Problem-based learning in virtual GIS learning-environments

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1. Different Views of Teaching and Learning

Many studies, one of the most recent and controversial being PISA (Artelt et. al., 2001), show us the phenomenon of inert knowledge. This phenomenon is defined as knowledge, a person can reproduce, but not apply to a certain problem. Often, the information is presented in an abstract way without any connection to the context in which the knowledge should be applied. Therefore, knowledge stays isolated in a person's mind.
To avoid this phenomenon, a new form of teaching is appropriate, referred to as problem-based learning. Before starting to explain this concept, two main views of teaching and learning are presented.

1.1 The Traditional View of Teaching and Learning

The traditional view of teaching and learning has three main assumptions:

1. Knowledge is a consequence of learning both facts and routines.
2. Knowledge can be transmitted from one person to another like products.
3. Learners can bridge the gap between theory and practice themselves.

Therefore, the traditional view of teaching and learning is characterized by frontal instruction. Systematic knowledge without concrete application is mediated. The way of teaching is determined by the content, which should be transferred. This is based on the idea that the instructor edits and transmits 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 (Kopp, Zabel & Mandl, 2002). The focal point of this instruction philosophy is: The teacher has an active position, while the learner is passive. Learning is a mainly receptive process. Further characteristics of this view are systematic teaching and learning, strict limitation of subjects and control of the learning success. This form of traditional teaching is suitable, if a learner gets information about a certain topic he afterwards has to reproduce. Normally, the learner recalls this knowledge related to facts, but is not able to apply it to a certain problem. The transfer from the learning situation to the concrete application is often difficult – the result is "inert knowledge" (Arzberger & Brehm, 1994).

1.2 The Constructivist View of Teaching and Learning

This problem of "inert knowledge" forms the starting point of constructivist approaches in teaching and learning. In order to prevent inert knowledge, according to a constructivist position, learning is a process actively taking place in the mind of a learner. Learning is a constructive, social process; the learner is in an active position. Instruction has no longer the main position in teaching. Furthermore, the learner himself is in a self-active position, while the teacher must offer situations and tools for solving problems, react on certain needs of the learner and act as coach and advisor. Teaching has the meaning of supporting, encouraging and consulting; the teacher is in a reactive position. In this approach, knowledge is the product of an individual and social construction. Learning is a self-active, constructivist process in a certain action context (Mader & Stöckl, 1999).

In a constructivist view therefore, learning and teaching have six essential process characteristics:

- Learning is a motivational process: Learners must have an aim and the desire to learn something. Often, the learning effort is determined by the learner's motivation and interest about the topic he must learn.
- Learning is an active process: Effective learning is only possible, when the learner is active. Motivation and interest are necessary antecedents for activity.

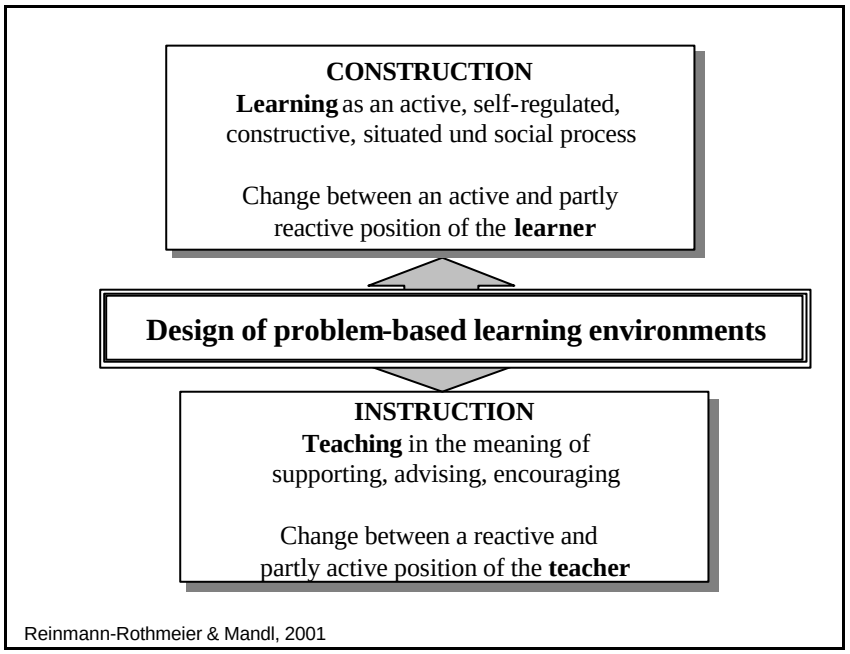
- Learning is a self-regulated process: A learner must get the chance to control his own learning process while dealing with a certain content.
- Learning is a constructivist process: A learner can only acquire and use knowledge sensible, when he can integrate the new knowledge in old, still existing structures of his mind and when he can interpret it on the basis of individual experience.
- Learning is a situated process: Knowledge is always linked to a certain situation. Therefore, the acquisition of knowledge is connected to a specific context.
- Learning is a social process: The acquisition of knowledge usually takes part in interaction with others. Learning is a process, belonging to a special learning culture, in which contents – as well as values and attitudes – are negotiated.

Learning environments which integrate all these process characteristics are very complex. Therefore, the learner often cannot cope with this demand. To avoid this effect, the learner needs a certain amount of instruction and support. A balance between an explicit guidance and support by the teacher and a constructive activity by the learner should be aimed for.

1.3 Problem-based learning

In problem-based learning environments, both views, the constructivist and the instructional view, are combined to form a new balance. This approach tries to integrate both processes: Learning as an active, self-regulated, constructive, situated and social process and teaching in the meaning of encouraging, supporting and consulting, as well as instructing, presenting and explaining.

Design of problem-based learning environments



To design problem-based learning environments, four principles have to be considered (Reinmann-Rothmeier & Mandl, 2001):

(1) Authenticity and reference to application:
Abstract knowledge should be presented using practical examples, problems or cases to show its relevance for the professional field. Simultaneously, this way of providing content shows the applicability of knowledge and raises the learners' motivation and interest in the specific topic.

(2) Multiple contexts and perspectives:
To avoid knowledge fixed on one certain context, the topics should be presented in different situations and from different perspectives. This way of showing multiple contexts and perspectives evoke a more flexible knowledge about a subject. At the same time, this method stimulates the ability to analyse things in a differentiated way and to apply the knowledge in other circumstances.

(3) Social learning arrangements:

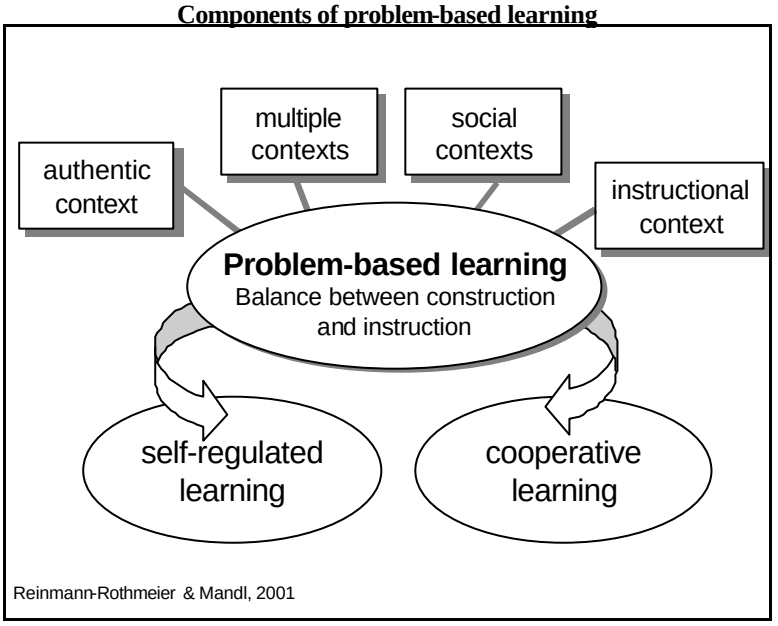
Although, learning is an individual process, social aspects get more and more important in the process of acquiring knowledge, because the ability to cooperate and communicate is essential in all professions. Furthermore, working on tasks in groups is an adequate way to support and to deepen the learners' understanding of contents and connections.

(4) Instructions and information and construction supply:

Instructions are helpful for the learner as support while working on tasks of the learning environment. Therefore, it is important, that the learning environment does not demand too much from the learners to avoid a cognitive overload. This, however, should not decrease the commitment of the learners. On the contrary: With the help of certain instructions, the learner should be encouraged to search details of the information they need for the task on their own.

While these four principles are part of the learning environment, the learner must bring along two essential skills: the skill of self-regulated and the skill of cooperative learning. Without the ability of acquiring knowledge on one's own and the ability to cooperate with others, a problem-based learning environment will not be functional. But even if these abilities are a necessary requirement, the learner has the opportunity to improve these skills through training in a problem-based environment, as well.

Components of problem-based learning

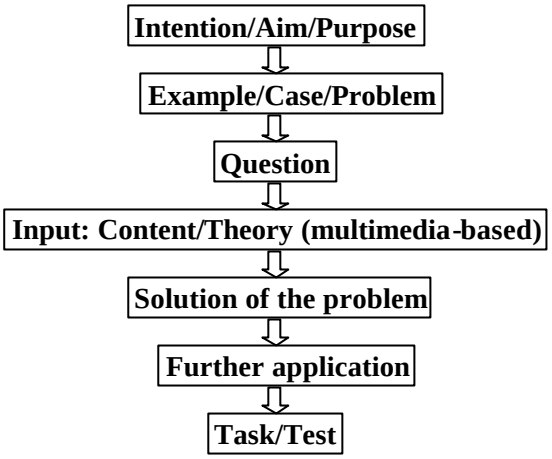


2. Implementation of problem-based learning in a virtual GIS learning-environment (www.geoinformation.net)

2.1 Problem-based learning

In a virtual GIS learning-environment, the mediation of knowledge is an essential part. 14 learning modules related to different topics of GIS focus on main issues. To integrate problem-based learning, a certain structure is proposed. This is as follows:

Structure of a virtual self-learning module



Intention/Aim/Purpose

In the beginning of each unit, the intentions of the following pages are listed. To know the aims of the learning module is very important for the learner, because he can compare his own targets with the intentions of the author using this information. Comparing internal targets with external aims is essential in the beginning, but also at the end of the process. Two very important components for self-constructing knowledge are firstly, recognizing, whether the unit is helpful to close knowledge gaps in the beginning, and secondly, comparing, whether the goals of the unit are reached at the end.

Example/Case/Problem

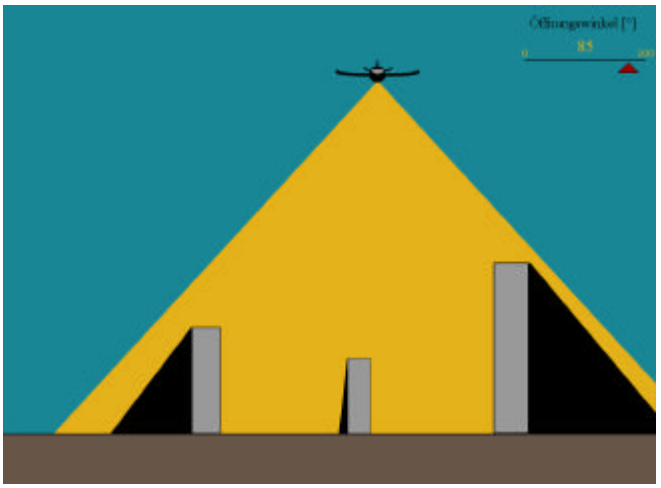
Especially this supply for self-learning should be prepared with cases, problems and examples, which help students to understand the theoretical background in a certain authentic context.

Question

Showing an example in combination with a special question in the beginning is an adequate way to sensitise the learner for the problem and the following content.

Input: Content/Theory (multimedia-based)

The presentation of information should also stimulate the learner to think actively about the topic presented. Especially in GIS, a big amount of visualizations, such as pictures, graphics or animations, can help to activate a constructive, self-regulated learning process of knowledge acquisition.
Another effect of implementation of multimedia is the perpetuation of learning motivation. On the one hand, the understanding of connections is often easier with pictures or graphics. On the other hand, interactively controlled processes show certain effects better. Both forms help to simplify and demonstrate the content in a concrete way.



Interactivity in the example of shadowing at the airbone laserscanning.

Solution of the problem

To bring the real-life example used in the beginning together with the mediated theoretical knowledge, the solution of the question must be explained. This solution integrates real problems and the knowledge how to solve them. Here, the learner must think about the content he has acquired before.

Further application

A further explanation of the topic with various examples or problems can show the applicability of the special theme in different fields. To guarantee the acquisition of applicable knowledge showing multiple perspectives and contexts is very important.

Task/Test

Questions at the end of a small learning unit should deepen the learned knowledge. Furthermore, this kind of self-evaluation shows the learner, whether he learned the content or not. Learners could possibly work on certain tasks together.

2.2 Self-regulated learning

In the whole learning environment, learners have two opportunities to acquire knowledge: They can acquire knowledge on their own without any lecture, seminar or tutorial accompanying the supply and they can use the environment as support of certain lectures or seminars. In both ways of learning, the learners can decide, whether they want to use this virtual learning-environment, and if so, when, where and how long they want to learn within it. Therefore, this learning supply is characterized by a totally voluntary and self-regulated type of learning.

2.3 Cooperative learning

An essential part in GIS education is programming. But often, learners have problems understanding the functioning of programming. Therefore, a special program is developed, where programming is visualized in algorithms. To further simplify this complex knowledge, learners have the possibility to cooperate with others while programming. In this cooperation, learner A can watch on his own PC, what learner B is programming and vice versa. Meanwhile, they can talk with each other online about the task they want to solve or other difficult themes. As a lot of students have difficulties in programming, this form of cooperation can help to simplify the tasks.

3. References

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