary determination of ‘yellow jacket wasps’ (Vespidae), dragonflies (Odonata) and caryophyllaceous plants (Caryophyllaceae). Apart from an easier determination of animals and plants such a system offers further forms of application:

1. The data density allows to add extensive information such as illustration of habitus and details, maps of dispersal areas, physiological data, behaviour etc.
2. The computer allows any comparison of pictures and illustrations which helps to determine the organisms more precisely.
3. The system is an ‘open-system’ and allows the user to add useful information, for example, place of finding and observations.
4. The system could serve to make the interchange of data easier.

**Cooperation:** Institute for Biology at the University in Landau (Prof. Friedrich), Institute for Specific Botany at the University Ulm, environmental organizations

**Reference:** J. Croft, HISPID Herbarium Information Standards and Protocols for Interchange of Data,

Internet Publication Nov 1990

### **Analysis, organisation and evaluation of computer training courses**

Because common computer training courses lack to assess the learning progress this project analyses the effectiveness of such courses. The analysis also includes the search for relevant pedagogical and psychological aspects. The aim is to control the quality of computer training courses and past all that to develop optimising measures.

For this purpose a scientifically supported introductory course to WinWord has been developed. The course is open to all students at the University in Landau and places emphasis on the impact of:

- didactic measures
- individual learning patterns
- interface
- and measures of organisation.

**Cooperation:** Zentrum für emp. päd. Forschung (Mrs. Bannert),

Abt. Methodenlehre am FB Psychologie (Mrs. Altstötter-Gleich)

**Reference:** H. Stever, Hochschuldidaktik, Informationstechnik und Qualifizierungsoffensive, in Zentralblatt für Didaktik der Mathematik, 1988, Vol. 20, pp 265-267

### **Methods for intercultural efficiency assessment of university computer courses**

The project deals with the question whether the didactic concept of project B could serve as a basic framework for university computer courses of different cultures. Besides the project aims to find out if standard methods for efficiency assessment of such courses do already exist or how they can be developed. The research concentrates on the following questions:

- Is the experience of students from different cultures homogeneous enough in order to conceive a standard computer course with standard applications?
- Is it possible to define a software/hardware independent computer standard which can definitely be used in different cultures too?
- What ways do exist to describe models of informatics that are understandable for all students?
- Are the methods for efficiency assessment of different cultures compatible?

As representatives of different cultures the following institutions have been selected:

University of Havana, Cuba; University of Budweis, Czech Republic and the University in Landau, Germany. The usability of data from the People's Republic of China is still to be discussed.

### **Interdisciplinary evaluation of possibilities, conditions, chances and risks of university teleteaching methods**

For teleteaching purposes the Institute of Educational Informatics installed the Sony video-conference system PCS-5000 using six ISDN-B-Channels and an additional beamer. The lectures take place in co-operation with the University of Kaiserslautern, Germany, and the local AV-studio at the University in Landau. About 25 participants can use the teleteaching services. In recent semesters the departments of Biology, English and Psychology and the Institute of Educational Informatics made frequent use of the facilities.

With the improvement of software and hardware components initial problems such as the lack of synchronous lip movement or poor legibility of overhead transparencies have largely been solved. Nevertheless, there still remain problems in the field of university didactics in connection with multimedia applications concerning organisation, content and aspects of didactic methods. (Doberkat and Schmedding, 1999)

**Cooperation:** Regionales Hochschulrechenzentrum Kaiserslautern (RHRK)

**Reference:** E.-E. Doberkat, D. Schmedding, Zauberformel für die Lehre? Multimedia an deutschen Universitäten, in: Forschung & Lehre, 1999, Vol. 5, pp 249-256

### **Integrated didactic concept of mathematical scientific basics for vocational training of master craftsmen (CBT)**

The institute works on a concept of teaching basic mathematical knowledge and skills related to vocational training of master craftsmen in the field of electrical and metal engineering. The provision of application-orientated mathematics is pointed out as an important basis of the required competence of master craftsmen in their professional surroundings.

The programme designs a framework for the development of training support materials to learn mathematics. As basis for this project serve the following three elements: earlier experiences, recent constructivistically orientated instructional approaches of pedagogical psychology; and finally the consideration of current professional frame guidelines and examination regulations of the Chambers of Industry and Commerce.

These materials are developed as three fundamentally differently designed CBT-units to enable a learning on distinct levels using material on the learner's own initiative. An active self-organisation is offered to the course participants by using interactive multimedia-based presentation. (Stever and Wolff, 1998)

**Cooperation:** DIHT-Gesellschaft für berufliche Bildung, Bonn

**Reference:** H. Stever & K.P. Wolff, Integratives Konzept für den Einsatz von Multimediakomponenten. Abschlußbericht zum Forschungsprojekt, W. Bertelsmann Verlag, 1998

### **Demands and effects of new data communication-based jobs (telecommuter)**

In the course of this project the structure of demands of teleworking places have been analysed interdisciplinarily. The analysis included informatics-orientated questions of how to set up an exemplary telecommuter place taking into account a possible traffic prioritisation for data flows. Furthermore development, realisation and evaluation of standard interviews on personal profiles of telecommuter participants as well as an analysis of gender specifications are part of this project.

**Cooperation:** Prof. G. F. Müller, Fachbereich Psychologie, Universität Koblenz-Landau, Abt. Landau

Prof. H.-J. Schlösser, Wirtschaftswissenschaft, Universität Siegen

**Reference:** G.F. Müller, Dispositionelle Bedingungsfaktoren von Telearbeit, in: Zeitschrift für Arbeits- und Organisationspsychologie, 2001, 45(N.F.19), pp 93-96

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### **Teaching Activities**

Since the foundation of the Institute of Educational Informatics at the University in Landau students can choose information technology as an additional subject. Admission to the course is open to all teacher students. Considering the latest development of information technology the studies comprise: A Systems, procedures and general applications B Subject based applications C Educational scientific references. The range of teaching activities can be demonstrated by the following selection of examination papers and assignments:

### **Problem-solving strategies and computer programming - a model in special consideration of a course for secondary education**

The project develops a model to describe the learning process of problem-solving strategies and computer programming. This model is based on the analysis of programming technologies for software production and important aspects of problem-solving techniques. The results are verified by practically orientated examples.

### **LOGO in primary school: a school experiment**

The detailed discussion of concepts and assessments of using computers in primary school includes four steps:

- Analysis of the discussion to use computers in class
- Description of the school experiment
- Evaluation of the school experiment
- Discussion of relevant literature

### **Computer-Algebra-Programs for mathematics in classes of 16-year-old pupils. A comparison of MAPLE and DERIVE**

MAPLE and DERIVE are compared according to four didactic-methodical criteria of lesson planning. The comparison of concrete examples makes the result more transparent and easier to understand.

### **Elementary approach to introduce genetic algorithms**

The optimisation of mathematical functions belongs to the classical repertoire of mathematics for teacher students. The assignment focuses on the usefulness of genetic algorithms for solving elementary problems. These algorithms were first developed in 1975. The problem of the travelling salesman is analysed as prime example.

### **Formal grammar for description of branching patterns**

Branching patterns and their description play an increasingly important role in the formal analysis of systems. The work presents a special formal grammar known as the Lindemayer Systems. Furthermore the assignment deals with the development of a program to visualise the Lindemayer systems on a computer screen.

### **Visualisation of convergence relations for calculation of $f(x) = 0$ functions**

The work tackles a classical problem of numerical mathematics in a completely new manner using current methods of informatics. Computer graphics serve to visualise the convergence relations of certain iteration methods which are discussed with terms of fractional geometry and the chaos theory.

### **Characteristics of functions and learning algorithms of the multilayer perceptron**

On the basis of the model of nerve cells the work analyses a specific neuron network, the so-called multilayer perceptron. The work considers characteristics of functions and provides learning algorithms for this network. The aim of this project is to give precise mathematical definitions and to program a simulation of a multilayer perceptron.

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### **Prospects**

Questions, content and methods of educational informatics will always be subject to change. Yet, actual trends in the participating sciences are unlikely to cause sudden reactions. The further development will be guaranteed if scientists of different fields become partners of an interdisciplinary approach of research. Since its foundation in 1973 the Institute of Educational Informatics at the University in Landau has worked on projects using an interdisciplinary approach. The main objective is to explain and to develop further the traverse dimension of educational informatics.