Active learning and the process of science: beyond information skills

Maurits ERTSEN
Delft University of Technology
Faculty of Civil Engineering
PO Box 5048 2600 GA Delft
The Netherlands
m.ertsen@citg.tudelft.nl

Jan KOOISTRA
Utrecht University
Faculty of Social Sciences
j.kooistra@uu.nl

Rudi STOUFFS
Delft University of Technology
Faculty of Architecture
r.stouffs@bk.tudelft.nl

SUMMARY: *Information is produced, communicated and validated within peer networks. It is important for engineering students and universities to (learn to) develop and work within these peer-driven, information-based networks. The pragmatic consequence of the use of ICT in education within these communities is that students become correspondents. One of the most difficult issues is how to develop a strategic didactic scenario with which the traditional handling of scientific material could be shaped and interconnected with the objectives of education and research as these are expressed in the curricula of the faculties, given the considerable differences that can exist between curricula and student populations of different universities.*

KEY-WORDS: *E-platform, information skills, didactic scenario, peer networks*

1. INTRODUCTION

Modern scientists and engineers need to process huge amounts of information. This information is produced, communicated and validated within peer networks. It is important for engineering students and universities to (learn to) develop and work within these peer-driven, information-based networks already during the study period, to continue them after graduation and to involve other experts. The introduction of E-platforms in higher education offers opportunities to develop new interactive systems to search, communicate, distribute, create and save information. Working with an E-platform, which accommodates new ways of dealing with information causes noise in the academic educational system. Common sentiments expressed by faculty members are "Why introduce such a complicated system when you can go to the library and borrow a book?" "Dealing with electronic scientific information takes a lot of time, it is an attack on our course". Also at the level of the library itself, working with new ICT tools raises a lot of discussion. "How to guarantee quality?" "Who pays for the information?"

All these sentiments and statements deserve serious attention. Nevertheless, with the advent of ICT, possibilities to communicate within scientific networks about information have changed drastically and inevitably the communities will take over some of the tasks that in the past were taken up by the libraries. The position of the librarian was that of *selecting, acquiring, ordering, indexing and making available* data. Now these tasks are split into three parts, which are not necessarily the sole responsibility of the librarian: typifying and selecting (compare *quality-based selection*); acquiring and making available (compare *information logistics*); and ordering, opening-up and guaranteeing (compare *information mediation*).

The pragmatic consequence of the use of ICT in education is that students become correspondents. Students move up to the former position of the librarian. The use of ICT flattens the hierarchy between librarian, faculty and student. Students become librarians as they were at the beginning of the era of modern science. Thus students are learning that all these books, articles and readers they have to stow away, actually are meant to be disassembled into their references and that these books release much of their information through this activity. Libraries are like freezers. They keep the information that is assembled into books deeply frozen till their moment of consumption - or till the moment their storage life is over. Use of ICT means speeding up knowledge and reducing the need of the kind of packing and the type of storage that we hold to be normal and to be necessary to be a library. In this paper we discuss both backgrounds and examples of educational modules, in which this general idea is applied.

In terms of education we are trying to employ the model of correspondence about references according to academic manners in our education. Education centres on the scientific correspondence within the boundaries / conditions set by an E-platform in which simultaneously the processes of seeking, communicating, distributing and validating on / of electronic scientific material occur.

Circulation speed, the extent of robustness, management and exercising authority over the knowledge, everything follows suddenly pragmatically the laws of ICT. Here the most important difference between the concept behind information skills or dealing with scientific material becomes apparent. The knowledge really takes a run, accelerates and sings interactively around in the circle of them who formerly could be defined as readers, but now suddenly have become the network that exercises the authority over the very same knowledge by itself.

Dealing with information has always been one of the central learning goals of academic education. With the strong rise of electronic learning environments, one is forced to make a move from focusing on basic information skills to deal with digital scientific material. 'Deal with' implies more than 'possess skills'. It concerns (learning how) to work according to the rules and manners that determine the exchange of scientific knowledge. The goal is no longer to understand the library system or even use it, but to know ones way with scientific material as it presents itself through the E-platform. We would maintain, however, that using an E-platform does not change the nature of the scientific process / business as usual. Academic manners are as old as science itself and independent of paper or electronics. The business of science means to develop active correspondence about references in networks. In this tradition, libraries have arisen as the reservoirs / depots in which these correspondences were kept. Through metadata the (f)actual correspondence is enabled. Opening and re-ensuring tracibility of scientific material through the use of metadata therefore shapes scientific communication. Yet, the use of E-platforms as information-rich environments can be considered at the same time as revolutionary. Our assumption therefore can also be considered as a paradox.

2. FIRST EXPERIENCES IN UTRECHT

In 1998 the library of Utrecht University started to develop an interactive program for the search and exchange of information called *Ommat* (*Omgaan met Wetenschappelijk Materiaal; Dealing with scientific material)*, with two versions, a *training version* and a *support version*. The training version was introduced in 1999 together with the introduction of the E-platform Blackboard. It was integrated in the courses of 5 disciplines at the Faculty of Social Sciences. At the moment about 2000 students at the Faculty of Social Sciences at Utrecht University use Ommat, in psychology, sociology, general social sciences, anthropology and education science. What these (undergraduate) students have in common is that they have to perform the same kind of assignment: a design of a research project on a topic and writing a paper. The students are working together in subgroups (4-5 persons) on their topic but have to accomplish an individual paper (sometimes in pairs). The time required to complete the program within a course varies from 20 to 60 hours, this is between 10% and 30% of the total course size.

In the case of an investment of 60 hours the students learn to provide their paper with a series of correct references by using the support version of the program, they learn to review the paper of a colleague student paying attention to the use of references and they learn to share information on the topic that they choose together. Sharing happens by building a collective database on the (subgroup) discussion board of the E-platform. In the case of a 20-hour investment, the training stresses the use of the support version and the processes of validating the information found by the students. In this case the students perform the so-called *network exercise.*

In 2001, Delft University of Technology joined the Ommat program, with particular emphasis on the development of a *portal version* of the program. The extras offered by the portal version consist of technical and social procedures to transfer student products from the E-platform environment (Blackboard) into open Internet environments supported by the library, Virtual Knowledge Centres. In Delft the Ommat program is named *DelftSpecial*: *Delft Student Personal Education Coach for Information Alerting and Learning*. It has been in use since 2001 at undergraduate and graduate level at the Faculty of Civil Engineering and at the Faculty of Technology, Policy and Management at undergraduate level.

3. CIVIL ENGINEERING IN DELFT

A first pilot trial took place at Civil Engineering in the period March - April 2002 and was completed with a follow-up study in September 2002 – June 2003. The pilot tested the concept of a portal, the technology and the didactics of a shared digital information-rich environment. The pilot trial course was a graduate project within the civil engineering curriculum on Integrated River Basin Management (IRBM) in the context of the European Water Framework Directive 2000/-60/-EC. The WFD establishes a framework for water management in Europe and complements the many water directives that already exist. Its key objective is to achieve 'good water status' for all European waters by 2015.

Twenty-three students, divided into three teams, had to formulate a river basin management plan for a sub-basin in the Netherlands. The plan had to cover both water quantity and quality issues. This assignment followed directly from the WFD and Dutch water policy. Groups were encouraged to use (material from) reference situations. The students worked on the portal during the period assigned to the project (seven full weeks). The work on the project was managed by means of the didactic system of the program, which focused on the provision of instruction and the organization of the exchange of information between the sub-projects. The customary project-team setting (discussed in Ertsen 2000) remained intact during the course of the project. The project groups discussed the benefits of a river basin management plan and which elements should be present. This assignment followed from the experimental set-up

of the project educational environment, especially the input from the library.

Participating students were supported at three levels: (1) interactions and exchange between team members on a face-to-face basis and within Blackboard; (2) direct contact on a weekly basis with a tutoring staff member of the Faculty; and (3) discussions and exchange within Blackboard between teams (see the box for a typical set-up). Within the DUT digital learning environment Blackboard, a shared site was available. Each separate project group used its own sub-site within the shared environment. Documents made, discussions held, links found and material collected, were placed in the respective group environments. Such a work process not only results in a product in the shape of a report, but also potentially supports the development of river basin management in the Netherlands.

Issues of perception of users involved in collaboration in an information-rich digital work environment were investigated by means of two surveys employing two scales. The surveys were carried out prior and subsequent to the IRBM project. The measurements were made using the Subjective Computer Experience Scale (SCES) (Smith et al 2000) and the Subjective E-platform Experience Scale (SEES) (Kooistra et al 2003). Results of these surveys are reported elsewhere (Ertsen et al 2003).

These considerations and the promising results of the pilot were reason enough to continue activities to promote the use of the E-platform within education and research within Civil Engineering, in particular the 'wet' groups (water management and hydraulic engineering). A second project education pilot on IRBM was conducted in the period of March – June 2003. Although due to external reasons the number of participants was unfortunately low (5 participants), this allowed for a stronger focus on the possibilities for information exchange between users of an E-platform through the establishment of a database. Such a database is likely to become one of the key factors in establishing successful communities of practice, being it students or professionals. In a third year course, the (individual) BSc-graduation project, two elements of the pilots connected to correspondence are integrated: (1) developing a database with relevant information (including applying this information in the design) and (2) peer reviews of student reports by fellow students. The integration in other courses is under development.

4. ARCHITECTURE IN DELFT

At the Faculty of Architecture, the metadata system KeySet serves to provide each student work or design product (e.g., model, image, text, picture, animation) with a unique key consisting of four or more keywords (Stouffs et al 2004). KeySet defines four dimensions corresponding to which keywords are assigned as metadata to data. These dimensions constitute the qualities that the data possess at different levels. In KeySet, assigning keywords to data is considered a form of claiming. The four dimensions form as it were the space in which claiming the data takes place. These claims concern:

- the constructive qualities of the data, that is, the idea one tries to represent in the design;
- the objective qualities of the data, that is, the (f)actual elements that one uses to express this idea;
- the relational qualities of the data, that is, the influence the design has on the user and, vice versa, the influence of the user on the design;
- the subjective qualities of the data, that is, the emotion that the design elicits.

Technically, KeySet encompasses an entry form, used to compose the key, and a search tool that can retrieve all entered keywords and combinations of keywords in different ways for adaptation or reuse. Didactically, KeySet pushes students to deal with the paradox that a database is losing informative quality when it is cleared into a neat one. They learn that a certain measure of chaos lubricates the exchange of information and that, to be informative, a database has to cherish the differences that arise from the same assignment students get. Strategically, KeySet encourages students to learn from one another and work together as young professionals by providing them the opportunity to compare their work and design solutions directly.

The development of KeySet forms part of an educational project to develop a learning environment to support group work and discourse, named InfoBase. The goal of the InfoBase project is to provide students with and teach them how to utilise a digital environment in which they can store, exchange and manage the information they collect and generate, individually and in group, and at their own initiative. The focus in the InfoBase environment is on multimedia information, including texts, images, audio, video, drawings, 3D models, etc. The InfoBase environment currently supports two interface modules. The StudentWork module (including KeySet) is the main interface module of the environment and contains a student work submission section and a public section in which student work can be searched and viewed (next to an administrative instructor section in which submission deadlines can be set and grades can be assigned to the work). A second interface module, named MediatedDiscourse, enables students to collectively build an information structure in support of and to represent a discourse. It includes the following functionality: to relate a newly submitted contribution to existing contributions in the information structure, to develop a semantic structure of keywords and to assign keywords to contributions, to mark contributions according to a number of characteristics, and to comment on contributions as well as respond to others' comments. The MediatedDiscourse interface module is used in a number of educational experiments in order to gain insight into the manner in which these functionalities (can) contribute to supporting communication and group processes (Akar et al 2003). In both interface modules, overviews with thumbnails offer the user quick insight into the content of the results

of a search query. Images in JPEG, GIF and PNG format are automatically provided with a thumbnail. Other formats can be supplemented with an image by the author (which is often required). Otherwise, the environment does not impose any restrictions on the format of the content or contributions. Browser plug-ins provide assistance in visualising the different formats.

In September 2003, KeySet was introduced in the first semester of the BSc Architecture curriculum. Specifically, students were introduced to the use of metadata when submitting course work in a computer modelling workshop (Kooistra et al 2004). For each image they submitted they had to specify four claims corresponding to the four quality dimensions. For each dimension, a small set of keywords was provided from which the student had to choose one. A search tool provided access to the resulting collections. Students appreciated the formation of a cooperative database composed of their submissions, encoded using metadata and searchable accordingly. Students used the search tool to search either collection using one of the sets of claims they used to encode their own submissions.

Last year, the use of KeySet and the InfoBase environment was evaluated using the SCES and SEES scales. Surveys were carried out before and after a second semester computer modelling workshop, in which KeySet was linked to the submission of student work. About 300 students took part in the workshop in which they needed to model a constructive detail of an existing building. The submission requirements for this model were three elevation and two perspective view images. Students assigned metadata to each image. For each dimension, a short list of keywords was specified from which the student could make a selection. Only for the *relational quality* dimension, a fixed claim "reference detail for architects and building specialists" was selected for all images. The correlations found between the SEES ICT and KeySet factors and the variance analysis conducted clarified the strategy that we think that needs to be followed (Kooistra et al 2005): Make students more familiar with dealing with metadata (KeySet) and they will find it worthwhile and also rather fun. The latter not only depends on whether the instrument is profiled appropriately but also on the courses or workshops in which it is included. As such, it also depends on a stimulating policy of the Faculty.

5. FINAL REMARKS

Our experiences with using E-platforms enabled with integrated procedures and facilities for the processes of seeking, communicating, distributing and validating on / of electronic scientific material de facto centre on developing so-called virtual knowledge centres. Despite the work that we have invested in building websites with training modules, portals and support systems, the most difficult task has really been developing a strategic didactic scenario with which the traditional handling of scientific material could be shaped and interconnected with the objectives of education and research as these are expressed in the curricula of the faculties. One of the main problems of educational systems is their ambiguity when it comes to sharing information. On the one hand the student has to learn to share information openly. Science is open correspondence about references. On the other hand, most educational systems are set up to isolate and individualize students in the end for the sake of testing their knowledge.

Another issue is the evident and considerable difference between student populations of Utrecht and Delft. The Utrecht population (social science students) is in search of theoretical material that may help to understand phenomena and test or develop (new) theories. Delft engineering students (and many staff members for that matter) are primarily interested in material they need to design solutions (solve 'problems'), such as figures, constructions and reports. In Delft, the didactic scenario and hence ICT support was adapted to the technological academic culture.

Within Delft, however, there is considerable difference between design within the Faculties of Architecture and Civil Engineering & Geosciences. In the Architecture curriculum, the main focus is on the individual student sharing his/her contributions and the perceptions of both him/herself and the others. Another main focus of Architecture is on the use of images. For the curriculum of Civil Engineering, focus is on exchanges within and between teams (Ertsen 2002b, Ertsen 2000). The changing position of civil engineers within society, and their need to link the engineering aspects much more explicitly to broader issues in society, calls for education and training these concepts into account (Ertsen 2002a). Information validation and sharing appears as a key issue. A main focus of validation in both practice and education is on validating design assumptions and requirements for civil engineering projects.

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Blackboard Delft:
http://blackboard.tudelft.nl

Ommat:
http://ommat.library.uu.nl

DelftSpecial:
http://www.library.tudelft.nl/ctkc/ned/Informatievaardigheden/DelftSpecial/delftspecial.html

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