

## 29 Strategic Planning for Web-based Learning and Teaching at Tampere University of Technology

**Kirsi Silius, Seppo Pohjolainen**

Tampere University of Technology, Finland  
 kirsi.silius@tut.fi  
 seppo.pohjolainen@tut.fi

### Abstract

The purpose of this paper is to discuss the action to support the development of web-based learning and teaching in higher education. A central question is how web-based learning and teaching should be incorporated into the strategic planning of the University.

**Keywords:** web-based learning and teaching, strategic planning, organisational change.

### 1. Introduction

The Finnish Virtual University was founded in 2001. The activities of the Virtual University are based on a shared networking model formed by all the Finnish universities. The Finnish Virtual University is one part in the realisation of the visions, specified in the Information strategy for education and research 2000 - 2004 devised by the Finnish Ministry of Education. (<http://www.minedu.fi/julkaisut/pdf/tietostrategia/2002hankesuunnitelmat.pdf>).

"There will be a virtual university in Finland, operated jointly by several higher education institutions, businesses and research organisations producing and offering internationally competitive educational services of a high standard."

In the year 2001 work to achieve that goal was started by improving the efficiency of networking between universities, by enlarging the activities of the newly formed network, by maintaining the high quality of education and research, by developing the pedagogical skills needed in web-based education, by supporting innovative uses of information and communication technologies in education, and by making the Virtual University an attractive choice. (<http://www.minedu.fi/julkaisut/pdf/tietostrategia/2002hankesuunnitelmat.pdf>).

Tampere University of Technology (TUT) participated in the consortium of the Finnish Virtual University when it was founded at the beginning of 2001. At the same time a virtual university project was set up at TUT to fulfill locally the strategy of Finnish Virtual University.

Tampere University of Technology employs approximately 1800 persons, 360 of them are assigned to teaching and 660 to assisting teaching and research. The University has

approximately 10 500 students and consists of ten departments including 33 institutes and 8 auxiliary institutes.

It is the mission of TUT to provide the most advanced technical university education and conduct research in the field of technology. In addition to basic research in technology and the natural sciences, the importance of applied research and product development is considerable. TUT is known for its excellent co-operation with industry and business life. The Digital Media Institute at TUT is a research center for information technology of international significance.

The purpose of this paper is to discuss the strategic planning of web based learning and teaching at university level in Finland. We also address the need to organisational change and change in the line of action at Tampere University of Technology. A central question is how web-based learning and teaching should be incorporated into the strategic planning of the University.

#### 1.1. Strategic planning

According to the Murdoch University (Anderson et al. 1999) "Strategic planning aims to direct the activities of an organization towards the attainment of strategic objectives. It is concerned with the setting of objectives, the development of procedures for implementing the objectives and monitoring the extent to which they can be achieved."

Various approaches and emphases underlie the strategy process for web-based teaching. What strategies have in common, however, is that they pursue better learning for students. Many researchers stress the importance of having a strategy for web-based teaching.

According to Cornford (2001) attempts to build virtual university from bottom-up, course-by-course, without reconstructing the basic structures of the university prone to failure.

Bartolic-Zlomislic & Bates (2002) point out that the economics of online courses require up-front investment, development of business plans, project management, financial and technical support, ... professionalism and a team approach to course development and delivery. Whether or not web-based learning can be considerable successful and worth the investment will largely depend on the value and goals of organisation.

Kaufmann, Watkins and Guerra (2001) note that those that will be successful in making valuable contribution to learners and society will be those that focus on offering useful learning opportunities. After all, does it really add any value to an organization (or learners) to provide educational opportunities at a time and location convenient to them if the opportunity provides no value in terms of assisting them, their organizations and/or our communities on achieving defined and useful goals. Many organizations are now offering high-tech distance learning, yet few have focused on comparable resources on the basic elements of sound instructional and performance system design.

The ten broad principles below (which are primarily based on Argyris (1990) and Kotter (1996) and presented by Higher Education Funding Council for England, Centre for Higher Education Practice, The Open University (HEFCE 99/95) (1999)) we have found useful in our strategy process.

- Principle 1: Develop vision and strategy
- Principle 2: Establish a sense of necessity
- Principle 3: Create a guiding coalition
- Principle 4: Communicate widely and continuously
- Principle 5: Be prepared to listen
- Principle 6: Develop a shared commitment
- Principle 7: Generate some early success
- Principle 8: Realize when game playing is going on and deal with it
- Principle 9: Consolidate and embed the gains
- Principle 10: Do not rest on your laurels

Below we present TUT strategy planning and examine how it reiterates the principles named above.

## **2. Strategic planning to support web-based learning and teaching at Tampere University of Technology (TUT)**

It is eminently appropriate to develop infrastructure at TUT which enhances opportunities for web-based learning and teaching. In addition to infrastructure web-based teaching entails special features with regard to teaching methods and content production. The Ministry of Education and the Finnish Virtual University national strategies moreover set the border conditions for strategies in IT for teaching purposes. The experiences of the first year have shown how much organizational culture determines the focus of strategy work. What is of interest in organizational change is to identify those key areas through which new perspectives and modes of operation can be rooted in the organization.

As a basis for strategy work at TUT a SWOT analysis was conducted on web-based teaching, a survey of the use of IT in teaching and a study was made, one aim of which was to ascertain the valued added generated by web-based learning. In the light of these data a target situation was created and the measures necessary in order to achieve this.

### **2.1. Virtual University of Tampere University of Technology**

The Virtual University of Tampere University of Technology (VUTUT) was founded at the beginning of 2001. The Virtual University of TUT concentrates especially on developing methods and contents for web-based education to meet the demands of the technical sciences. The project's main goals are to improve the quality of teaching and to facilitate students' and teachers' everyday routines with network-based services. The object is to utilize research findings and technology in the field of web-based teaching.

As Cornford (2002) has pointed out it is important to see the virtual university project as extending across the whole of university. The virtual university is not just a matter of flexible teaching and learning systems but extends into administration, students recruitment, research networks and library systems and so on. In TUT these crucial interest groups have been included in the implementation of the virtual university right from the planning stage. The Rector appointed a steering group for the Virtual University Project composed of experts in data management, teaching services, library and the departments. At TUT there is expertise in web-based teaching from the perspective of their respective disciplines in the Hypermedia Laboratory (Ruokamo & Pohjolainen 2000, 1998), the Computer Science Laboratory and the Virtual Reality Center.

The annual budget of the project is 420,000 Euros, which covers the startup funding of the pilot project and the activities of the support and development team (the VU Team). Since 2001 there have been 47 departmentally implemented pilot projects in web-based teaching in VUTUT. These pilots have concerned research, development and content production.

The activities of VUTUT are web-based. The aim is to include actors from all departments in the development work. To achieve this some 10,000 Euro from the annual budget of the virtual university has been allocated to several pilot projects in order to get them up and running.

### **2.2. The SWOT analysis**

In 2001 as a point of departure for the development of web-based teaching VUTUT considered the strengths, weaknesses, opportunities and threats associated with web-based teaching and learning.

The SWOT analysis was used to give a direction to virtual university activity. It was decided to remedy the threat posed by lack of strategy in such a way that the strategy points traditionally updated at TUT would also take account of the new demands presented by web-based teaching.

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> <li>- High level of technical expertise</li> <li>- Infrastructure: new, innovative technologies, capability and knowhow to develop tools</li> <li>- Interest and activity in the personnel for the production of</li> <li>- Homogeneous web-based course material background of students</li> <li>- Good IT skills of students</li> </ul>	<ul style="list-style-type: none"> <li>- Different practices with accreditation at different universities</li> <li>- Slight experience of utilizing web-based teaching</li> <li>- "Not Invented Here" attitude</li> <li>- Teaching culture: teaching traditionally teacher-centered, not teamwork</li> <li>- Net pedagogy not mastered</li> <li>- Lack of resources, no teacher to be paid</li> <li>- Inability to perceive the value added through the web-based teaching (e.g. diversity in teaching)</li> </ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> <li>- Technical development scope for infrastructure</li> <li>- Electronic personnel identification – development work</li> <li>- Partnership of responsibilities and specialization between universities</li> <li>- Including distance learners to increase group size of small courses</li> <li>- Increasing students' options</li> <li>- Flexible participation in studies, studying more effective</li> <li>- Utilization of material produced elsewhere</li> <li>- Production of high quality material</li> </ul>	<ul style="list-style-type: none"> <li>- Development work lacks sense of purpose, lack of strategy</li> <li>- Demand for web-based teaching and learning partly unknown</li> <li>- Weakness in information transfer may lead to best practices in web-based teaching remaining isolated experiments</li> <li>- Lack of resources, tutoring costs frequently forgotten, enthusiasm at risk of sticking at the first wave</li> <li>- Teachers confronted with totally new and extensive demands</li> </ul>

Table 1: SWOT analysis of web-based learning at Tampere University of Technology

### 2.3. Utilization of information nets and computers in teaching 2001

In 2001 it was the turn of information management strategy work, which included a workgroup composed of experts in TUT web-based teaching. In autumn 2001 this work group took stock of the situation with regard to the use of IT in teaching at TUT. This survey was conducted by means of a net questionnaire sent to all course in all departments of TUT. The response data cover 41% (544 courses) of the total offered in 2001 (Silius et al. 2002).

According to the survey in 2001 computers was used in TUT in teaching principally for functions pertaining to the teaching arrangements (including information dissemination, distribution of teaching material, enrolment, distribution and return of tasks, monitoring points gained, tools for course administration). In approximately one quarter of courses there was a web-based learning environment behind a password. Teaching actually mentored in the web by the teacher was relatively rare in relation to all courses offered.

On the other hand the web was utilised for purposes of collecting feedback with a view to improving teaching and also for providing feedback on practice assignments completed by students. There were no applications in use for support in learning or knowledge structuring. Throughout the institution the teaching material distributed over the web was mostly lecture handouts in electronic form. There were almost no teaching materials in use which had been specifically designed for use over the web, the exception being those courses implemented specifically as pilots for the Virtual University of TUT.

The following table presents the utilization of the web in the organization of teaching.

Use made of the web	(%) of responses
Information on course homepages	70%
Distribution channel for course material	70%
Submitting assignments to teacher	50%
Course administration applications	60%
Monitoring points for partial completion	50%
Giving feedback for improvement of course or teaching	30%

Table 2: Utilization of web in organizing teaching.

The survey revealed that at TUT there were only under one hundred courses on which the share of web-based learning was over 40% of the studying or teaching mode. Moreover, web-based teaching still contained a small amount of learning

discussion connected to the subject area taught. The survey indicated that TUT was using no much applications supporting learning and knowledge structuring to support net study.

Table 3 presents utilisation of the web in teaching.

Ways of utilizing the web in teaching	(%) of responses
Supervised web discussion	10%
Spontaneous web discussion	20%
Teachers giving students feedback on the web	50%
Web tutoring, verbal feedback on practice assignments	60%

Table 3: Use of the web in teaching .

Teaching material actually designed for use on the web was used by less than one third of respondents. Less than 20% reported using commercially available web material. On the other hand some 60% of respondents reported using free-of-charge material freely available on the web.

#### 2.4. Students in web-based courses at TUT

To obtain more information about good practices on web-based learning in technical sciences various virtual university pilot courses were evaluated. Especially students' background information and their expectations of added value on web-based learning were studied. The majority of the students were at the beginning of their studies and usually they did not have any experiences of web-based learning. In their opinion they had been succeeded quite well in earlier studies. They live near the campus and they were going to study a web-based course at home or in the computer classroom at the University of Technology. Of these students 40% were working while studying and 30% of them studied during the working day at their workplace. Students reported that they could use word processing software, program helps, email, web-browser and install plug-ins but they did not know news and chat as well (Silius 2002b, Forsblom & Silius 2002).

Those students who were working while studying were in special need of flexibility in their study schedules. They mentioned that participation in courses organised only at campus were inconvenient for the most of them. For those students the opportunity to study via the web was the value added. In the situations where course schedules overlapped or courses were full the web-based teaching and learning were reported to be value added.

Access to course material was also mentioned as an added value. In their opinion using the web in learning and teaching

students are able to automate their everyday routines and routine tasks (like the delivery of teaching materials, enrolment in exercise groups or courses etc.).

Students expected that web-based teaching and learning would improve the quality of teaching materials. They hoped that teaching materials would be illustrated, for example, by simulation, modelling and visualisation. The students expected that they would get more just-on-time feedback and support for their study in web-based teaching.

The students expected that their learning to learn skills and self-direction skills would improve in web-based learning and also that open learning environment and tutoring practices would support the development of those skills.

#### 2.5. Development of infrastructure

Developing web-based teaching requires sufficient infrastructure: information nets computers, AV equipment software and premises. At TUT the development of infrastructure supporting web teaching is taking a favourable direction.

On the TUT campus staff and students can use TUT information systems and the Internet on TUT computers. The personnel and students also have the option of contact to the TUT campus net from home. The student dormitories have broadband connections to the campus network.

The speed of the campus network is 1Gbit/s and it is connected to Finnish university network (Funet) with a 155 Mbit/s ATM connection. In 2003 it is planned to update the connection to 1 Gbit/s and to add more wireless local area networks (WLANs) to the campus area. WLANs will be set up to all major lecturing facilities, vestibules and conference rooms. These solutions represent an effort to achieve flexibility for web and computer-based teaching and studying. An effort will be made to ensure flexibility in studies through portable laptop computers to be loaned out from the Library and intended for use on campus.

In addition to these computers students have round the clock access to 295 computers located in nine terminal classrooms maintained by the library and in the library building proper. The computer classrooms are also equipped with additional equipment such as scanners and workstations with recordable CD:s. The classrooms are equipped with software for the needs of the mainstream undergraduate. Several classrooms are to be equipped with the equipment and software needed specifically by distant students. In addition to these generally maintained computer classrooms TUT has a total of 33 microcomputer classrooms maintained by the various departments. These are used for departmental teaching.

TUT is implementing a portal including student and teacher interface. The TUT portal will enhance the functionality of the currently extensive TUT intranet pages which serve as a channel for information dissemination.

The portal includes student and teacher interface. The new student interface includes enrolment at the University of Technology, for courses and examinations, an application for monitoring studies completed, application for providing feedback and for planning studies. Within the limits of the opportunities available these services will be developed for mobile terminals. The teacher interface includes a calendar, an application for processing feedback, options for compiling students' background information for purposes of course profiling, an application for course management, and application for updating the study guide tools for creating course homepages, an application for reservations and information on teaching equipment in various spaces, management of studies taken and registration application and an application for updating the study guide.

## **2.6. Developmental goals for web teaching**

Web-based teaching is to be developed at TUT in such a way that it both supports teaching given on campus and distance learning by TUT students and students of other universities and educational organizations. Due to work, pace of studies and life situation a considerable proportion of TUT's own students can at time be compared to ODL students proper. The methods developed for them also support such on-campus students for whom there was no room on courses or whose schedules involve timetable clashes.

Effort will be invested in making teaching more diverse by offering more opportunities to participate in multi-disciplinary courses between various organizations. It has been deemed important to offer such courses in the portal of Finnish Virtual University.

According to the information management strategy the target situation for TUT web-based teaching in 2005 is as follows:

### ***Organization of teaching through IT:***

All TUT courses will have uniform homepages providing the information necessary for completing the course and access to teaching materials. The courses will further have the use of electronic means of communication such as newsgroups and e-mail programmes. In addition, there will be, in many courses, standardized learning platforms that are tailored to the needs of courses. The web will be used to disseminate information on matters to be updated. The information dissemination practices, course accreditability, practices for approving and registering courses have been designed to serve ODL students, too.

### ***Developing teaching through IT:***

Application which support the learning process such as simulation, learning games computer-aided interactive tasks and mind-map applications will be used on numerous courses. Some 50% of courses will utilize the web to promote monitoring of studies while 10% will use the web in a pre-planned qualitative manner to direct learning. Students will be

able to utilize the web in some 20% of courses in taking mock examinations and diagnostic questions. Moreover, the tutoring of web-based teaching modules will be designed to direct the progress of ODL students.

### ***Quantitative goal:***

The goal is that in 2005 on average every department will offer one course within TUT top expertise through the portal of the Finnish Virtual University. These courses will target some three hundred of TUT's external ODL students. Likewise some three hundred TUT students would complete other universities courses through the portal of Finnish Virtual University. Another type of ODL student at which web-based studies are targeted consists of TUT's own students, Open University students and the personnel of companies.

## **2.7. Key action points**

In addition to development of infrastructure and software it has been decided on the Virtual University of TUT to develop the following measures for web-based learning and teaching:

- Education
- Support
- Courseware production
- Research
- National co-operation

### **2.7.1. Education and support**

Support and training in producing web-based teaching have been organized on the Virtual University Project, which employs four support persons for web-based teaching (so called VU Team). They arrange training in content production and implementation, pedagogy, teaching methods and learning styles, value added in web-based teaching, graphic design, techniques in web-based teaching and matters pertaining to copyright. In addition to providing training these support persons assist the departments in the design and implementation of web-based teaching projects. Once a month some 20 people currently producing web-based courses convene at a meeting where topical questions are addressed.

Producing good quality web-base teaching materials requires a production team. The resources and skills of the individual teacher are not sufficient for the production of good quality and interactive hypermedia material. Thus in 2002 support measures and training were initiated in the departments, likewise the activities of the Virtual University Workshop. This is a working space earmarked for TUT teachers and the digital implementation of web-based teaching content based on "do-it-yourself" activity. The workshop is a low-threshold advice and working point open to all. In the workshop, in addition to equipment and software, supervision is provided by the support persons in digital content production and

pedagogy, likewise design assistance in material production, structure and design of graphic appearance, assessment of usability, hints on tools and net publishing and supervision for web-based study.

### **2.7.2. Courseware production**

A considerable part of the TUT virtual university annual budget has been distributed for the implementation of the departments' pilot projects. This constitutes an effort to support above all the departments' content production, when teaching materials are produced and teaching methods using IT and appropriate to the field of technology are developed and tested. This has been in the nature of startup funding in addition to which other funds of the departments have been invested. In the last two years of the project a total of 33 such content production projects have been implemented in various departments.

### **2.7.3. Research and development**

In addition to content production, TUT research and development work on web-based teaching is conducted both in the departments and the VU Team.

The research in the departments focuses on the development and evaluation of learning environment platforms, the evaluation of existing web tools developed in TUT and further development, likewise virtual reality techniques and the use of mobile terminals.

VU-team concentrates to study the best practises and the value added of web based teaching and learning in the field of technical sciences

For instance in order to obtain more information about good web-based learning practices in technical sciences eleven teaching experiments were also evaluated last autumn. All good practices were collected to web site <http://www.virtuaaliyliopisto.tut.fi/verkkopakki> (Silius et al. 2002). The evaluation process consists of pedagogical and usability sections (see Albion 1999, Leinonen et al. 2002, Quinn 1996, Soloway et al. 1996, Squires 1997, Squires & Preece 1999, Tergan 1998). The researchers paid attention to how the learning context and pedagogical appropriateness were taken into account in user interface, tools, tasks, quizzes and in planning, designing and implementation of content production.

In order to successfully develop web-based learning and teaching the Hypermedia Laboratory and the VU Team of TUT are doing joint research to clarify the best practces and the conception of added value by investigating the advantages and disadvantages of web-based learning in various contexts. The data will be collected in the pilots of the Hypermedia Laboratory and the Virtual University of TUT.

### **2.7.4. National co-operation**

TUT is coordinating two national network projects in the Finnish Virtual University. The themes of the projects are mathematical modelling and open source courseware, correspondingly. Many universities participate in the national network projects and the teachers of these universities are responsible for certain parts of the courses produced. Students from different universities can take the courses. Web-based learning methods, content production and administrative measures to support distance learning will be developed in the national network projects.

## **3. Discussion and Conclusions**

We discussed in this paper action needed to support the development of web-based learning and teaching at the Tampere University of Technology in co-operation with the Finnish Virtual University. Special focus were on strategic issues of development of web-based learning and teaching. The experience from the first year, especially that from web-based courses at TUT demonstrates that there is a need for organisational change in the University. The whole organization should participate in the planning and implementation process in order to enable the change.

The experiences have shown how much organizational culture determines the focus of strategy work. What is of interest in organizational change is to identify those key areas through which new perspectives and modes of operation can be rooted in the organization. We therefore take the view that although developing the utilization of IT is included in many TUT strategies, it is necessary to formulate a strategy specifically for the development of IT for the institution.

Of the forgoing the ten principles evinced by Argyris (1990) and Kotter (1996), "Develop vision and strategy" are extremely important from the perspective that the strategy should be a combined effort on the part of various actors in the university. This presents the university with a challenge, as web-based teaching on a wide scale is very new and strategy work has principles of its own. Areas in which traditionally separate strategies have been formulated come very close to ICT strategy for application in teaching, but in these not much emphasis has been given to the utilization of ICT in teaching. The strategy for the utilization of ICT in teaching from the perspective of web-based teaching dovetails with subareas including information management strategy, information strategy and strategy for the development of teaching. In addition to these there is a new area not catered for by the established units and for which no strategic plan has earlier been formulated. This demands new practices and change in the university organization.

The second of the principles evinced by Argyris (1990) and Kotter (1996) "Establish a sense of necessity" is shown to be important especially from the perspective of commitment. It has been found at TUT that commitment to research work as part of the support and development work for web-based teaching helps to yield strategically important information for

the organization. It would moreover appear that in such a transitional phase the research communities rely on those units which themselves produce research. Securing a commitment from the departments and teachers of TUT depends on the benefits web-based teaching has to offer. Benefits are seen to include improved efficiency in the operations of the departments, flexibility and diversity in studies, student satisfaction and automation of study and study routines through IT.

In organizing the Virtual University Project an effort was made to secure the respective commitments of the key units, such as data management, student services, library and departments for the development of web-based teaching. Principle number three "Create a guiding coalition" (Argyris (1990) and Kotter (1996)) was ensured by establishing a steering group composed of expert representatives from the aforementioned areas to delineate the activities of TUT web-based teaching.

Argyris (1990) and Kotter (1996) address the importance of creating interactivity and shared understanding. To enhance dialogue and listening there is a need in the university for different forums at different levels to achieve a shared understanding. It is important that administrative, pedagogical and course production related themes be debated in seminars targeted at the entire personnel, in pilot meetings, meetings of decision-makers and above all at student events.

The principle of "Generate some early success" (Argyris 1990, Kotter 1996) helps new actors to join in the discussion necessary for development. At TUT the courses of several departments selected as pilots for the first year were courses which already had some experience of web-based teaching. During the first year these courses were presented at various meetings intended for the personnel. Furthermore, pages presenting good practices were compiled from these for the homepages of the Virtual University.

In conclusion it may be stated that to strengthen net activity and co-ordinate the development of web-based teaching there is a need for a permanent unit to take care of research, training and support activities pertaining to web-based teaching in co-operation with other actors of the university. Establishing such an organization demands organizational change and a shared vision of the future of web-based teaching.

## References

- Anderson, D., Johnson, R. & Milligan, B. (1999). Strategic Planning in Australian Universities. <http://www.dest.gov.au/archive/highered/eippubs/99-1/report.pdf> (checked up 2.7.2002)
- Albion, P.R. (1999). Heuristic evaluation of educational multimedia: from theory to practice. <http://www.usq.edu.au/users/albion/papers/ascilite99.html> (checked up 2.7.2002)
- Bartolic-Zlomislic, S. & Bates, A.W. (2002). Investing in Online Learning: Potential Benefits and Limitations. <http://bates.cstudies.ubc.ca/investing.html> (checked up 2.7.2002)
- Cornford, J. (2001). The Virtual University is... the University Made Concrete? <http://www.ncl.ac.uk/curds/vuniv/JCLA.pdf> (check up 2.7.2002)
- Forsblom, N. & Silius, K. 2002. What is the Added Value of Web-based Learning and Teaching? The Case Tampere University of Technology. The New Educational Benefits of ICT in Higher Education Conference. Rotterdam, the Netherlands, September 2-4, 2002.
- HEFCE 99/95 (1999). Institutional learning and teaching strategies. A guide to good practice. [http://www.hefce.ac.uk/pubs/hefce/1999/99\\_55.htm](http://www.hefce.ac.uk/pubs/hefce/1999/99_55.htm)
- Kaufmann, R., Watkins, R. & Querra, I. (2001). The future of distance learning. Finding and sustaining usefull results. Educational Technology, vol 41 (3).
- Koulutuksen ja tutkimuksen tietostrategia 2000-2004: Hanksuunnitelmat 2002. Opetusministeriö. Koulutus- ja tiedepolitiikanosasto. <http://www.minedu.fi/julkaisut/pdf/tietostrategia/2002hanksuunnitelmat.pdf> (checked up 2.7.2002)
- Leinonen, T. et al. (2002). Collaborative discovering of key ideas in knowledge building. Computer Support for Collaborative Learning (CSCL 2002) Conference. Boulder, Colorado, USA, January 7-11, 2002.
- Quinn, C. N. 1996. Pragmatic Evaluation: Lessons from Usability. <http://www.ascilite.org.au/conferences/adelaide96/papers/18.html> (checked up 2.7.2002)
- Ruokamo H., Pohjolainen S., 2000. Distance learning in a multimedia networks project: main results. British Journal of Educational Technology, Vol 31, No 2, 2000, 117-125.
- Ruokamo H., Pohjolainen S., 1998. Pedagogical Principles for Evaluation of Hypermedia Based Learning Environments in Mathematics, Journal for Universal Computer Science, 4 (3), 1988, pp. 292-307, <http://www.iicm.edu/jucs>.
- Silius K. (2002a). Digitaalisen tieto- ja viestintätekniikan hyödyntäminen opetuskäytössä vuonna 2001 TTKK:lla. <http://www.virtuaaliyliopisto.tut.fi/verkkopakki/case/opetuksessa01.php>
- Silius K. (2002b). Verkkoo- opetuksen hyödyt. <http://www.virtuaaliyliopisto.tut.fi/verkkopakki/case/hyodyt.php>
- Silius, K., Tervakari, A-M. & Kaartokallio, H. (2002). Verkkopakki. <http://www.virtuaaliyliopisto.tut.fi/verkkopakki/>

- Soloway, E. et al. (1996). Learning theories in Practice: case Studies of Learned-Centered Design. Computer-Human Interaction. CHI'96. Electronic proceedings.  
<http://info.acm.org/sigchi/chi96/proceedings/papers/Soloway/es-txt.htm> (checked up 2.7.2002)
- Squires, D. (1997). An heuristic approach to the evaluation of educational multimedia software. Computer Assisted Learning Conference, University of Exeter.  
<http://www.media.uwe.ac.uk/masoud/cal-97/papers/squires.htm> (checked up 2.7.2002)
- Squires, D. & Preece, J. (1999). Predicting Quality in Educational Software: Evaluating for learning, usability and synergy between them.  
<http://www.ifsm.umbc.edu/communities/Heur2.html>  
(checked up 2.7.2002)
- Tergan, S-O. (1998). Checklists for the evaluation of educational software. Critical review and projects. Innovations in Education and Training International, 35 (1), 9-20.