Problem oriented learning on-line

- First experiences at the Centre for Geo-Information -

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Abstract

A number of experiences in creating digital learning environments have been done by the centre for Geo-information. One of the latest experencies was related to support problem-oriented learning approach. The main components of such an environment, rco's and cso's, are discussed in relation to the didactic apporach, the educational classes and the way they should become re-usable and sharable.

The digital learning environments of three courses are described as well as the preliminary results of an evaluation of the courses by students. Finally the importance of rco's are stressed in the context of problem-oriented learning.

1. Introduction

Nowadays a number of academic institutes discuss about the renewal of didactical approach. This discussion has been initiated by what is called the "information society" expectations: an overload of information, high frequency of information renewal, information for everybody at anyplace, anytime and anywhere. All of these expectations are heavily based on the social impacts of information and communication technology (ICT). These expectations influence the didactical concepts too.

The traditional "cohort-based" learning (CBL) with fixed schemes and orders of training material looks to be replaced by ways of "problem oriented" learning (POL). The most important differences between these two opposite ways of training seem to be: teacher-driven versus student-driven, "learning by following" versus "learning by experiencing", "well defined" learning environment versus "open defined" learning environment [POL1]

What will be the educational 'look' of geo-information sciences when this didactical transition continues, based on the use of ICT. The term digital learning environment (DLE) is often used to express the extended use of ICT in education.

To come up with some preliminary conclusions the relation between didactical approaches and the role of ICT will be discussed. This will be followed by some experiences of creating a learning environment and the results of the students' evaluation of such learning environments. All concepts and results of this paper are based on the results of the WOLL-project [CGI1] and a sub-project within the ARIADNE-programme [ARI1].

2. Didactic approaches and ICT

To discuss the future look of the ICT based education of geo-information sciences a classification of the different didactic approaches and the role of ICT could be made.

Didactic Approach / ICT	**Cohort based**	**Intermediate**	**Problem oriented**
No ICT state			
Local ICT state			
Global ICT state			

Table 1: Didactic approaches and ICT

Table 1 presents three different types of didactic approaches. The cohort-based learning (CBL) is teacher-driven and well structured. It means that a student has to follow the structure that has been defined by the teacher [1]. Traditional lectures are obvious examples of this approach as well as assignments that offer the "has-to-be-followed-steps".

On the opposite site, a purely problem oriented approach is student-driven and open-structured, because (groups of) students define their problems and own ways to solve the problems. The teacher is a merely a supervisor or mentor. An example of such a problem-oriented approach is given in box 1.

The intermediate approach could be each course format that intertwines both a-typical approaches, but shows clearly cohort-like and problem oriented-like components.

SEVEN STEPS TUTOR

Group session 1

1. explore the case: clarify unfamiliar terms and related concepts;
2. define the problem or hypotheses
3. try to accept or reject the problems or hypotheses with common and available knowledge
4. organise ideas: identify what is not yet known or understood
5. prioritise learning needs: set learning goals and objectives, define individual tasks

Individual tasks

6. self study: realise objectives

Group session 2

7. report individually: share new knowledge, solve the problem by applying new knowledge; reflect on learning curve

Box 1: the 7-steps approach

When I reflect from this classification at the original course materials of our centre [CGI2] it turns out mainly cohort-driven.

The classification of these didactic approaches doesn't give any clue to the role of ICT. As shown in table 1 each of the approaches can be realised without ICT. In geo-information science this should be out of question. This new field of scientific interest is already based on the mutual relation of ICT and the basic geo-sciences like geography and geodesy. However geo-information science concepts can be trained without ICT it should make courses very unrealistic.

More realistic is the local ICT state of the training material. Local ICT state means that a collection of digital training materials that is offered to students has been defined by a local responsible (teacher, group of teachers of a department) via the local computer system. This local computer system can vary between a stand alone PC, a local network or an intranet client-server system.

Global ICT state means that the digital training materials has been defined by responsibles who do not belong to the same department of an organisation and can be offered by an internet based client-server system. This means that the Web (regarding ICT–based educational material) is the limit.

What could be concluded so far. The differences between didactic approaches without ICT, with local ICT and global ICT point clearly at the fact that the variety of learning materials can increase, because it becomes less and less location, time and teacher independent. On the other hand it says nothing about the content and the quality of the materials.

3. The roles of RCO and CSO

From all didactic courses it can be learned that at least four classes of course materials can be mentioned: concepts, instructions, assignments and assessments. Concepts offer the "what" elements of each course: (meanings on) theories, methodologies, formal descriptions and examples of these. Instructions (tutors) are the well described ways "how" to handle the "what". Assignments offer students the opportunities (exercises, data, tools, results) to exercise their skills, knowledge and attitudes about the "what" and "how". Assessments (sometimes look-a-likes of assignments) are the means to (self-)evaluate the learning objectives.

For example, a cohort-based course has been a rigid structure of concepts, instructions, assignments and assessments. The structure fully defines the order, time and results of the course elements, according the learning objectives. Sometimes the rigidity of the structure is so essential that it turns out difficult to break it down in the four classes.

The contrary is the problem-oriented course. Learning objectives have been defined and the material offered to the students, mostly a short essay, has to initiate the learning process considering these objectives. One can understand that working out the essay according the "7-

step" methodology could turn out in a kaleidoscopic learnscape. More obvious in this approach is the need for clearly separated classes, because the teacher doesn't structure the relations between these.

The intermediate approach is, of course, the in-between of well- and open-structured class relations.

This distinction between these four classes seems to be helpful to precise the content of the learning materials. Some of the digital learning environments (eg. Oracle Learning Assistant) introduce the term re-usable content object (rco). An rco can strictly be seen as a peculiar part of a course that exists of a concept, an instruction, an assignment or an assessment, each of them in a digital format [VON1].

The differences between the approaches become explicitly in the way that classes are structured. This may create a problem if we want to work in a digital learning environment [2]. Because there will be a quest for the content and the size of an rco.

In the cohort approach an rco will exist of all components related to each other by a certain rigid didactic 'glue'. As said before "it turns out difficult to break it down in four classes". For these reason such rco's I do call *blended* rco's. The benefit of such an approach in an ICT environment is that everything in need to realise the learning objectives is available and reachable and students can be monitored very neatly.

In the problem-oriented approach each training class should be a separate rco. For this reason I call such rco's *pure* rco's. In stead of the cohort approach for this approach it is not always clear if all 'expected' pure rco's, considering the learning objectives, are available and reachable. Besides it is difficult to track the students.

In the intermediate approach there will be a mixture of blended and pure rco's. So in this approach there is much more diversity in rco's.

The introduction of component structuring objects (cso's) can probably solve the problem of different types of rco's (blended and pure). A cso can be seen as a characteristic part of a course, in a digital format, that links pure rco's to provide the classes of training materials in a certain structure. In this way a cso is something like an user interface. The benefit of a division between cso and rco is a clear distinction between content (rco) and transfer or interaction (cso).

4. Experiencing the approaches

In two parallel projects has been experienced with the different didactic approaches and the use of ICT in geo-information science courses. One of these projects is the WOLL (Wageningen Online Lifelong Learning) project [CGI1] that aims at the development of a geo-information science curriculum that could be provided by ICT means. The other project is the geo-information project BASWEB. This project is a sub-project of the ARIADNE

(Alliance of Remote Instructional Authoring and Distribution Networks for Europe) project [ARI1]. This project aims at the use of the learning environment tools that have been developed during the ARIADNE project to create a course GIS-basics.

The ARIADNE tools are based on sharing and re-using rco's which have to be created and labelled via meta-data. The meta-data describe the source (creator, original publication) of the material, the educational level, the type of component, the digital format and even the language [ARI2], [IMS1]. As soon as an rco has been described, peered and stored in a central database a course can be created out of the rco-database.

The WOLL project is comparable with ARIADNE but instead of making new tools the digital learning environment is based on existing Microsoft software and some basic database to web tools. The rco's, created within the WOLL project, are also described by meta-data. Both, rco's in the ARIADNE database and the WOLL database could be exchanged.

Both projects keep the creation of cso's (the user interface that links the rco's) to the teacher who has to structure the rco's. To do so the ARIADNE-project offers the ALI (advanced learner interface). The WOLL project offers the Coursebuilder.

Using the ARIADNE tools a cohort-approach of Basic GIS has been implemented [CGI3]. Training materials for the introduction in geo-information science that have been developed by the CGI in the last five years have been as good as possible been structured in blended (former parts of a course syllabus) and pure rco's (tutorials in screencam format, data sets in arcview format, etc.). Successively all rco's have been decribed by meta-data and stored into the Ariadne database. Using ALI most of the rco's have been fitted into a tight course structure (fig.1) that should provide first and second year Dutch students.

The students who follow this ICT-paced self-study course have to follow a strict daily schedule. The course could be seen as a distance learning course but is only offered within an intranet. For all this reasons the current course is in a local ICT state.

The WOLL project tools have been used to develop a course in spatial modelling in landscape ecology for fourth year students in landscape ecology and physical planning. The course aims the evaluation of the Dutch national nature-conservation management strategy by using GIS-based simulation of landscape ecology principles (bio-diversity classification, dispersion, eco system development, etc.). This course is based on an intermediate didactic approach [CGI4]. The pure rco's have been compiled from earlier works of the department itself, but most of the materials come from other institutes (mainly the Netherlands) and web-sites from research and educational institutes (Denmark, Netherlands, Switzerland, United Kingdom and United States). The structure of the course (cso's) has completely been newly developed based on HTML and coursebuilder. Some of the cso's are the scheduler, texts, graphics and symbols to connect pure rco's, as well as synchronous and a-synchronous discussion sites (figure 2).

A daily schedule is guiding the students. Most of the assignments demand the students to do small self-defined research work. Most of the tools to practice the assignments are arcview, including a number of pre-defined avenue scripts and pre-processed data sets.

Considering the background of the pure rco's and the fact that the course could be used as distance learning course offerd by internet this course can be typified as being in a global ICT state.

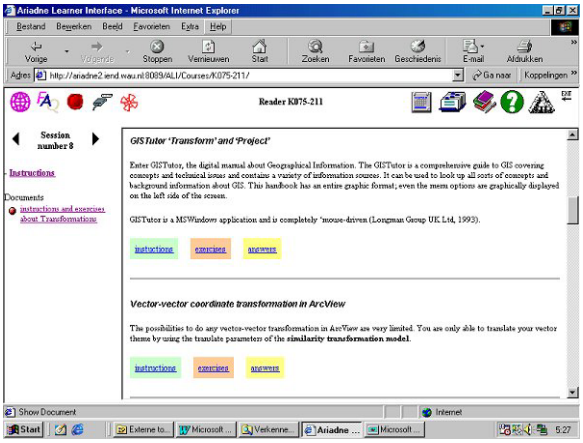

Figure 1: DLE Basic GIS in Landscape Ecology

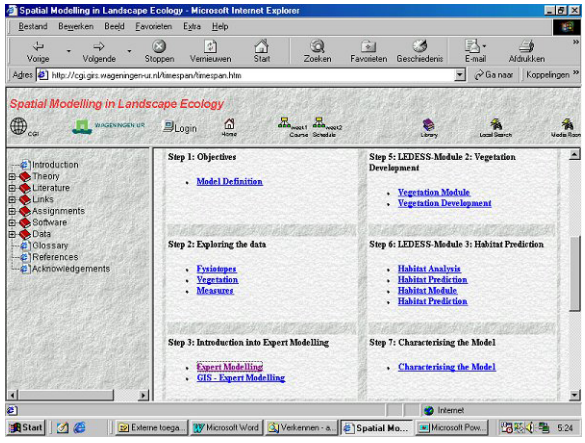

Figure 2: DLE Spatial modelling

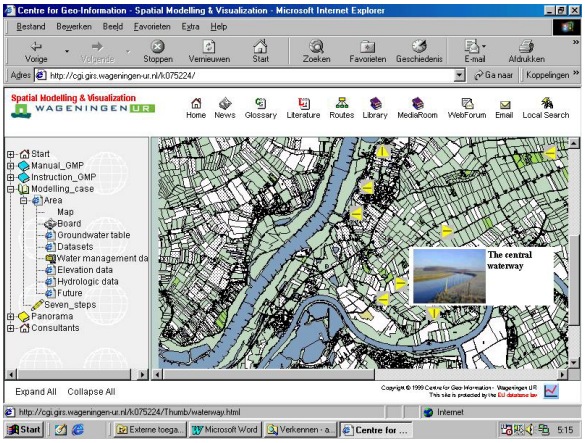

Figure 3: DLE spatial modelling and visualization

Another course developed by use of the WOLL tools, spatial modelling and visualization [CGI5], tries to explore the problem oriented approach. This course aims at the learning of the implementation of spatial-temporal simulations by spatial modelling and visualisation techniques. The course has been developed within a MSc setting in which the fourth year students (geo-information science and environmental science) work on location or nearby locations (the same network facilities are guaranteed).

The students play three different roles: a 'cohort' student (learning by following lectures and doing practicals), a 'problem oriented' student (learning by defining problems and ways to solve the problem) and a consultant role (group work in a project setting). For each role the learning environment (figure 3) offers blended and pure rco's which can be found by a 'blue

book' (cohort material), a 'yellow book' (problem oriented material) and a 'green book' (the consultancy material). The consultant role is an extension of the problem oriented role but focuses more on a practical situation and aims at using and evaluating the knowledge and skills that should be obtained by the other two roles (box 2).

The course is in a global ICT state (rco's are coming from different institutes and the course can be followed by internet) but is not ready for distance learning purposes. Discussion and support by supervisors is still a matter of real-world meetings.

- The Mayor and Alderman need a better overview of the consequences of these programmes. For this reason they invite four consultants to advise them by a more quantitative analysis of some aspects of the programmes.
- The quantitative analysis must be based on the contemporary geo-information technology based dynamic modelling and shows sequentially the differences between the three scenarios. The modelling perspective should be based on one important aspect of each scenario (e.g. hydrology, urban settlement, infra-structural pressure, environmental quality, recreational movement, etc.). Each consultant is free to choose the subject in concern.
- Each of the consultants has to present their results in a discussible (community report (readable via internet) and publishable (local newspaper) forms.
- The invited consultants start their work the 28th of February and after three weeks they have to present their mid-term review. At the end of the sixth week they have to present their concept results. At the end of the eight weeks they have to submit their final results (including report and newspaper article).
- All geo-spatial data of the area is available via: UNIX //GISSRV/home/g12/u1/maaswaal

Box 2: part of the assignment

6. Students evaluation

Each of the three courses has to be evaluated. At the moment of writing this paper the course "spatial modelling in landscape ecology" has not been finished and evaluated. The evaluation results of the course "spatial modelling and visualization" are not fully processed. Due to this only the preliminary results can be mentioned in this paper. The "basic GIS" course is already evaluated and results are available.

The evaluation of the "basic GIS" course shows the following main results. However the course has given in a traditional (lectures, practicals but no DLE) setting, most students (N=16) have difficulties to finish the assignments within the given time frame. This can be explained by the use of the DLE in combination with the geo-information processing software. For example they did use two screens if they had the opportunity. By one screen

they check the rco's which are needed to fulfil an assignment. On the other screen they process and present (by arcview) the geographic data sets. Also the difficulties they had with searching for a certain part of the theories, instructions or assignment show this. Finally many students complained about the fact that browsing through the digital material was unclear and time consuming.

The most preferred part of the DLE was the one that clearly divides theory, instructions and assignments (figure 1). Students prefer graphics, symbols, pictures in the DLE interface. Reading larger parts of text was avoided by printing this text. An interesting detail is that the majority of the students never used the icons and symbols that haven't been explained in advance. The best-used cso is the *scheduler*, followed by the *faq* icon. The *search* and *mediaroom* icons haven't used at all.

Other significant remarks were: 60% of the students don't expect to fulfil this course as it has been given as a strict self study; 100% of the students want to have a teacher around; the role of the teacher must be laid back (40%), instructive (50%), always be there (100%). The students did like the remote sensing (70%) and the cartography (100%) assignments most. They dislike the GIS-tutor and data models (100%) assignments.

The evaluation results show that the "cohort approach" is dominated by the schedule cso and trying to do things in time. The differences between the classes are not clear, but one part of the course (the transformation cso) was preferred. In this part the cso shows clearly the four classes.

The students (N=24) that followed the course "spatial modelling & visualization" did experience GIS, remote sensing, but never worked with a digital learning environment. One of the major struggles during the course start-up was the cultural and social heterogeneity of each group.

One of the main conclusions out of the evaluation is the lack of time to perform the three roles. The majority of student spent 30% more time than credited. Most students found the problem-oriented way very interesting and stimulating but they also had the opinion that the cohort part of the course should be extended (!) to improve the quality of the problem oriented consultancy part.

Because the lack of time students were too much focussed on their own group-work and not of all to the questions and results of their fellow students. Regarding the consultancy work it turns out that students found the group-work not always stimulating because of the great differences in the levels of knowledge and skills and some students were not able to realise the personal learning objectives. On the other hand some students were enthusiastic about the consultancy work because it is stimulating, tasks can be divided and they learn from each other.

Regarding the DLE all of the students did like the structure and the materials. In contrary what could be expected the use of *search*, *mediaroom* and *discussion* icons was nihil. A possible explanation is the fact that a lot of theories, examples, data, and so on were already

available by the DLE. Besides students did always have Web search facilities available. In the course it turns out that only for GIS-applications the Web search has been used. All other materials were used from the DLE.

The role of the supervisors seemed to be very important especially to assess their own working process.

7. Conclusions

Which educational 'look' of geo-information science courses, based on the use of ICT, can be expected, when the didactical transition from "cohort" approach to "problem oriented" approach will continue. In a very sound form a problem-oriented course will exist of a short essay that enables the student to define: problems and related tasks to solve these problems. The DLE should provide the student with search facilities and feedback mechanisms. Important feedback mechanisms are (on-line) meetings with one or more supervisors, probably (on-line) discussion with specialists and (on-line) monitoring the students learning process during a course. Each of these mechanisms is currently not adequate or available. The results of a questionnaire to more then 100 academic teachers in the United States who worked with digital courses showed a severe increase of labour time [HSI1].

The contemporary situation demands for pure rco's. The benefit of such rco's will be the possibility to describe them by meta data that could give direction to the level and the quality of the rco's. Relating rco's to learning objectives will become more professional. Besides the rco's can be shared and re-used. Big challenges for the geo-information society are related to the meta-data description of these rco's: what are the smallest rco's, how to peer review rco's, which quality criteria has a rco to be met.

Especially for the problem-oriented approach the pure rco's are elementary. Free web search by students will give too many different and unacceptable results. As long as screening the students is difficult the other way around, during a course only pre-selected rco's will be offered, seems to be worthwhile. In the course "spatial modelling and visualization" this has been done by a combination of "cohort" approach and the problem-oriented approach. During the problem-oriented part rco's are provided to the students by cso's like an hierarchy tree (a component of the course material (the so-called 'panorama' or 'yellow book'), by a search mechanism for the rco's in the hierarchy tree and a search mechanism in the mediaroom (local ICT state).

Switching from a problem-oriented approach into a cohort approach will then be a matter of cso developing.

Notes

[1] I made the assumption that most of the teachers in an academic educational environment develop the course structure themselves. This is a big contrast with teachers from other school types like secondary schools. They (have to) adapt courses which have been structured by special education groups of publishing organisations.

[2] Digital learning environment (DLE): an ICT application created for professional education institutes to administer, to organise, to monitor and to teach students. In this paper by DLE is only meant the ICT application to teach students.

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