

# DIDACTIC AND METHODOLOGICAL CHALLENGES IN NEW MEDIA BASED TEACHING AND LEARNING FOR GIS

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## ABSTRACT:

New Media teaching and learning is on everyone's lips at the moment. It must be analyzed whether e-learning and multimedia with its possibilities can make a lasting contribution to the university teaching. New Media will influence both, the presence teaching and the self-learning at home. This paper deals with the educational dimension of the new media and with didactic models and learning theories. Only if advantages in comparison to the classical teaching are observable, new media will have a chance in the teaching. Especially in the area of GIS new possibilities can arise and the teaching will improve. Thereby classic teaching should not be replaced by, but added with new media meaningfully. Furthermore, it is absolutely necessary to offer an up-to-date university teaching in global competition. In the future, the network and cooperation between the universities will make the teaching more standardised. Teaching material can be exchanged more easily.

## 1. INTRODUCTION

As part of the project "Geoinformation - Multimedia for a New Interdisciplinary Course of Study", web-based multimedia study units are developed and pedagogically formed. On the one hand this project supports the lecture, on the other hand it supports self- and distance learning. Goal of the project is to open the potential of new media for the introduction of an interdisciplinary subject "geoinformation" in all geoscientific courses of studies. Visualization and animation are used in order to increase acceptance of formal methods and computer-based systems.

The project is composed of three parts:

1. **Generic courses:** 14 courses are created, which cover all substantial topics of geoinformation. There are offered two versions. One version for the present teaching, one for self- and distance learning. The evaluation is accompanied by lecturers in teaching methods, media designers and professional graphic designers.
2. **Interactive GeoJava learning environment:** The GeoJava learning environment should make possible the interactive, exploratory and co-operative work with Geo-algorithms und (Geo) data structures. A GeoChat makes cooperative and/or distributed learning possible.
3. **Project environment:** The project environment integrates the other components and offers all services which are necessary for the implementation of academic projects. A geodata server offers the possibility to access geodata quickly. These geodata are available directly in the studying modules and the learning environment.

## 2. EDUCATIONAL-POLICY SIGNIFICANCE OF THE NEW MEDIA

We are in a social change. We are at the threshold of the industry epoch to the information epoch. In future, we will have to continue education and acquire new methods and techniques permanently. The study limits itself no more to a period of time, it will take "the whole life". Because of the very fast increment of knowledge, the "half-life" of knowledge that was acquired at university will be shorter. Here, new media offer a large potential.

In order to keep low the costs for education, the gain of knowledge must go fast and efficiently. Here, a great advantage of new media can be seen. For example: An employee can learn with an e-learning course at his workplace and remains attainable anyway.

Just like in the working life, the influence of the new media will cause basic changes in the universities. According to a study of the Federal Ministry of Education and Research of 2002 for computer using and new media in Germany, almost every student has a possibility to work on computer during his studies. However, the PC competence of students varies very much. Critical seems to be that 35% of the students don't know whether Internet-supported teaching events are offered in their university. Only 10% of the students know about interactive teaching whereby 4% use them also. 13 % of the students of earth science have a negative attitude while 31 % adopt a positive position on computer-based tutorials (Middendorff, 2002).

The risk is that the teaching splits the students. Students, who have the possibility to work with computers and Internet at home and students, who don't have. In the next years, the task must be to make computer-aided tutorials better known and to emphasise their advantages in the teaching.

### 3. THE FIRST QUESTIONS

While sketching a tutorial, different questions arise:

1. Which target group shall be addressed?
2. Which contents are to be mediated?
3. Which “knowledge” and which “abilities” the learner is supposed to acquire?
4. Which methodical authority has to be acquired?  
Which media are to be used?
5. How shall the design elements look like?

These questions should be clarified in advance, before questions about didactical-methodical designs are relevant.

### 4. PEDAGOGICALLY - DIDACTICS CONSIDERATIONS

From educational-didactical considerations, the following objectives are to be aimed at:

1. To give basic or orientation knowledge of the subject GIS in the form of learning modules.
2. To give applicable knowledge in order to enable a transfer of the knowledge into practice.
3. To give the competence in cooperation, self-learning and multimedia.

### 5. KNOWLEDGE TRANSPORT

The demand may not be that learning is seen as a transport of abstract knowledge. The demand must be that knowledge will be implementable. Only if the instructional and the application context resemble each other, knowledge transport can be expected (Issing, Klimsa, 1997).

#### 5.1 What means learning?

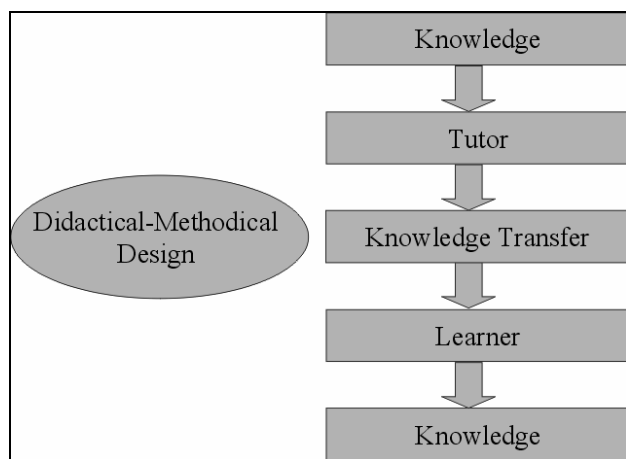


Figure 1. Simplified model of learning

In simple terms: learning means to memorise new knowledge in suitable forms. In order that this succeeds as well as possible, knowledge transport must be optimised. The curriculum must be worked out in such a way, that the learner can retell the curriculum not just by heart, but he shall be able to use this knowledge. Didactic models support the instructor to create learning modules (fig. 1.). In simple terms, these didactic models describe how knowledge reaches into the learner's head.

### 5.2 Learning Theories

Didactic models describe the way of the knowledge arrangement. Didactic models serve as orientation functions and support the lecturer at his didactic decisions. In pedagogy, essentially three studying theories are essentially discussed: Behaviourism, Cognitivism and Constructivism.

**5.2.1 Behaviourism:** In behaviourism, learning is based on models of stimulation and reaction. Stimulations (teaching contents) are processed in an undefined way of the brain and cause a studying success as a reaction. Learning represents a customisation of the behaviour to alterable situations of stimulation. It is seen as a conditioned reflex that is purchased by adaption. The thinking processes are ignored basically in this approach. One speaks from a “black box”. After this, learning is a process that is controlled from outside.

This theory says that for teaching it is important to use the right stimulations in right number and intensity. Complex studying events shall be analysed into simple studying steps. The studying behaviour is evaluated by praise or reproach. The studying progress is checked permanently.

Main representative of behaviourism is B. F. Skinner. He emphasised the advantages of program learning at the beginning of the sixties.

**5.2.2 Cognitivism:** The difference between behaviourism and Cognitivism is primarily:

1. At behaviourism the thinking processes are a “black box”.
2. At Cognitivism thinking processes are brought to the foreground.

Processes like understanding, solving problems and thinking play an essential part. A central question at the Cognitivism is: how will declarative and procedural knowledge structures be formed?

The process to solve a problem is classified very important. The learner shall be stimulated by complex teaching structures to ask and search. Thereby the basic assumption is that cognitive structures in human brain develop by active behaviour.

**5.2.3 Constructivism:** The Constructivism starts out from the theory that the recognising subject does not show the reality passively, but the subject can only construct actively in the knowledge process (Issing, Klimsa, 1997, p 197.) Themselves, seeing and hearing do not represent the reality, but they are individual constructions of the own perception. New knowledge must be “realised”, “learned”, “experienced” and integrated into the already available knowledge structure (v. Glasersfeld, 1987).

The Basic idea of the Constructivism is that the learner is stimulated to construct his knowledge independently: *Every human being constructs his own world* (Brun's, Gajewski, 1999, p 14). Learning is seen as an individual process, every human being learns on his own way. From constructivistic visibility, learning is an active, situational and social process. Therefore, there is no optimal learning method that can be applied to every human being. Although there are no rules for the creation and sequence of teaching, there are conditions how the acquisition of knowledge shall be done. One condition is to form the lessons problem orientated.

### 5.3 Problem Orientated Teaching

Problem-oriented arranging of virtual learning environment forms the base of constructivistic teaching. Problem oriented teaching can be described by 5 principles:

1. reference to application
2. multiple contexts and perspectives
3. social learning arrangements
4. information and construction supply
5. briefing guidance and support

### 5.4 Result

The traditional way of teaching is characterized by frontal instruction. Systematic knowledge without concrete application is mediated. Behind this is the idea of the instructor editing and transmitting contents in such a way that, at the end of the "knowledge transport", the learner possesses this knowledge in the same form as the instructor. The focal point of this instruction philosophy is: The instructor is active, the learner is passive. The risk of this kind of knowledge transfer is the development of "slow-acting knowledge". This problem of "slow-acting knowledge" forms the starting point of constructivistic approaches in instructing and in learning. In order to prevent "slow-acting knowledge", constructivistic approaches emphasize the active construction processes of the learner. Learning is interpreted as a self-active, constructional process in a certain action context. Virtual learning environments must offer situations, in which such construction performances are possible. An example for this is to go through certain processes within a project: The learner is supposed to find solution models on his own with the help of supplied tools. The student should be able to apply these models also in other context.

Primarily in the GIS area, the constructivistic approach has to be preferred because a lot of different fields are included and must be combined.

## 6. STRUCTURE OF A VIRTUAL SELF-TUTORIAL

Ideally, the structure of a virtual self-tutorial looks as follows:

1. introduction
2. information presentation
3. question
4. response analysis
5. feedback

The introduction could be a video sequence giving an overview of teaching subjects and recording authentic applications.

The information presentation can be available in the form of text, pictures, video sequences, simulations, audio, etc. Which technique is applied depends on the material to be transmitted. In any case, different aspects of the problem should be shown.

The question and response analysis are controls for the success of learning for both the instructor and the learner. In the virtual learning environment, different kinds of response are possible, e.g. multiple choice, gap text, drag and drop, etc.

Ideally, an expert response should be available after the learner's response to the question, independent of the correctness of the answer. This expert response should contain more detailed information. In such a case one speaks of an elaborated feedback.

## 7. LEARNING MOTIVATION BY INTERACTIVITY

One of the most important questions about teaching should be how to perpetuate learning motivation? One possibility is interactivity (Issing, 1998):

1. Controlling the flow of information.
2. Selecting contents and controlling the own way of learning.
3. Selecting and controlling the presentation form of the contents.
4. "Dialog" with the computer by means of data input and output.
5. Manipulating, modelling and generating multimedia data and objects.
6. Communicating asynchronously and synchronously and co-operating over the network.

Most tutorials in the market only include level 1 to 3. Usually the learner can determine and select contents and objects. Of genuine interactivity can only be spoken (Issing, 1998):

1. if the learner is allowed to be creative and contents can be changed or created,
2. if the program is not rigid and static, but reacts dynamically and adaptive to the input of the learner,
3. if the learner himself takes control of his learning process,
4. if the system assists or helps the learner if necessary.

## 8. EXAMPLES OF INTERACTIVITY

Interactivity means also that parameters can be chosen completely arbitrary. The learner shall be able to see what happens when he changes values. Specific effects can be shown better and the learner understands them better. An additional advantage is that animations enjoy and increase the motivation. In the following, two interactivity animations are shown that permit the learner to change parameters.

### 8.1 Flash Animation to Laserscanning

To demonstrate the shadowing at the airborne laserscanning (Fig. 2) it is advantageous, if one can choose the altitude, the scanning angle and the position of the airplane completely arbitrary. In the example, the airplane takes the position of the mouse cursor in real-time. The shadows of the buildings change according to the position and altitude of the airplane and according to scanning angle. The scanning angle can be changed with a slider.

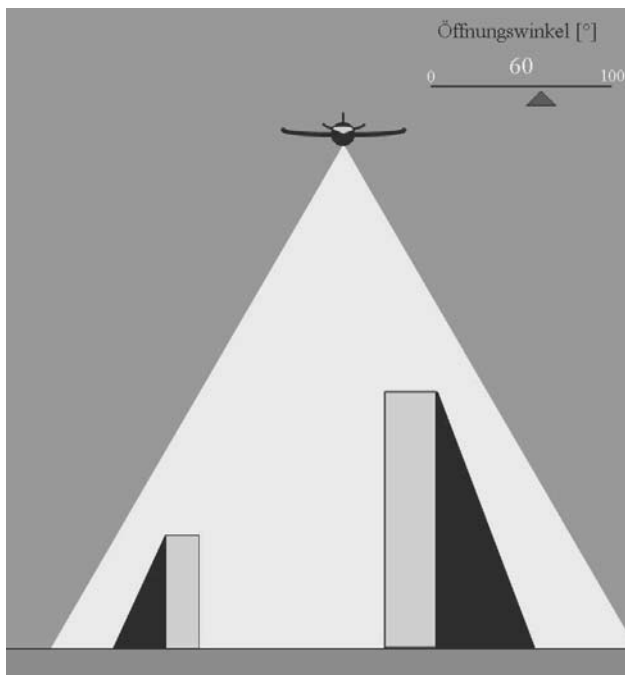


Figure 2. Interactivity at the example of shadowing at the airborne laserscanning

### 8.2 Java 3D Animation to Geodetic Reference Systems

A big advantage of the new media is also the possibility to make 3D animations. Objects can be rotated in any directions and can be looked from each side. Java 3D offers the possibility to generate 3D worlds very simply. It is independent from platforms and runs also as applet in the Internet.

An Ellipsoid is represented as a basic function whereby the parameters can be changed. This depiction serves as a basis of visualizations of e.g. the transverse radius of curvature (fig. 3.). One can not imagine many elements in 3D well. Explanations and 2D illustrations do not suffice often, to progress an exact idea. These 3D displays can help, to understand spatial things better.

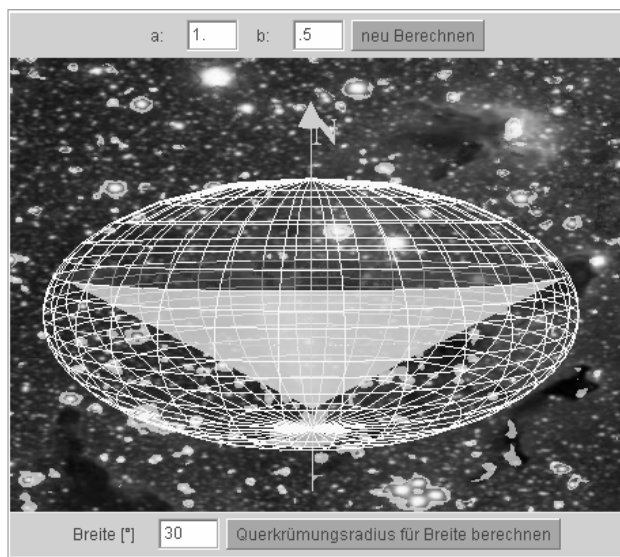


Figure 3. Interactivity at the example of the transverse radius of curvature at an ellipsoid

## 9. RESULT

With all euphoria, that is to be observed in many places, one may not forget that the development is just at the beginning. Many questions must be clarified still. Where are the differences between knowledge transfer with new media and the traditional teaching? Which learning theory is to be preferred? Can be obtained a better success in learning with new media? The quality increase of the teaching with new media is not simply “measurable”. Reliable studies are still missing.

It will take some time, until all advantages of the new media will be visible. However, it is quite obvious that new media represents an advantage with many complex topics in relation to the classical methods. Though, the danger is a cognitive overloading that expects too much of the learner.

Long-term concepts must be developed first, which correspond with the educational and didactic requirements. The technical development of the software and hardware must be considered, solutions must be expanded and modified constantly. For a successful introduction of new media in teaching, it is of particularly importance to set the right course at the beginning. A close cooperation with lecturers in teaching methods, media designers and computer scientists is absolutely necessary in order to produce demanding studying offers. It must be considered of course, for which field studying offers will be created. Naturally there are different requirements for the development of learning modules for liberal arts of surely than for GIS.

It will be exciting to see which forms the multimedia supported teaching will assume in the course of time.

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