The Swedish Learning Lab. Proposal to the Knut and Alice Wallenberg Foundation.

Uppsala University, Karolinska institutet, Royal Institute of Technology,

October 31, 1999

Executive Summary

The Knut and Alice Wallenberg Foundation has invited the partners of the Swedish Learning Lab (Swe-LL) to present a proposal to the Foundation for project funding.

The Swe-LL has been established as a platform for collaboration between Uppsala University, the Karolinska Institutet and the Royal Institute of Technology in Sweden and Stanford University in the USA as well as with other partners within the Wallenberg Global Learning Network.

The Swe-LL has already started to act as one unity with a single governing body and one coordinating executive. The partners have built effective and interlinked teams for planning, assessment and technology, led by three directors. This proposal is in all parts the result of genuine cooperation between the three partners and their local organizations. The goal of the partnership is to make a significant contribution to the advancement of learning practices. The Swedish Learning Lab will engage in theoretical and empirical studies to explore new forms of collaborative learning supported by Information and Communication Technologies (ICT) in order to better understand how and when learning is improved and when it is not.

The proposal is aligned with the Stanford Learning Lab (SLL) and the Wallenberg Global Learning Network (WGLN) mission. Through the collaboration and co-investments within this partnership we wish to establish common practices for research on learning processes and practices, development of teaching and learning strategies and exchange of people, ideas, experience and expertise. Our approach is a scientific one. The experiments we intend to perform are guided by questions, which serve the purpose of giving a defined focus to each study, of what to be measured and assessed.

The aims of this project proposal are to

- Explore the pedagogical possibilities of computer supported learning in specific areas of university education, *e.g.* through the creation of physical and virtual dynamic learning environment
- Develop new methodologies and strategies to promote the learning process
- Create new potentials for educators and students to mediate and access content through ICT in order to facilitate professional development

In the two projects below, *Meeting places for learning* and *Bioinformatics*, we will create development opportunities, which will make the coordination of cooperative teaching and learning efforts and collaborative assessment activities possible among the partners. The primary task in this endeavor is to have an impact on our own institutions and to make these projects work as catalysts in our academic environments. Furthermore, we envision, in these areas, that we will be able to produce results on conditions for learning, and on learning outcomes that will be of general interest and incremental to the formulation of development strategies at a wide range of educational institutions.

The current projects address the challenge to improve learning practices through the implementation of practical experiments in real life academic courses and existing educational fora. A number of physical and virtual learning environments will be the setting of the deployment activities. The constructs of the experiments manifest our conviction that learning is situated, *i.e.* occurs in social or cultural contexts. From this standpoint communication is the key concept.

It is critical to the success of the Swe-LL that all experiments within the two projects are subject to rigorous assessment. The assessment program is designed in collaboration between the Stanford Learning Lab (SLL) and the Swe-LL assessment teams. Results from all areas will be actively disseminated. One important tool for dialogue and experience exchange between researchers, faculty and students will be the virtual environment *Exploratorium* on the Swe-LL website.

Introduction

ICT – a challenge for educational institutions

The rapid expansion of new technologies into all levels of society demands focused efforts both to stimulate this expansion in productive directions and to systematically and critically evaluate it. The expansion occurs in a context where some individuals, groups or organizations will extensively exploit the challenges posed by the newer technologies. Others will learn to be proficient enough for everyday activities.

Correspondingly, the rapid expansion of ICT presents an on-going challenge for educational institutions in their teaching, research, and community roles. Some educational institutions have begun rising to the challenge, with several common issues emerging. For example, the appropriateness of traditional approaches to teaching has been questioned in line with introduction of newer technologies. A need to re-assess conventional organizational schemes has become evident. The design of suitable infrastructure to support changes occurring within the educational sector has become necessary. Despite these common issues, there are currently few systematic attempts to coordinate developments across educational institutions.

In the discussion of the impact of technology on education it is often claimed that learning will change in some way or other. The technology is evocative as it gives rise to many questions pertaining to human psychological capacity: Can more students learn more in less time? Will fewer teachers supervise more students? There is substantial scientific evidence to show that questions of this type are theoretically misleading and futile. The same kind of evidence also tells us that very rarely, if ever, is the implementation of ICT the only change in an educational situation. The implementation will and must be accompanied by other synchronous changes.

Learning in context

In the age of computers, traditional conceptions of learning are being re-assessed. Traditionally, learning was viewed as a rational, predictable behavior. This *rationalistic* approach rested on the assumption that knowledge exists independent of the human being, to be acquired in a straightforward manner, albeit with effort involved. The implications of a rationalistic approach are that the teacher's task is to inform and the students' task is to acquire and recall on demand.

During the 1960's a new set of psychological tools were brought to the study of cognition by Piaget. He claimed that the capacity for knowledge rests within the individual and emphasized the active role played by the individual in cognitive development. His *constructivist* approach implies that the learner must be active so that the main task of the teacher is to supervise or coach.

A contemporary conception of learning emphasizes its context-based or "situated" character. According to the idea of situated learning, human beings engage in social and cultural practices and learning occurs within such practices. Communication is a key concept since it mediates between individual and environment. Knowledge emerges from the interaction; the learning process as well as the resulting knowledge is situation- or context-dependent.

A corresponding argument to the above is the notion of inert concepts common in university courses such as algorithms and decontextualized definitions might be useless if students cannot apply them. Within such a conception of learning, the teacher is assigned an important role, initiating crucial interaction and facilitating introduction into traditions of practice.

The proposed experiments will not assume predefined abstract pedagogical models that are to be applied. Instead, the aim is to explore crucial conditions for learning in specific contexts.

Assessment

Related to ICT new forms of communication and new conditions for learning have emerged. The assessment of this project will focus on student learning. We are interested in learning as a process of interaction between student(s), teacher(s), content, technology and learning environment.

This implies that the conditions for, the process and the outcome of learning will be monitored. Furthermore, our aim will be to integrate the learning process and its assessment.The experiments we intend to perform are guided by questions, which serve the purpose of giving a defined focus to each study of what to be measured and assessed.

The principal assessment question is the extent to which the various experiments contribute to find out how and when learning is improved. The direction of the Swe-LL assessment efforts is to develop and perform assessment research and development of highest international standard. Documented valid and reliable knowledge of the outcomes of projects within Swe-LL is of utmost importance for the judgment of future developmental interventions in educational settings.
Hence, Swe-LL proposes to allocate extensive resources on this issue. The assessment work, including methodological considerations, will be conducted in close cooperation between the Swe-LL and the Stanford Learning Lab Assessment projects. The assessment activities will be anchored on continuous dialogue with involved faculty. Their “ownership” of, and participation in, the assessment activities grounded in their conceptions of requirements and problems are a guarantee for the validity of the assessment efforts.

The assessment work will be conducted on two different levels:
Assessment of learning processes and outcomes related to specified criteria.
The ways in which students engage in learning activities will be investigated and work produced by students will be analyzed. Such work can take the form of solutions to problems, design products, and investigative reports.

The assessment of the experiment or intervention.
With focuses on the learning processes and learning environments (the actual learning setting) the interaction between student(s), teacher(s), content, technology and learning spaces will be investigated.

The assessment framework in general, is based on that predetermined general objectives reflecting aspects of learning and teaching are measured in the different experiments performed within the main two Swe-LL projects.

The aspect categories of learning and teaching are:

- Learning, Teaching and Examination (LTE)
- Educational Technical Devices (ETD)
- Students' and Teachers' Experiences (STE)
- Cooperation Across Cultural Boarders (CACB)
- Educational Economy (EE)

Under these categories are the general objectives elaborated (see below). Using carefully chosen methods, these objectives will be subject to assessment in terms of success, relevance and importance related to the assessment priorities mentioned above. Assessment of the individual experiments will be done under different general objectives. Totally, encompassing the two main projects, the assessment activities will cover all general objectives under the aspect categories of learning and teaching.

General objectives

Learning, Teaching and Examination (LTE)

1. To develop ICT-supported education, with student engagement and responsibilities in focus, which lead to improved learning outcomes related to predetermined goals and professional competence in focused knowledge areas.
2. To develop examination, within proposed ICT-learning environments, that is not only used as means of control but which also contributes to the development of knowledge, skills and professional competence.

Educational Technical Devices (ETD)

3. To explore in specific areas of study whether a virtual learning environment under certain circumstances can be better suited for learning than a physical one.
4. To explore, for specific areas of study, whether certain advanced tools (such as 3D Virtual Reality, elaborated encoding and addition of metadata) depending on course structures and educational contents are preferable.

Students' and Teachers' Experiences (STE)

5. To explore whether proposed collaborative learning and ICT-supported learning settings promote individual student self-confidence, motivation, interest, engagement and emotional satisfaction.
6. To explore whether ICT-supported learning environments impact on the development of teachers professionalism including motivation and willingness to implement various approaches to teaching.

Cooperation Across Cultural Boarders (CACB)

7. To explore whether excellence in learning is reinforced by collaborative work in globally distributed teams compared to activities in local teams.

Educational Economy (EE)

8. To explore whether ICT-supported learning offers students high quality educational activities in an individualized way without an increase in total cost.

Dissemination

Dissemination of information, results and experiences requires different media to be employed both nationally and internationally. Some of these will include traditional reports and papers, publication on the Swe-LL web site, reports at seminars and interaction among students and teachers of the participating universities. Others will include new and creative ways of using the results and experiences such as the *Exploratorium* (p.54 ff).

Dissemination and assessment activities are iterative processes, which will be conducted in several steps described below.

- The dialogue between Swe-LL and faculty will focus on finding out appropriate and desirable ways of developing courses and curricula in conjunction with teachers' requirements and conceived problems together with the appropriate use of technology.
- The goal is to extract and distinguish components of appropriate assessment parameters to a particular problem, subject, course or situation.
- This way of using the results promotes the creation of profiles based on teachers' requirements and practice and where the starting point is to define the teaching objectives and goals and when possible also to elicit students' conceptions.
- The joint effort to design and realize the new ICT-supported learning environment will be based on continuous dialogue and on thorough assessment and evaluation including the process of redefining and revision of the predefined objectives, goals and conceptions in the new learning environment.
- By a continuous use, reuse and revision of the results and products the competence will be growing, changing and expanding over time.

Project 1: New Meeting Places for Learning – New learning environments

Summary

This project will experiment with, and investigate, the potential of new information and communication technology (ICT) to put the student's learning in focus at universities and other learning organizations. Such a focus on learning requires the design of new learning activities and environments, which activate the learners, as well as systematic assessment of learning outcomes. This approach provides the basis for a critical evaluation of the effectiveness of the technology against the goal for which it is being used, namely, improved student learning.

The present physical environment at most Universities is not supporting the new learning strategy, and the possibilities of for example virtual collaborative learning environments are not extensively explored. However, it is not easily determined how to develop these new physical and virtual learning environments, or as they might be called, "meeting places for learning". Therefore, this project is focusing on both the physical and virtual environment supporting the shift towards an improved learning environment. In this project we will also address the complex problem of how to assess the student learning outcomes in these new meeting places for learning.

The work within the "New meeting places" project will focus on both the general objectives of the Swedish Learning Lab as well as concentrate on specific objectives and tasks.

The objectives and the needs and possibilities might differ between different learning activities and educational programs, and therefore three separate experiments will be undertaken to explore one or more specific objectives. Groups representing the Swe-LL partners will perform all experiments. The experiments have been selected to reflect a broad range of problems, scenarios and educational areas reflecting both the diversity and the similarity of the partners of the Swe-LL and of the SLL. The results from these experiments will be assessed and evaluated both by students, teachers and by the Swe-LL assessment team, who in turn will give feedback to the experiments to spread the information into the areas under study, resulting in a continuous building of knowledge.

Introduction

In universities and other learning organizations the effectiveness of traditional teaching is currently being questioned because it often fails to focus on student learning. New information and communication technology has the potential to bring about a shift in focus to a student perspective. The potential of new technologies in education will materialize only in contexts where the technology is employed as a means to fulfill learning goals rather than being an end in itself. A focus on learning requires the design of new learning activities and environments, which activate the learners, as well as systematic assessment of learning outcomes. This approach provides the basis for a critical evaluation of the effectiveness of the technology against the goal for which it is being used, namely, improved learning outcomes.

Objectives and guiding questions

The work within the "New meeting places" project will focus on both the general objectives of the Swedish Learning Lab, mentioned above, as well as concentrate on a number of specific objectives and tasks. The most prominent objectives of this project are:

- To explore ways in which learning environments can be improved when using ICT, taking into account both physical and virtual features.
- To explore conditions in which a virtual collaborative learning environment might enhance learning.
- To explore if and how learning might be improved by advanced representations (such as 3D VR representations, elaborated encoding, metadata enrichment) of learning environments, course structures and educational content.
- To evaluate both informal and intended learning outcomes from the design and use of new learning activities and environments.
- To investigate ways in which ICT can contribute to collaboration among globally distributed teams.
- To explore ways in which the learner can be activated in knowledge construction through the use of ICT.
- To document ways in which ICT might promote knowledge generation and cooperation between universities, both nationally and globally.

Approach

Since there are several objectives and the needs and possibilities might differ between different learning activities and educational programs, three different experiments, or studies, will be undertaken to explore one or more specific objectives. The experiments have been selected to reflect a broad range of problems, scenarios and educational areas representing both the diversity and the similarity of all three partners of the Swe-LL and the SLL. The experiments will be performed in groups with representatives from the partners of Swe-LL and from Stanford.

The primary experiments will deal with a limited number of tasks, listed below, and described in more detail under separate sections further down in this document.

The selected experiments will start before, or at, January 2000 and will be performed as one or two year studies, assessed and evaluated before the end of the year 2001. However, in order to achieve their full effect, a number of these projects should, if possible, continue up to 5 years to gain full effect and enable a thorough evaluation and dissemination of the results.

Project overview

The three experiments proposed for the "New meeting places for learning" project will perform work within the following areas:

1, *Distributed Interactive Learning Spaces (DILS*) – An experiment concerning the development of physical and virtual learning spaces supporting a wide spectrum of learning activities, local as well as distributed, supported by information technology. This experiment is a joint venture between KTH, UU, KI and Stanford.

2, Experiments on *content archives*, *student portfolios* and *3D virtual learning environments*. These experiments will explore the implications of the use of digital resources created by students (personal portfolios) and teachers (content archives) as well as the impact of advanced 3D virtual environments as a medium to deliver course content to the students.

3, Development and analysis of different *virtual collaborative techniques and tools* that can support the acquirement of not only theoretical knowledge, but also of "soft" knowledge, known to be important in professional life. Examples of this might be problem solving capacity and interpersonal communication skills.

Thus, the three experiments will be complementary and support each other since their emphasis is on *communication*, on *representations* of course structure, content and learning environments, viz. on *simulation* of complex subject matter.

To make the experiments effective and focused on the specific objectives, a number of different Tracks will be developed in experiment 1 and 3, see Figure 1 and the detailed descriptions of the experiments on page 12 ff.

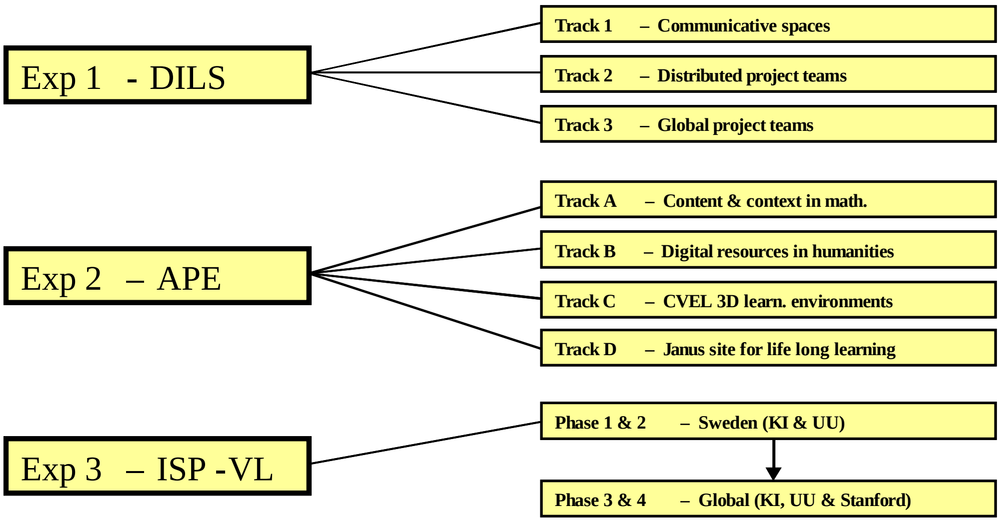

Figure 1. Layout of the Meeting Places experiments and tracks

Assessment and indicators of success

Assessment is often forgotten or neglected when technology based learning is introduced. All steps in this project will, however, be assessed and analyzed. For close links to learning practices all parts of the project will be implemented as academic courses. To secure the quality of assessment data, the assessment process will be parallel to the development and deployment activities. The parameters of assessment will be determined in cooperation between Swe-LL and the Stanford Learning Lab Assessment team, a work already progressing.

The links between competence, learning and assessment have become evident during recent years, where activities and strategies for assessment could be seen as the nexus between assessment methods, learning activities and outcomes. One of the purposes with higher education is to prepare students for knowledge creation, application and dissemination. Therefore, we will develop an assessment strategy which both closely reflect (desired) learning outcomes and leads to a beneficial influence on the learning process. It is also important to focus on the consequential validity of assessment, e.g. the broader consequences of the assessment activities beyond those, which are immediately evident.

All experiments will be assessed both in terms of the level of success, relevance and importance as well as relative to the eight general objectives of the Swe-LL (p.12 ff)

Experiment no	Obj. 1	Obj. 2	Obj. 3	Obj. 4	Obj. 5	Obj. 6	Obj. 7	Obj. 8
1 – DILS	X		X	X		X	X	X
3 – APE	X	X	X	X		X		
2 – ISP-VL	X	X	X	X	X	X	X	X

A number of indicators of success will also be determined and continuously monitored and evaluated. The final reports from the projects will discuss these indicators and their impact on future projects of the Swe-LL.

Dissemination of results

All activities in the Swedish Learning Lab projects are designed to target questions and tasks of common interest relevant to most areas of the academy. However, to be able to focus on specific topics within the limited time and resources available, a limited number of pedagogical issues will be addressed. Project results will be published at the Swe-LL web site and presented at workshops, seminars and conferences. Assessment studies of wider interest will be submitted for publication to international journals and academic press.

The SLL will be directly involved in several experiments and will have full access to project results enabling an effective way of knowledge dissemination in both directions. Furthermore, in a number of the experiments planned, other Swedish universities will have either an active participation or possibility to join as observers. Details regarding external participation are described in the experiment outlines below.

Proposed Meeting place activities and projects

New meeting places for learning:
Experiment 1 - Distributed Interactive Learning Spaces (DILS)

The DILS experiment concerns the development of learning spaces supporting a wide spectrum of learning activities, local as well as distributed, supported by information technology. The experiment will be conducted in close interaction with the other activities in the Learning Lab environment.

At the end of the experiment, in December 2001, the partners will demonstrate a set of physical nodes supporting local learning activities and which can be interconnected to form a distributed interactive learning space, involving the Wallenberg Hall, supporting the courses.

Background

Existing learning spaces are designed for specific modes of instruction, such as lectures or group work. Our intention is to create a new flexible physical learning space concept which is designed for, and easily and instantly adaptable to, many different learning modes, some of them concurrently happening in the same space. The physical learning space has to support group work, informal meetings, seminar discussions, individual reflection and meditation, public performances, lectures, experimental laboratory work, interactive distance learning, etc. The physical space should also be possible to extend into a virtual space by connecting spaces or adding individual distant learners to the learning community.

The global aspect of education is inevitable, but not trivial to support. Most universities want to increase their international exchange, both between students and faculty. We want to explore ways to do this to a larger extent without necessarily moving students between countries and continents.

Objectives and guiding questions

A guiding question is if the learning outcome can be improved by integrating the design of the spatial and technological support system in the design of the curriculum. The focus of the experiment will be on local physical learning spaces that can be interconnected when needed. The learning space should, in the minds of the users, form a unified setting supporting many different modes of learning.

We will explore innovative architecture and interior design as well as modern information and communication technology, turning traditional classrooms and laboratory environments into flexible learning spaces. The objective is to design spaces that will easily adapt to the different learning modes, from solitary study to performance, from lectures to spontaneous café and corridor meetings, etc.

One central issue is the investigation of the pedagogical aspects of a new type of learning environment. We will study the interplay between pedagogical methods and a flexible but unified learning space in different courses and learning situations. The new roles of the teachers will also be addressed.

We will study the influence of physical and virtual presence on the students' perceptions of the learning environment and of the learning process. In cooperation with other meeting place studies, the effects of student mobility and distributed collaborative work will be investigated.

Some studies will explore the possibilities to use distributed interactive learning spaces in courses organized in distributed global teams. The development of the methodology include general issues like teambuilding, project planning, methods to deal with distance, time zone differences, cultural differences, etc. Is it possible to build trust over the network, without physically meeting the person you want/have to work and interact with?

The projects will both focus on the change of existing courses and programs and the development of totally new ones.

Methods for transferring the findings of this limited study to larger settings and to the academic world in general will be studied.

Plan for deployment

The DILS experiment will focus on three parallel tracks, each focused on specified courses, specific learning spaces and a specific set of objectives.

Track 1. Communicative Spaces

Physical spaces:
KTH – KTHB and Electrum
UU - Learning Lab building, Polacksbacken, Ekonomicum, Ekermanska huset, Konsistoriehuset and three designated communication centers
Stanford - Wallenberg Hall
Technology components: Tools for interactive communication and campus networks with wireless access for personal mobile computing and communication with public interactive rooms connected to the high performance network backbone.

The first track will be carried out by actively involving the students of three new programs in joint experiments, the Media Technology and the Information Technology programs at KTH and the Media program at Uppsala University.

Pedagogical issues to be tested include:
- Can the learning processes, both structured and serendipitous, be improved by innovations in the supporting physical learning environment?
- Can a physical learning space be designed to flexibly and rapidly adapt to different learning modes?
- Can a supportive learning environment be extended into the virtual domain using technology?
- Will a supportive environment, designed by students and teachers in cooperation, increase motivation and reduce stress?
- Can peer learning and vicarious learning (capture and re-use of particularly valuable educational dialogues via courseware) be used to multiply the payback from effort that faculty put into project based courses, thereby improving their scalability?

The Media Technology program at KTH and the Media program at UU, both aim at giving the students a deep understanding of the different phases of media. The KTH program is focused on the entire communication process and supporting technology. Students can experiment with various media applications: electronic publishing, network learning, telepresence, etc. The courses that are central for the understanding of the total communication process and that are specific for the Media Technology program are studied in an environment that supports communication, creativity, and active learning.

In 2000 the Department of information science at Uppsala University will start a new course called Radio Journalism in a Converging Media Environment. The course is directed towards students that already have a degree in journalism. There will be a group of 20 students on the course, all with basic skill in journalism and radio journalism. The aim is to investigate new possibilities of radio journalism in a digital environment and to explore new forms of radio practice.

The creation of a communicative space is often a question of appropriating a given space for a specific purpose. Making a space fit for communication and media production under such circumstances is at the core of the investigation in Uppsala. Finding out how new media technology can be used for learning purposes is essential. Rather than developing a learning space "de novo" for new communication technology, our aim is to examine the consequences for a specific media form. The focus of the Uppsala team will be on issues like

- How can existing premises can be appropriated and designed for effective and creative learning and teaching in journalism?
- How can an established form of learning be accommodated in the new digital media environment?

The Information Technology program aims at communication systems design. An important part is devoted to understanding user requirements and how to meet them. For the KTH program in Information Technology, the learning spaces to be designed for the new IT-program at the KTH Kista campus will be involved. Experiences from an earlier effort will be the starting point for a leading edge learning space design, which will be used as a laboratory environment for the students. The space will include interactive walls, tables and other furniture, which can interact with the wearables defining the personal mobile computing and communication environment. This development will be conducted in joint courses between the IT-program and courses in the computer science program at Stanford and be related to the development of a similar environment in the Wallenberg Hall at Stanford.

Courses at the UU departments of Information Technology, History and Archaeology will be used for contrast. Because of the nature and traditions of the humanities there will be no predominantly ICT-based courses in history and archaeology. Rather, ICT components will be used in several courses. Both departments plan to introduce wireless local area networks in their buildings. Thus there will be opportunities to compare humanities students and technology students in their use of the technology and the new collaboration possibilities.

Other comparative studies will be undertaken with students in the course "Humanity and Nature", which is interesting since students themselves initiate it. It focuses on the impact of human society on nature and has since 1992 been developed and provided by the Student Center for Environment and Development (CEMUS), UU. It is thus an expression of a demand from students, and it is also an example of collaboration between two universities, Uppsala University and the Swedish University of Agriculture.

It is important that the findings can be implemented and further developed in other educational programs at the different participating universities and, eventually, to higher education in general. Also, the use of the learning spaces must not be limited to the courses given there as described above. The environment should always be open to spontaneous, unstructured meetings and informal learning.

Track 2. The impact of distributed project teams on learning excellence

Physical space: Stanford: TermanME310loft, KTH: Mechatronics Design Lab
Technology component: Campus network with wireless access for personal computing and communication and high performance network for interactive spaces. Tools for interactive communication.

This track will concentrate on courses using projects with globally distributed teams as pedagogical method. The questions to be answered include:

- Could excellence in learning be reinforced by collaborative work in globally distributed teams?
- Does collaborative learning in globally distributed teams reinforce individual student self-confidence, motivation, interest, engagement and emotional satisfaction?
- Could technology support offer students high quality educational activities in an individual and team based way without an increase in total cost?
- Could technology replace physical meetings between people? Could we reduce traveling?

The courses involved include:

- ME210/ME310, a graduate-level course offered by the Design Division of the Mechanical Engineering Department at Stanford University. It is a three-quarter (30 week) sequence in which globally distributed design teams (typically three graduate students per team with an average of 1-8 years of professional experience) work on design challenges proposed and supported by corporate partners. A high tech design loft supports the students and advanced tools and services for computer supported collaborative learning is used (c/o the Center for Design Research).

- The advanced course (4F1161/62) in Mechatronics at Dept. of Machine Design, KTH is a problem based, project organized design course. The number of student is at the moment limit to 36 each year. The course is organized so three teams (12 KTH students each + students from other universities) have an industrial corporate partner. The industrial corporate partner formulates the project proposal and provides basic resources for realization.

In this track, we will provide globally distributed teams with state of the art communication tools for advanced project work. We will connect physical experimental-laboratories (ME310 loft at Stanford University and the Mechatronic Design Lab at KTH) so that the students, faculty members and corporate partners can perform project work on a day-to-day basis. The distributed project labs should be connected electronically 24 hours a day.

In the first phase (year 1 – January 2000 -- June 2000), a small-scale experiment will be executed with 3 KTH teams. Two of them are globally distributed student teams including Stanford students. Corporate partners will be Adtranz and Alfa Laval Agri. The third project will not involve an international distributed partner. At Stanford University around 10 projects will be executed. Some of them include globally distributed teams some are local.

In the second phase (year 2 October 2000 -- June 2001), we will include a more partners from another Learning Lab Partner University (for example Metropolitan institute of Technology in Japan). We will also investigate the possibilities to perform globally distributed team-based courses in a lager scale, and to other disciplines.

Track 3. Working across time zones and cultures in globally distributed project teams

Physical spaces: KTH: Electrum, Stanford: Thornton102, Singapore: Executive Classroom
Technology component: all means of global communication

The course, which is proposed to be the basis for this track, "Global Project Coordination", is currently taught jointly between KTH, Stanford and the National University of Singapore (NUS) and involving students also from other universities, e.g. the University of Stockholm and the Stockholm School of Economics. The students work with faculty on global projects. Students and faculty from the university of Uppsala and KI will be invited to participate in the course.

The purpose of the course is to learn how to work effectively in cross-cultural teams to address the challenges of coordinating a global project to deliver quality results, on time, and within budget. Sponsoring companies and government organizations that have interests in Sweden, Silicon Valley, and Singapore provides Funding and guidance for the projects. Managers of sponsoring organizations will also provide direction and coaching to the global project teams. Earlier sponsors have been for example: Ernst & Young, Ericsson, Hewlett Packard, Xerox Corporation. In year 2000, there will be 5 or 6 projects, involving 6-7 students each, with at least two students per project from each University (35 - 40 students in total).

Students completing the course will learn how to overcome barriers of time, distance, and culture. They will use all forms of communication available to them: telephone, ”snail-mail”, air express courier, video teleconferencing, internet telephony, fax, e-mail, newsgroups, chat rooms, other tools on the World Wide Web, and face-to-face meetings. They will learn to mutually set and align expectations of the project team, their faculty project supervisors, and their clients, the project sponsors.

Students will apply concepts, frameworks and diagnostic instruments to understand and manage differences in attitudes, values and behavior that can affect team communications, effectiveness, motivation, and *esprit de corps*.

The parameters to be evaluated include the efficiency of different supporting technologies to overcome the barriers of time, distance, and culture.

Assessment and indicators of success

All three tracks will be accessed according general assessment procedure and especially in the areas described below.

- Their main educational focus is the human communication process and the ways this can be supported by technology. Learning is one of the main forms of human communication. We will assess this experiment by monitoring the student's engagement and willingness to take responsibility for the learning situation.
- The student examination process in the proposed courses is different. We will assess the role of the student examination process in relation to its role for control and/or for contributing to the development of knowledge and professional skills.
- We should try to observe if collaborative learning enforces individual self-confidence, motivation and interest for learning.
- We will monitor the development of the teacher's professionalism. That includes the way the professors involved choose to communicate and publish the results of the experiments.
- A special focus will be on the assessment of using globally distributed project teams as a learning strategy in higher education.
- We will explore the problem of scaling up the learning activity from an experimental stage to be a part of a full scale, normal activity in university programs and curricula.

The main indicators of success will be the experiences and opinions of the students, teachers and the assessment group.

Future

The proposed experiments need a longitudinal component. We need to follow the students from the first year to graduation and possibly also when they enter the professional career. The process of scaling up the most promising results from local experiments to full scale, normal operation will take some years.

Principal Investigator and participating partners

PI Swe-LL	Björn Pehrson, KTH
PI SLL	Larry Leifer, SLL
Swe-LL partners	KTH Media Technology Program KTH Department of Machine Design KTH Information Technology Program

	Uppsala University, Media and Communication Studies, Dept. of Information Science Uppsala University, Dept. of Information Technology Uppsala University, Depts. of History and Archaeology Uppsala University, CEMUS Karolinska Institutet, KI-LL
Stanford partners	Stanford Learning Lab Wallenberg Hall Project Dept of Mechanical Engineering Design Division Dept of Industrial Engineering and Engineering Management Dept of Electrical Engineering Dept of Computer Science
External partners	Akademiska Hus in Track 1 Ericsson and Hewlett-Packard in Track 1 and 3 University of Singapore in Track 3

Time frame

December 1999	Project start, establishment of the prototype learning spaces Deploy assessment resources to T1-T3
December 2000	First preliminary evaluation
January 2001	Advanced full-scale learning space studies in the proposed courses.
December 2001	Second evaluation

Budget

	Year 1-2 (kSEK)	
Project Development	3,210	
Assessment	669	
Swe-LL staff	547	
Infrastructure	1,300	
Total Project Cost	**5,726**	
Estimated WGLN funding	410	(50,000 US$)
Total Cost for Swe-LL	**5,316**	

New meeting places for learning:
Experiment 2 - Content archives, student portfolios & 3D environments (APE).

The purpose of the study is to develop and test tools, principles and practices in the management of electronic portfolios, content archives and 3D communication and visualization environments for learning.

Electronic portfolios are personalized collections acquired by students during the course of their years at the university. An electronic portfolio might include the student's own or peer students' annotations, papers and project presentations, courseware and reference literature, material created by their teachers, test and examination results, copies of or links to various resources. It might serve several purposes: depository of material for personal use or to be shared with other students or with teachers, documentation of the progress of the studies, reference points in the career planning. When the student leaves the university it might be useful in future professional activities. When applying for a job it might contain items to be presented to an employer. A web site managed by an individual student might function as his or her electronic portfolio. Some web pages might be strictly personal, others commonly available, or available to teachers or groups of peer students.

A fruitful use of electronic portfolios must be related to the educational goals and content. It is crucial that students are offered course content, teachers' commentaries and guidelines, test results and other relevant material in portable modularized formats, suitable to be incorporated into their electronic portfolios and to be reused for various purposes that may not be foreseen by the teacher. Therefore the development of electronic portfolio practices presupposes the creation of archives of content modules that are easy to share, to navigate, and to combine and reuse in new contexts. In order to enhance portability and flexibility these modules should be equipped with metadata and when possible apply to relevant international standards. An important design principle is that the structure of the module archives should be separated from the structure of the actual course given. Thus, by separating what is taught from how it is taught, one and the same archive might be used in different courses by means of different filtering and presentation. For a specific course the teacher proposes the students certain paths through the archive and certain subsets of content modules to be used by the students and in some cases added to their electronic portfolios. We foresee that the presentation and orientation tool Conzilla, developed in cooperation between KTH and UU, will be useful since it allows for the creation of both conceptual maps of content archives and maps of the individual teacher's design of a certain course.

Three dimensional virtual reality environments will be used as meeting places where teachers, students and invited guests will be represented by avatars. In those landscapes there will be visual representations of the students' portfolios and of the archives created by the teachers, as well as of other resources for learning. Thus, students and teachers will be able not only to encounter and discuss with each other, but also to collaborate on shared course material.

The experiments will be undertaken in several subject domains: mathematics, the humanities, language education, information science and pharmacology. See separate presentations below. Thereby opportunities will be given for cross-fertilization, as well as for the assessment of the subject-specific problems and for comparative studies.

Track A. Content and context of Mathematics in Engineering Education

This experiment aims at the further operationalization of the electronic portfolio methodology by choosing one particular subject, mathematics, modeling the structure of domain knowledge in a conceptual modeling framework and the explanations of particular mathematical concepts by multimedia productions stored in a shared database. These two enhancements have the purpose to augment the electronic portfolio activities from being mainly on the meta-knowledge level to being better integrated in the domain knowledge level learning processes. The experiment is carried out in parallel on two of KTH´s new programs: The Information Technology program and the Media Technology program. Our intention is that this experiment should develop into a long-term project in the same sense as its Stanford counterpart, at least covering the first generation of the Media and IT program students, from the time they enter the program in 1999/2000 and then leave for their first jobs in 2004/2005.

Background

The motivation for this experiment is that the students and teachers of KTH masters programs have an insufficient understanding of the overall goals of the programs, the dependencies among subject matter and courses and the long-term consequences of individual choices within the education. The ambition is to promote this understanding by a variety of means and to study how students acquire, maintain and employ the knowledge and skills they accumulate over the course of their study career at KTH.

In particular this experiment focus on the Mathematics education within the masters programs at KTH. Major problems within the mathematics education are to achieve an understanding of the relationships among mathematical concepts, understanding of the relationships between naive exploratory models and formalizations and the need for mathematical knowledge in applied courses.

Objectives & guiding questions

The first challenge is to create mechanisms in a 4-5 years masters program that implements the basic electronic portfolio methodology. This includes:

- Articulation of common goals for the whole program. These goals should concern both acquisition of specific subject matter and general skills.
- Course descriptions in terms of how they contribute to the common goals
- Personal student electronic portfolios that the students build incrementally during the education
- Analysis of different collaborative techniques and tools that can support student and teachers in the self-evaluation and coaching process
- Analysis of the relations between the formal curricula and the informal learning processes taking place during the education

- Definition of formal demands within the program to push for students self evaluation of progress with respect to different goals
- Definition of formal demands within the program to push for teachers self evaluation of their own course with respect to how much these contribute to different goals
- The porting, trying out and possibly adaptation of electronic portfolio tools developed at Stanford and other sites.

The main guiding question is if knowledge capture, organization, re-use, self-coaching and collaboration will enhance the learning experience.

The second challenge is to let the different actors (students and teachers) within the learning process, model one particular subject in terms of a suitable conceptual modeling language. The guiding question is if such modeling enterprises will enhance the students learning processes and also enhance the teachers' competence with respect to how they can modularize the subject matter. Another guiding question is if this formalization will make the electronic portfolio methodology more efficient as the portfolios can be expressed in a much more operational way referring to the elements of the conceptual model.

The third challenge is to introduce modules of explanations for particular concepts within the conceptual structure and to store, share and revise these explanations in a globally accessible database. The guiding question here is if the communication and reuse of electronically stored explanation modules for concepts will enhance the learning processes for a particular subject matter.

Deployment

This experiment will be carried out in two contexts: the Media Technology and the Information Technology programs at KTH.

In each program, the different aspects of basic electronic portfolio methodology have to be implemented

- A particular subject is chosen for both programs: Mathematics.
- A particular conceptual modeling language suitable for modeling mathematical concepts is chosen.
- Different scenarios for structuring and modeling mathematical concepts and reference to these structures within the electronic portfolios will be tried out in the two masters programs. The number of courses that contribute to this process will be scaled up incrementally.
- The communication, modification and reuse of electronically stored explanations to mathematical concepts will be introduced in both programs. The number of courses actively involved in this process will be scaled up incrementally.
- Different kinds of tools will be tested with respect to how they support all the above processes.
- Besides in mathematics courses the portfolio principles will be utilized also in other parts of the KTH programs

Assessment

A longitudinal study of how the first two classes of Media and Information Technology students develop a systematic understanding of mathematical knowledge during their learning careers.

The study should include the understanding of how students understand the structure of the education with focus on the introduction and use of mathematical knowledge, how the exchange of explanation modules enhance the learning of mathematical concepts, how the students make their choices of optional courses and how different aspects of the education, formal and informal, contributes to the learning process.

Principal Investigator and participating partners

PI Swe-LL	Carl Gustav Jansson, KTH (Information technology), Leif Handberg, KTH (Media technology) & Ambjörn Naeve, KTH (CID)
PI SLL	Larry Leifer, SLL
Stanford partners:	SLL (The Learning Career project)
Swe-LL partners:	KTH (Information technology) KTH (Media technology) KTH (Nada/CID) UU (Teacher education) KI (KI-LL)

Time frame

1999 - 2000	Preliminary studies
2000 - 2001	Preliminary deployment within the two programs
2001	Final assessment

Budget

	Year 1-2 (kSEK)
Project Development	910
Assessment	189
Swe-LL staff	154
Infrastructure	250
Total Project Cost	**1,503**
Estimated WGLN funding	
Total Cost for Swe-LL	**1,503**

Track B. Digital resources in the humanities

Since digital material is only sparingly used in most humanities courses, these experiments will be exploratory in character. Thus, they will not cover a whole course but rather the uses of electronic portfolio techniques in parts of the courses. The focus is on the integration of digital representations of literary sources, historical witnesses, and linguistic resources for language learning such as on-line dictionaries and text corpora into distributed learning environments in order to improve co-operation and learning.

Background

The experiments will engage staff at U-LL and KTH-LL, humanities departments and teacher education at Uppsala University, and engineering specialists at KTH. They will benefit from previous work at KTH on digital editing principles for historical and literary sources, for example medieval and 16th and 1700th century manuscripts and August Strindberg's collected works, as well as from work on text corpora at UU Dept. of Linguistics and English Dept. The experiments will also benefit from networks such as the Socrates-Erasmus Thematic-Network ACO*HUM (Advanced Computing In The Humanities).

During the last decades information technology has changed the research practices of many scholars in the humanities. One important aspect is the increased opportunities for co-operation and exchange within the research community. Ten years ago, individual researchers, research groups and archivists typically used proprietary non-portable formats for their depositories of digitalized sources such as electronic versions of printed texts, transcribed manuscripts or language corpora. Today there are de facto encoding standards, most important the TEI DTD (the Text Encoding Initiative Document Type Definition), which permits scholars to create, use and share collections of well-structured high-quality digital resources. However, most students do not take part in this development. Course content is, thus, not sufficiently integrated into the virtual meeting places. The experiments will contribute to improve upon this integration.

An expected benefit from using digital resources in language courses is the 'liberation' of classroom- and teacher-time so that it can be devoted mainly to the training of communicative skills, while it is hoped that the honing of certain other types of language skills as well as some tests and exams could take place outside the classroom, using digital resources. This is the stated objective of Stanford University's Digital Language Learning Project.

Objectives & guiding questions

The TEI type of encoding principles allows for a separation between on the one hand the structuring of the content and on the other hand the forms of presentation. Therefore one and the same content collection might be filtered and presented in many ways for different target groups with different previous knowledge and needs, from freshmen to specialists. Most important, though, is that modularized and portable content encourages the teachers and students to combine material from different sources into their own learning environment, to exchange points of view, and to add their own contributions.

The experiments will mainly be WWW based. Guiding questions are:

- What kind of support will ameliorate teachers' and students' opportunities to share and collaborate on digital resources in history, literature and language education?
- How do different navigational and filtering tools contribute to the students' capacity to work with digital resources and to relate them to material in their personal electronic portfolios?
- What kind of metadata is needed for different kinds of content?
- Which design principles are eligible in the organization of source archives in the humanities in order to make them accessible from different perspectives according to various needs and various previous knowledge?
- How can computerized tests and exams in language education be combined with existing digital resources to provide support for individualized learning, by adapting the level, character, amount and order of the presented material to the student's proficiency level (as seen in her test results and/or teacher's comments and recommendations) and learning style? Further, how can (a) test grading and (b) recommendations, based on test results, for self-study course, exercise, reading, etc. materials, be at least partly automated?
- What advantages and disadvantages does a more elaborate scholarly encoding give compared to traditional HTML presentation?

Plan for deployment

Staff and students in history, literature, teacher education, language and linguistics departments will be engaged in exploring the uses of historical, literary and linguistic sources. Since computers are used relatively little in humanities courses, and since some teachers may well experience some anxiety at the prospect of using the computer as a teaching aid, it is important that the faculty be actively involved in the introduction of this new technology from the very start.

Tools developed at KTH such as Conzilla and AntiLoop will be used to provide support for navigation and filtering of source archives and for incorporating content modules into the students' electronic portfolios.

Collaboration with experts at Riksarkivet (the Swedish National Archives), Riksantikvarieämbetet (the Central Board of National Antiquities) and the editors of August Strindberg's and C.J.L Almqvist's collected works.

Assessment

The aim of the assessment is to answer the guiding questions posed above. Thus, students' use of different kinds of sources will be monitored and their papers, conference postings and other products will be analyzed. The uses of different representation forms will be compared, for example printed material, traditional web sites, web sites for critical editions including scholarly commentaries, advanced encoding schemes, various kind of metadata. One important focus point in the assessment is the opportunities and difficulties encountered by the students when they try to extract material from scholarly editions for shared use and collaboration and in order to include it into their personal portfolios.

Principal Investigator and participating partners

PI Swe-LL	Lars Borin, UU (Linguistics) & Jonas Gustafsson, UU (Teacher education)
PI SLL	Larry Friedlander, SLL
Swe-LL partners:	Uppsala University, Linguistics, Language departments, Literature, History, Teacher education KTH, CID, Nada KI, KI-LL
Stanford partners:	Digital Language Learning Project

Time frame

Jan - Aug 2000	Design of content and environments, training of teachers
Sept 2000-Dec 2001	Experiments with students
Dec 2000	Preliminary first evaluation
Dec 2001	Secondary evaluation

Budget

	Year 1-2 (kSEK)
Project Development	965
Assessment	189
Swe-LL staff	154
Infrastructure	200
Total Project Cost	**1,508**
Estimated WGLN funding	
Total Cost for Swe-LL	**1,508**

Track C. CVEL experiments (3D communication and visualization environments for learning)

Background

In a variety of disciplines, educational settings are still based much on lectures and other learning forms that allow only for limited interactivity and communication between students and lecturers. Graphically appealing virtual meeting places can be considered as a new teaching medium to deliver course content to the students. In these virtual meeting places, students and teachers are represented by their corresponding avatars. The meeting place may consist of a scenario, which presents contents of either an entire course or just some specific lecture topics. This virtual communication environment can for example be based on a typical game element in order to increase personal involvement and participation.

Pedagogical success of this type of learning environment will depend on the careful preparation of the contents and implementation of the avatar based learning environment. We are convinced that this type of learning space will address quite a number of pedagogical issues in a positive manner and can be applied as a generic tool across many disciplines.

In addition, in many disciplines, the nature of lectures content lends to a three-dimensional visualization. Typical examples here are courses in graphical design & programming where spatial relationships and 3D shape and form today still is taught using conventional 2D media. For a proper understanding of how objects behave if they are moved and deformed in 3D space it is essential to visualize these processes.

Objectives & guiding questions

In contrast to traditional learning situations, e.g. oral lectures, the avatar based learning environment will require that the student actively seeks and collects knowledge components. Knowledge could also be shared amongst students in virtual colloquia or even be traded to earn virtual credits, or be used strategically within this learning environment. In that regard, there is a continuous drive in the learning individual to acquire new knowledge all the time.

In conventional teaching situations, there is little or no communication at all amongst students under a lecture. Even in the case of group work in a classroom, practical limitations lead to rigid structures. Most commonly, group work is performed in two-person groups (neighbor) or larger groups, which in general are organized once at the beginning of a class. Any-to-any communication is possible in discussion rounds. However, in those rounds extroverted students tend to dominate while introverted students retire. In addition, critical comments or embarrassing situations are often avoided due to face-to-face confrontation. In the avatar based communication space, any form of group work and communication is possible, since the real identity of avatars is only known to teachers.

Due to the networked character of the virtual communication place, students in locally remote areas will share the same learning space and share the same course content. In an international perspective knowledge convergence is created. Of course, a common engagement of the teachers involved in a course is an essential requirement for the definition of the content of a virtual learning space.

A virtual communication environment based on an Internet infrastructure is not anymore bound to any location in space. Depending on the definition and implementation of time rules in the system, it might not be necessary that all students enter the communication space at the same time, thus increasing flexibility in time as well.

Finally, teaching of course content which in its very nature is related to three-dimensional physical objects will be greatly enhance by visualization in three-dimensional display environments.

Plan of deployment

The challenges met in these experiments naturally map onto the pedagogical and technical experiences of the participating partners at Uppsala University and KTH. At Department of Information Science (DIS) at UU, previous research has been conducted in advanced three-dimensional visualization techniques and course material for a D-level course in Interactive Visualization has recently been prepared in digital form. Within the experiments DIS intents to link this course material into the avatar based learning environment and to develop additional interactive 3D content, which can be executed by students within a learning environment. DIS will run the system in a class with 25 students and assess usability of this learning environment. In addition to this, experiments will be undertaken in mathematics courses at KTH, where educational modules, for example in projective geometry, are already available. Representations of a course in geometric algebra are to be developed and tested in the avatar based shared environment ActiveWorlds.

A third domain for experiments is courses in literature and teacher education. Here the aim is exploratory. One focus of interest is for example the learning outcomes for students given access to 3D-perspectives on the structure of web sites containing course content or digitalized literary sources, to be compared with traditionally designed web sites.

At CID (Center for user oriented IT-Design, research area Digital Worlds), NADA/KTH, previous work has been conducted in the field of avatar based virtual meeting and presentation environments. CID will contribute with its development experience in this field and with usability studies of the final virtual learning environment. The technical platform for the experiments will be based on those previously developed shared 3D VR avatar populated environments.

The study will be performed in four phases.

1. To select and prepare appropriate course topics and to create or refine the digital content. Mostly involved in this step are the end user sites (content providers) where the virtual learning environment will be used and tested (DIS, mathematics, literature).
2. To further develop and adapt virtual meeting places based on previous development results at KTH/UU. NADA/KTH will contribute expertise, which will further develop and adapt a virtual meeting place based on ActiveWorlds, and DIS/UU, which will develop executable 3D content for the course mentioned above.
3. Usability tests of the virtual meeting environment in VR based interaction environments at DIS/UU and NADA.
4. Delivery to end users, assessment and evaluation in practical studies (NADA, DIS, literature, teacher education).

Assessment and indicators of success

The assessment process will be on two levels. General usability studies will be performed to assess the generic functionality of a virtual learning environment according to assessment criteria developed earlier at NADA/KTH and DIS/UU.
The end users in their respective settings will perform the usability test, with regard to the individual teaching context. End users will be supported by the NADA/DIS in establishing appropriate test protocols and performance indicators. On this level interaction between users at the different locations (KTH, UU) using the virtual learning environment will be monitored and assessed for their impact on the learning process.

Principal Investigator and participating partners

PI Swe-LL	Stefan Seipel, UU (DIS) & Sören Lenman, KTH (CID)
PI SLL	Larry Friedlander
Swe-LL partners	UU, Department of Information Science UU, literature, teacher education KTH/NADA (CID) Karolinska Institutet Student groups at UU

Time frame

Jan - June 2000	Phase 1
April 2000 – June 2001	Phase 2
April – Sept 2001	Phase 3
Oct – Dec 2001	Phase 4

Budget

	Year 1-2 (kSEK)
Project Development	810
Assessment	189
Swe-LL staff	154
Infrastructure	350
Total Project Cost	**1,503**
Estimated WGLN funding	
Total Cost for Swe-LL	**1,503**

Track D. Pharmacology and Clinical Pharmacology, the Janus learning site, - an individual web-site for life-long learning

Background

Today, patients are more informed about progress in medical treatment alternatives than ever. This applies to drug therapy also. Patients both expect and require individualized drug therapy. Internationally costs for health care do not increase substantially but costs for drugs are increasing at a rate about 5 to 10% annually in many countries. Since drugs are critical in treatment of most diseases, it is necessary that medical students systematically learn about how drugs exert their actions, why their effects may vary from one individual to another and how to prescribe the correct drug at the correct dose at a reasonable cost for each patient. The learning of these pharmacotherapeutic principles has to adhere to evidence-based treatment strategies.

During the courses in pharmacology and in clinical pharmacology students are trained to acquire sufficient knowledge that, once becoming a physician, he or she will be capable of applying rational pharmacological treatment principles. The student should learn to set up goals for the pharmacological therapy and enumerate and evaluate various therapeutic strategies for different types of diseases. During the courses in pharmacology, in clinical pharmacology and in most clinical courses, the medical students have to structure, combine and integrate different kinds of basal and clinical knowledge in an individualized way, as a basis for decision-making in their future professional role.

The proposed experiment is designed to determine to what extent the use of personal electronic portfolios enhance this process. We assume that the development of the present program will enhance a rational application of these principles in clinical training since adequate and scientific information will be easily accessible using the individual electronic portfolios and the Janus prescribing tools.

Pharmacology and clinical pharmacology are taught during several other undergraduate programs at KI, UU and Stanford and at other universities. Therefore, many other students may directly benefit from the outcome of the experiment. Electronic portfolios are likely to be a useful tool for practicing physicians also to facilitate the learning of how to critically cope with overwhelming flow of information about progress in drug therapy and about new chemical substances introduced in the health care system. In the proposed experiment, the use of individual personal portfolios is facilitated by integrating a computer based drug prescribing and decision support tool.

Electronic portfolios and digital learning devices integrated into the Janus drug prescribing and decision support tool, used in the daily work of the practicing doctor, provides a unique and easily accessible medium to enhance the continued learning after examination. The individual doctor as well as for teacher-planned distance courses might use it ad libitum. It is therefore critical that medical students are learning how to build and use electronic portfolios.

Janus Telepharmacology, Karolinska Institutet and Stockholm County Council have agreed to collaborate with SHINE and SUMMIT at Stanford on the development and assessment of the value of an interactive web-based site for teaching and training of students in pharmacology and rational drug therapeutic principles.
SHINE develops and evaluates state-of-the-art search engines for retrieval of evidence based medical information at the point-of-care and-teaching.

Objectives and guiding questions

The main objective is to develop and assess the value of electronic portfolios and digital learning devices integrated into a drug prescribing and decision support tool, to enhance the students learning of pharmacology and the practice of rational drug therapy. In addition the effects on the students preparedness for life long learning of evidence based pharmacotherapy will be studied.

- Do the proposed experiment support the ability to structure, combine and integrate different kinds of basal and clinical knowledge in an individualized way?
- Do this program, by increased knowledge in evidence based medicine and in understanding of the mechanisms of action of drugs, promote rational drug prescribing as defined in better results in written examinations?
- Do the proposed experiment increase the student's preparedness for, and ability to, clinical decision taking?

An interactive web-site dealing with pharmacodynamics (therapeutic and unwanted effects and mechanisms of action of drugs), pharmacokinetics (fate of drugs in the body), reasons for interindividual variation in drug effects and containing intuitively edited consensus document about drug treatment practices will be developed. Content from SHINE will be incorporated into the web site. A special tool for student's self evaluation of knowledge in pharmacology and clinical pharmacology will be developed. Further on, a structure for individual WEB-based e-folios and a web-based learning site (the Janus learning site) in pharmacology and clinical pharmacology will be designed and integrated with student adapted Janus drug prescribing and decisions support tools.

The portfolio will be designed so other medical subjects can be added later, and it will be developed together with the other teams. The portfolios are structured so the student can download information from and link to the interactive Janus learning web site-a special. In the individual e-folios all relevant information can be stored and will be retrievable during training in pharmacotherapy in specific patients and when learning pharmacotherapy with simulated patient cases at home.

Plan for deployment

The Janus learning site will involve students and teachers in pharmacology, clinical pharmacology and in major pharmacotherapeutic areas at Karolinska Institutet. We will also cooperate with the division of Clinical Pharmacology in Uppsala, as well as with other members of the Swe-LL. Teachers and students from Stanford School of Medicine are foreseen to work together with Swedish students in Stockholm and in California.

The Janus prescribing program will contain a large number of relevant simulated patient cases. University. The system is to be used during the pharmacology course, in clinical training, in ordinary teaching of clinical pharmacology and to review patient treatment cases during studies at home.

A special part of the experiment deals with the training of students in drug prescription and treatment practices during the clinical courses at the end of the program. Today, students learn to prescribe and dose drugs by observation and by adapting to existing clinical routines for drug treatment practiced by junior and senior staff at wards or outpatient clinics. During these clinical sessions easily accessible tools that simplify drug prescription and enable retrieval of relevant drug information are missing today.

In this experiment, the students are to prescribe drugs in simulated and in real patients using a student modified version of the Janus system. The complete system will also log the use and identify common possible misunderstandings and misconceptions among the students. This information can then be used to improve the formal teaching and provide feedback to individual users. The students can store and later retrieve results from these prescribing sessions in their individual Janus Learning site.

Assessment

The following objectives will be subject to assessment in the proposed experiment:

- To develop an ICT-supported education, with student involvement and responsibilities in focus, characterized as the process of making the students competent and professional participants in the focused knowledge area and resulting in optimal learning outcomes in relation to predetermined goals.
-To develop self-evaluation and examination within the proposed ICT-learning approach that is not only acts of control but activities for developing knowledge and professional skills.
- To explore if ICT-supported learning environments impact on the development of teachers professionalism including motivation and willingness to implement new approaches in teaching.
- To explore if ICT-supported learning offers students high quality educational activities in an individualized way without increasing total costs.

The value of the system, from the student’s point of view, will be assessed by logging the usage of the electronic portfolio sites, the prescribing tools and the student Janus web site. We will assess the impact of the system by comparing results from the written examination in pharmacology and internal medicine (clinical drug related questions). We will include results from two courses prior to and two courses after introduction of the system. We will also use special tools to assess the students preparedness for life long learning and ability to decision taking.

The design and development of the assessment tools is a major effort and will be performed in collaboration with assessment teams and experts from KI, KTH, UU and Stanford University Teams.

Future

Development and testing Handheld PCs for use of an individual Janus learning site. The Handheld PCs (or other similar devices) with communication possibilities will provide the students with mobile access to all information relevant for pharmacotherapy.

Primarily, we concentrate our work on the design and implementation of an application, which includes:

- A dictionary based on the Swedish PDR, the drug and the generic substance register provided by the Swedish pharmaceutical organization (LINFO), and the Medical Products Agency (MPA).
- A mobile and on-line tool that can access the Janus individual learning WEB-site.
- A set of supporting program modules, e.g. alert functions for side-effects of drugs and special problems related to drug therapy during pregnancy and lactation.

The system will also provide functions for

- Prescription of drugs, *e.g.* a search engine for a list of drug with its ATC codes
- Navigating between drug-groups, generic and drug names
- Look up On-line pharmacological up-to-date information from Janus WWW-site.
- Alert functions, *e.g.* drug-drug interaction, side-effects on drugs, canceled (dangerous) drug
- "Drug treatment strategies" for important diseases and "Diagnosis-treatment decision support" modified from Janus prescription application for general physicians.

Connections to Web-sites

Internet connection is supported through several communication modes including Ethernet PC-card for WinCE devices, IrDA etc. Since the screens on handheld devices are small, the information on the individual and master Janus Web-site has to be designed with this limitation in mind. By separating the presentation and the information when building the Web site, the same information can be presented on different devices. Filters can be used to remove e.g. graphics from web pages in order to make downloading faster.

Principal Investigator and participating partners

PI Swe-LL	Lars L Gustafsson, Division of Clinical Pharmacology, KI
PI SLL	Larry Leifer, SLL
Cooperating Investigator	Phyllis Gardner, School of Medicine
Swe-LL partners:	Karolinska Institutet (Division of Clinical Pharmacology) Karolinska Institutet (Dept. of Physiology & Pharmacology) Uppsala University (Division of Clinical Pharmacology) KTH (KTH-LL) Swe-LL assessment team at KI, KTH and UU

Stanford partners:	Stanford University (SUMMIT & SHINE)
	Stanford Learning Lab
Outside partners:	Stockholm County Council

Time frame

Feb 2000	Start- programming and pedagogic development
Jan - June 2000	Technical implementation
2001	Deployment
March-June 2001	Evaluation
Dec 2001	Final evaluation

Budget

	Year 1-2 (kSEK)	
Project Development	1,710	
Assessment	252	
Swe-LL staff	206	
Infrastructure	300	
Total Project Cost	**2,468**	
Estimated WGLN funding	410	(50,000 US$)
Total Cost for Swe-LL	**2,058**	

New meeting places for learning:
Experiment 3 - Interactive Simulation of Patients – a Virtual Learning space (ISP-VL)

A central issue in the learning process is how to learn not only facts and data, but also to learn how to deal with new problems and tasks, something that might be described as “soft” knowledge. This part of the ‘New meeting places for learning’ project will use the clinical learning situation of health care professionals as the model for exploration of the possibilities of virtual meeting and collaboration spaces. The experiment, the ISP-VL, will deal with real time simulated patients, trans-Atlantic virtual collaboration spaces and high-speed networking, incorporating all three Swedish LearningLab universities (KI, KTH, UU) and also Stanford School of Medicine. The project is designed for a collaborative student activity, in which the student is “in charge” of defining and finding adequate knowledge. There is furthermore an ambition of getting the students emotionally involved as an emotionally based learning has a high degree of retention.

Background

The Physician in training must learn how to solve clinical problems. It is an important goal that they also have a confidence in their own capacity of solving such problems. The educational setting for the clinical training varies considerably between different universities and even between the different hospitals within KI. Usually there has been some form of a combination of traditional lectures, small group tutorials and meetings with patients. During the clinical training students should preferably meet as many patients as possible with important and typical illnesses. This part of their education contains a number of problems, including that students usually do not see a complete scenario from the beginning of the diagnostic process to the end of the healing process. Most often they do not even see more than a part of the diagnostic process. The safety and integrity of the patients should never be jeopardized. This means that students cannot take a complete responsibility for the care of the patients in spite of the well-known learning incitement of responsibility. Finally, the ongoing change of treating more and more patients outside the hospitals diminishes the number of educational cases in the university hospitals.

Different types of patient simulations have been tried over the years to eliminate some of these problems. These simulations have used various techniques, like pen and paper simulations, use of actors as patients and different computer based simulations. Even if nothing can compare to the encounter with a real patient, some of these methods have been used with some success. One of the most advanced computer based patient simulators available today is the ISP system (Interactive Simulated Patients) developed at KI and used and appraised by groups of test students.

Medical practice differs considerably, not only between different countries but also between different universities and even between different hospitals in the same region. The follow-up possibilities within the ISP system with a stored track of the different users different approaches to the simulated patients make it very easy and attractive to compare the diagnostic routines, thereby arriving to regional, national or even international consensus on different typical cases.
As the system is constructed for a broad Internet connection, only minor modifications are necessary to allow for a case management in an open virtual

surrounding where several students - in a cooperative manner - can manage a simulated patient, regardless if they are using computers in the same room or computers in different countries.

Objectives & guiding questions

The challenges in the project are several and on different levels. The first is the refinement, testing and assessment of several cases in the Swedish language in different curricula and at different hospitals: in Uppsala the Academic Hospital, in Stockholm the Danderyd Hospital, the Huddinge Hospital, the Karolinska Hospital and others. A positive outcome would mean a quite improved education and training in patient management with improved talents in the students and maybe a more cost-effective education. The second is a translation to another language - English - and also to another culture with for example different criteria in diagnostic procedures and a different panorama of illnesses. The translation and testing procedure will be performed in cooperation with Stanford School of Medicine. The third is to offer students at different universities (KI, UU, Stanford) to meet and discuss patient management problems with a possibly increased understanding of national and other differences in the medical culture. This will be done via the high-speed link to Stanford. A fourth challenge - that will be evaluated separately - would be an expansion of the project into true virtual collaborative environments.

The proposed project is dealing with a number of current problems, like real world experience, effective delivery, collaboration possibility and assessment. We propose to build a global virtual learning space for learning and collaborative problem solving within the area of medicine, enabling a national as well as an international experimenting and assessment tool based on problem based learning.

Plan for deployment

The experiences so far in the use of the ISP system at KI, will be used to create a global virtual learning space where students from different locales at KI, at UU and at Stanford School of Medicine will collaborate and work with the same case simultaneously over high-speed networks. The use of a virtual patient will enable students to simulate a diagnostic procedure with a real life feeling of having responsibility for the well being of the patient. It will enable the student to a dialogue with the patient, complete physical examinations and the full laboratory facilities of a university hospital. The benefits include the reduction of harmful and painful investigations, unnecessary investigations and handling costs.

Two different sets of cases may be developed to strengthen the collaborative part of this experiment and to facilitate the study of the impact of differences in environment, culture and education. Cases emanating from the Karolinska Institutet, and Stanford School of Medicine will be used for both Swedish and US students in collaboration.

On-line student driven fora with immediate feedback possibilities to tutors and clinicians will further strengthen the virtual learning environment. Any student group from any locale can ask the patient questions and perform any examination, enabling an advanced learning situation with virtually unlimited collaboration and learning possibilities using a real world simulation. Using this system, the effects of local, locally distributed and global collaboration on the learning process in medicine can be assessed.

The project will be based on five (possibly six) steps:

1. To create and refine the virtual patient simulation system
2. To develop and test the national collaborative ISP-VL subsystem
3. Verify the translation and adjust the ISP-VL system to fit in both Swedish and US medical environment
4. Deploy and test the full scale global collaborative communication system
5. To perform a thorough assessment and evaluation of both the technologies used and of the effects on learning and problem solving capability.

As a possible sixth step, the system will be used as a testing base for Virtual Collaborative Environments using VR technology.

Assessment and indicators of success

The assessment process will be ongoing simultaneously with the development and deployment activities. Since the ISP system contains an integrated logging function of all user and system interactions, this will be used as the main basis for the assessment. The interaction between users at the different locations (KI, UU and Stanford) over the chat line and other collaborative tools used will be monitored and assessed for their impact on the learning process.

A number of specific indicators of success will be determined and evaluated:

- The function of the simulation process will be assessed and linked to the learning goals (understanding of clinical problems and problem solving).
- The virtual collaborative environment between students from three universities, two in Sweden and one in the USA will be tested and compared to the outcome from interactions within traditional group settings.
- As has been mentioned is one of the main goals in the project to support and strengthen the students beliefs in their abilities in clinical problem solving. It is also an important aspect to get the students emotionally involved. These aspects will be studied in the students involved.
- The impact on the teachers to cooperate on the advancement of simulation tools and different pedagogical methods will be studied.
- An important aspect of the project is to explore the similarities and the differences between Sweden and the USA what regards educational procedures, routes in clinical problem solving, and criteria in classifications and differences in illness panorama. This will most probably have effects on student learning in general and excellence of learning in particular.
- The cost-effectiveness of this potentially individualized system will be evaluated.
- In excess of these more educational issues will the function of the technical base of the system be monitored and evaluated in terms of technical functioning and importance for the project workflow.

Future

There is a great interest for testing Virtual Collaborative Environments (VCE) in the medical field. A test with real patients and in real hospital care can be hazardous. The ISP system with its virtual patients can offer an alternative. Students, teachers and other users would then be able to use the system simultaneously discussing the virtual patient in a VCE where all users and the patient appear as avatars.

An expansion of the system will be evaluated during the first two years. Such an expansion will involve partners in technology development at KTH, UU and Stanford.

Principal Investigator and participating partners

PI Swe-LL	Rolf Bergin, Karolinska Institutet (dept. HIS)
PI SLL	Larry Leifer, SLL
Cooperating Investigators	Phyllis Gardner, School of Medicine and Parvati Dev, SUMMIT
Swe-LL partners:	Karolinska Institutet (dept. HIS and a number of clinical departments) Uppsala University (dept. Medicine, Akademiska hospital) Uppsala University (DIS) KTH (Information Technology Program) KTH (KTH-LL) Student groups at KI and UU Swe-LL assessment team at KI, KTH and UU
Stanford partners:	Stanford University (Infectious Diseases, School of Medicine) Student groups at Stanford School of Medicine Stanford Learning Lab
Outside partners:	University of Linköping (School of Medicine) Umeå University (School of Medicine)

Time frame

November 1999	Begin development of the project
November 1999 - August 2000	Translation and adjustment to US environment
June 2000	Deploy the project in Sweden
October - December 2000	Evaluation of phase 1 & 2
January - August 2001	Deploy the project at Stanford & Sweden
September – November 2001	Evaluation of phase 3 & 4
December 2001	Final evaluation of the project, phase 5

Budget

	Year 1-2 (kSEK)
Project Development	2,616
Assessment	353
Swe-LL staff	289
Infrastructure	700
Total Project Cost	**3,958**
Estimated WGLN funding	1,066 (130,000 US$)
Total Cost for Swe-LL	**2,892**

Project 2: Bioinformatics – Learning in information intense, dynamic and cross disciplinary environments

Summary

Many academic disciplines, in particular within the Life Sciences, are very information intense in nature and the knowledge has a short half-life. In such disciplines, a major emphasis has to be placed on teaching the students to successfully navigate through the information flood and critically evaluate the information obtained. Also, it is becoming increasingly important to foster interaction at the interface of traditional disciplines. The objective of this project is to test hypotheses for student learning in situations were the information/knowledge to be acquired is of a highly complex nature and dynamic in time. Bioinformatics is such a new scientific discipline, bridging biology, medicine, mathematics and computer science. Information within this discipline is highly complex in nature; span a number of scientific disciplines, and has an extremely rapid turnover. This discipline is therefore a suitable testing ground for controlled experiments in the area of learning and teaching. The questions that initially will be investigated in this project are:

- To evaluate strategies for learning in information intensive fields.
- To evaluate different aspect of the learning situation such as group size (single individuals, peer-to-peer, mentor-student groups), type of interaction (virtual, real), technology base (passive web-based, interactive web-based, non-web based curriculum) geographic distribution of students (local, regional, global).
- To bring together scientists and teachers from disparate biomedical disciplines on the one hand, and from mathematics and computer science on the other, to stimulate cross-disciplinary educational interactions.
- To provide an educational platform in bioinformatics for other universities as well as for the various companies and government agencies in the area, based on the provision of web-based educational modules.
- To lay the foundation for a leading education program in Bioinformatics.

As part of this project we will develop and evaluate the results of a number of integrated test courses in bioinformatics as well as the impact of different teaching methods within a highly developing subject. This will entail collaboration between scientists and teachers at the four different campuses, development of an integrated curriculum with contributions from the different areas of expertise represented by scientists from the Swedish universities and Stanford University. The development of this course will allow students from the different campuses access to front-line education in the rapidly changing field of bioinformatics. The constellation consisting of Uppsala University, Karolinska Institutet, Royal Institute of Technology and Stanford University has excellent qualifications and assets in terms of overlapping and related research and education infrastructures in bioinformatics. The Stanford Learning Lab (SLL) will participate at all planning phases and play a particularly strong role in the assessment phase. We are confident that the joint efforts of the partners in the Swe-LL will provide a sufficient critical mass to establish an educational program in bioinformatics that can compete at the highest international level.

Introduction

The educational situation for many disciplines within the Life Sciences has been undergoing very rapid changes during the last five years. This process of rapid change has been brought about by two basic underlying changes; the accelerated volume of scientific results that has become available world wide, mainly due to the increase in the amount of natural science conducted, and the ease by which this information has been disseminated and becoming accessible, mainly through the establishment of the world wide web. These two changes has resulted in that students are faced with an ever increasing mass of information to digest, at the same time as this information is being updated, or even replaced, at a rapid rate. This type of new learning situation is most notable in the Life Sciences at present, but likely to become the rule rather than the exception in most disciplines in the near future. Therefore, there is a need to evaluate different models for student learning in complex and highly dynamic information environments.

The aim of this project will be to perform well-defined experiments on actual courses, in order to compare the efficiency of different alternative learning situations. In particular, the learning will be studied in relation to group size and composition (single individuals, peer-to-peer student groups, mentor-student groups), type of interaction (virtual, real), technology base (passive web-based curriculum, interactive web-based, non-web based curriculum), and geographic distribution of students (local, regional, global).

We believe that bioinformatics represents a suitable discipline to be used as a testing ground to study these issues, since it is characterized by an almost explosive growth in content as well as in complexity. Since it is formed at the interface between a number of highly distinct disciplines it also represent a suitable target for examining methods to foster interdisciplinary cross-talk and problem-based learning involving several types of competence.

Definition of the field of bioinformatics

Bioinformatics is a new scientific discipline, at the interface between biology, medicine, mathematics and computer science. Bioinformatics is concerned with the gathering, analysis, and exploitation of data, information, and knowledge in the Biological and Life Sciences. The sequence of the first completed genome (*Haemophilus influenzae*) was published in 1995 and it is expected that complete genome sequence information for 50-100 organisms will be available during the next few years, including the sequence of the human genome. The exponential increase in the amount of sequence data stored in public databases and the continuous development of novel methods and tools for the analysis of DNA sequences represent new challenges for modern molecular biologists. Today the information in the DNA sequence databases is increased by a factor of two every 15 months. An understanding of bioinformatics methods is essential in order to be able to handle, analyze and interpret the large volumes of raw sequence data that will be generated in the near future.

Three-dimensional models of protein structures constitute a framework for the understanding of molecular function at the atomic level of detail. Therefore, methods for predicting structural aspects of proteins (e.g. secondary structures, fold, binding mode of drugs) are crucial for optimal exploitation of the massive amounts of sequence data. In addition, much can be learned through systematic analysis, comparison, and classification of protein models. Since protein structure is generally more conserved than protein sequence, structural knowledge can also be employed to discover hidden sequence relationships. Such relationships can in turn be used to assign probable structure and function of previously uncharacterized proteins, which (apart from its basic scientific merits) is of great interest to the biomedical, pharmaceutical, and biotechnological industry. The human genome project will result in a blueprint of the gene content and structure of humans, and is projected to become available within a few years. Since almost all human diseases have a genetic component, this information will provide an unprecedented opportunity to identify genetic factors contributing to disease. In order to locate genetic risk factors large-scale genetic analyses and extensive statistical computer work-studies are necessary using both human families and animal models of human disease.

Given the presence of two large pharmaceutical companies, as well as a dozen of start-up biotechnological and medical companies in Sweden, there is a clear demand for university undergraduates and PhDs who are familiar and have extensive expertise in bioinformatics. In addition, the presence of readily accessible bioinformatics expertise is of crucial importance to academic scientists and teachers in all the fields that use the fruits of bioinformatics research. University Centers for bioinformatics are currently being established in Stockholm and Uppsala. There is an urgent need for an educational training program in bioinformatics, at both basic and more advanced levels. However, specific courses in bioinformatics have not until recently been available to students in either biology or medicine, nor in mathematics or computer sciences.

To date, Uppsala and Stockholm are leading the development of courses in bioinformatics for undergraduate and graduate students at both local and national levels. The courses are focused on the use of web-based material, in combination with lectures, discussion groups and small project works. Since bioinformatics is at the interface of life sciences on the one hand, and mathematics and computer sciences on the other, a major challenge is to integrate different fields of research and to teach bioinformatics so that biology students find mathematics and computer sciences fascinating, and vice versa.

Objectives and guiding questions

The work within the "Bioinformatics" project will focus on both the general objectives of the Swedish Learning Lab (p.6 ff), as well as concentrate on a number of specific objectives and tasks that are characteristic of courses in new and rapidly evolving research fields. The major questions that will be investigated in this project are:

- To examine how students navigate within a complex information environment.
- To bring together scientists and teachers from disparate biomedical, pharmaceutical and biological disciplines with research interests in bioinformatics, to stimulate an exchange of ideas and foster cross-discipline educational interactions.
- To bring about a synergistic cross-pollination between biomedical teachers on the one hand and mathematics and computer scientists on the other.
- To provide technical support for the creation of a platform for web-based modules in bioinformatics and examine how to best incorporate these modules into different infrastructures.
- To publicize and extrapolate the results to other learning situations.

There exist already a number of courses in bioinformatics at the four universities. However, within the ordinary university structures there are few opportunities for assessment of pedagogic strategies utilized within any given course. The Swe-LL project will provide a unique opportunity to study the optimal learning situation in bioinformatics, both with respect to technology and pedagogy. Such an initiative could serve as a stimulus for the development of courses in bioinformatics at many other universities. We believe that by combining individual research and teaching experiences with the experiences of the Swe-LL and SLL, we will be able to test hypotheses concerning the use of modern technology in bioinformatics at both the graduate and postgraduate levels. The results of this project should provide information about how to plan and evaluate courses in new and rapidly expanding fields of research.

Approach: Flexible facts and dynamic modules

Biological data is not only generated in overwhelming amounts today, it is also of a widely disparate nature. Furthermore, the development of methods to integrate and exploit the various data sources requires competence in mathematics and computer science. The scientific knowledge, however, is biomedical in nature and a basic understanding or appreciation of biomedicine is crucial for any integration methods to become successful. The challenge when teaching bioinformatics is to find ways of integrating, correlating and unifying these disparate sources of data, and to provide the biomedical student (who is usually not an expert in mathematics and computer science) with the competence to understand the algorithms incorporated in these methods and how to use existing software.

Vice versa, it is necessary to provide the mathematics and computer science students (who are usually not experts in biomedicine and molecular biology) with the competence to understand the biomedical nature of the questions that are being posed.

Progress in bioinformatics education will be critically dependent on the organizers and teachers ability to identify and exploit appropriate developments in both fields, and teach them in a way that is understandable for both biomedical and computer science students. Thus, the ideal teacher in bioinformatics should be well versed in computer and information science, and simultaneously have an in-depth understanding of the biological and medical sciences. Such a versatile, ideal teacher is currently non-existent but a virtual, ideal teacher can be created artificially by combining the expertise of biologists, mathematicians and computer scientists.

Our basic concept is to build a course on series of integrated *modules,* each of which has been created by experts in the different fields of research. An example of the strategy used is shown in Figure 2. These modules will be continuously updated, revised, expanded and new modules will constantly be added to create a complex and up-to-date educational environment. The modules will be designed with the help of professional web-designers so as to maximize the interactive contacts between the students, the Web pages and the teachers.

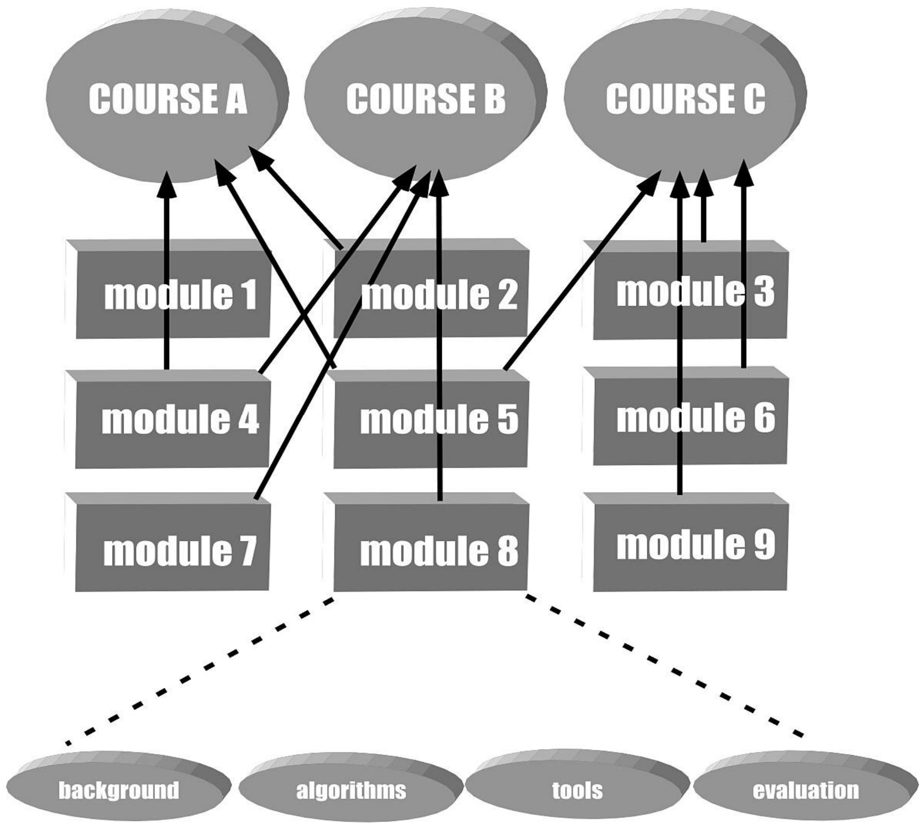

Figure 2. An example of course flows between the modules.

The bioinformatics project is intended to be used as a model system for courses in areas, which are undergoing rapid development, i.e. areas in which course books normally do not exist and even if they do, they soon become old-fashioned.

This places new demands on the provision of course material. The first goal within this project is therefore to create an infrastructure that is flexible enough to constantly change, grow and incorporate new facts and new information**.** The basic unit of this infrastructure (here referred to as a flexible fact) contains information sufficient for a set of Web pages describing the biomedical background, the actual problem, the algorithms, the tools and a page for self-evaluation. A library of several hundred “flexible facts” will be created and combined into a series of dynamic modules in accordance with the general design of the individual courses (Figure 2).

Thus, the aim of this project is to improve learning conditions for bioinformatics by designing ICT-supported course resources and examining the effectiveness of distributing these resources in different learning environments and under different learning conditions.

The three experiments proposed for the "Bioinformatics" project will perform work within the following areas:

- *Navigating in complex learning environments* - The aim of this experiment is to examine the way in which students navigate through a complex space of information in order to solve a given problem.
- *Local and global learning environments* - The aim of this comparative experiment is to study the importance of technological support and develop an optimal learning situation for studies that are independent of time and space.
- *Integration of new modules in bioinformatics* in different learning environments. The same set of modules will be evaluated as part of short intensive courses in bioinformatics as well as in the form of distributed packages which are integrated with the content of conventional courses in molecular biology, mathematics and computer sciences.

Assessment and indicators of success

The Bioinformatics project will be assessed both in terms of the level of success, relevance and importance with focus on the comparative perspective in terms of making measurement and comparisons in different learning and teaching situations. Comparisons will be made between the web-based (interactive and passive) learning environments and with traditional courses in Bioinformatics. The assessment will also be used in terms of evaluation of teachers’ experiences and professional development in this kind of ICT-supportive, complex, module-based and collaborative teaching environment. The Bioinformatics project will be assessed relative to the eight general objectives of the Swe-LL (p.6 ff).

	Obj.1	Obj.2	Obj.3	Obj.4	Obj.5	Obj.6	Obj.7	Obj.8
Bioinformatics	X	X	X		X	X	X	X

The Swe-LL objectives can be broken into several components and for the Bioinformatics project the following are important components. Teaching and learning activities in this project will be based upon activities that supports students' development of a trained mind, i.e. critical thinking, reasoning skills and an ability to think conceptually. The teaching will also focus on enhancing the students' ability to bring intellectual perspectives as well as problem-solving abilities to bear on relevant issues.

The challenges of assessment in this experiment are above all to distinguish relevant aspects or parts of comparison of the different conditions for and situations of learning.

One way to go is to use a combination of systematic and comparative approaches. In a systematic approach the focus of study is on patterns and processes. The testing here is to find out if a characteristic pattern or a relationship exists. The measurement would therefore consist of differentiating performance, ways of knowing and understanding, and or behavior, which includes how students tackle the chosen task or the task given to them.

In the comparative approach the characteristics of an elementary part are compared across to ore more predefined situations i.e. the interactive, the passive and the non web-based courses. If a difference is observed, a reason for this should be sought. If a difference is not observed, it is of interest to explore reasons for the similarity.

To initially apply the systematic approach in order to establish the existence of a pattern, characteristic or a relation is a logical condition for comparison of two or more entities. However the testing must focus on discerning whether a difference can be observed at all and thus the distinction between and the need for both approaches above.

Dissemination of results

The activities in the "Bioinformatics" project are designed to target questions of relevance to scientific areas undergoing rapid development. Project results will be published at the Swe-LL web site and presented at workshops, seminars and conferences. Assessment studies of wider interest will be submitted for publication to international journals and academic press.

The Stanford Learning Lab will be directly involved in several experiments and will have full access to project results enabling an effective way of knowledge dissemination in both directions. Most Swedish universities will be actively involved in the course experiments related to distance education. Furthermore, expertise for the design of modules in bioinformatics will be sought at all Swedish universities. It is anticipated that the results, tools and library of web pages will be available to all universities in Sweden upon completion of the project.

Proposed future development

Bioinformatics is currently in the process of slowly entering into the universities in the form of five- to ten-week courses. As a scientific discipline, bioinformatics has all the characteristics of a young, explosive and slightly chaotic field of research. However, it can be expected that it will gradually develop into an established field of research with entire departments devoted solely to research in bioinformatics. In the footsteps of this scientific development, it seems likely that entire educational programs will be created in which mathematics and computer science is interlinked with biology and medicine at a very advanced level. However, it takes time and efforts to incorporate new educational programs into existing university structures. Therefore, we suggest that the initial experiments proposed here will be followed up to study the pedagogic situation during which a new field of research is created and gradually transformed from a young, explosive area of interdisciplinary research into an established scientific discipline. Thus, the project in bioinformatics has the potential of developing into a unique study on how to teach rapidly evolving cross-disciplinary research areas, from the development of the first few courses to the gradual integration and final transformation of the new scientific discipline into mature educational programs.

Proposed Bioinformatics activities and projects

Background

The bioinformatics project includes the establishment of a series of courses. The first two years will be focused on (i) basic and more advanced courses in bioinformatics within a biological, medical, pharmaceutical and agricultural environment as well as on (ii) basic and more advanced courses in bioinformatics within a mathematical and computer science environment. Upon the successful completion of these projects, one of our goals is to generate a problem-based (PBL) course in bioinformatics in which students in biology, medicine, pharmacy, agriculture, mathematics and computer science will be exposed to a set of problems that can only be solved by their combined efforts and expertise.

The Swe-LL bioinformatics project will be responsible for leading the development of courses in both local and global contexts. Based on the local strengths and on articulated needs of prospective industrial partners, we propose to focus the project within the Swe-LL on four strategic teams, namely algorithms and databases, genome studies, expression and function, and structure and design. The detailed content of the courses in the project will be assembled from dozens of individual modules describing theory, problems, algorithms and database tools. The modules will be used in different constellations and with different degrees of local support so as to find the optimal learning situation for students with different backgrounds and in different types of courses (local as well as global). The expected result of this project is (i) an increased knowledge about the use and efficiency of modern technologies in interdisciplinary teaching as well as (ii) a world-class education in bioinformatics.

The Swe-LL project in bioinformatics will consist of the following activities:

- Creating a series of dynamic modules that can be combined to generate unique, local courses in bioinformatics in response to the specific needs and desires of the different universities in Sweden and at Stanford.
- Experimental studies of the efficiency of learning in situations differing with respect to:
    - Group size (single individuals, peer-to-peer, mentor-student groups)
    - Type of interaction (virtual, real)
    - Technology base (passive web-based, interactive web-based, non-web based curriculum)
    - Geographic distribution of students (local, regional, global).

Specific objectives and guiding questions

We have defined experiments related to the teaching of bioinformatics. The way in which students search information and navigate among web-sites when exposed to the task of solving a bioinformatics problem will be recorded and analyzed in relation to the students background situation and in relation to his/her understanding of the subject (as inferred from the on-going assessment). Bioinformatics problems will be embedded in different environments (biological, biomedical, pharmaceutical, mathematical, computational) and the ability for different student groups with different backgrounds to solve problems in the different environments will be tested. The same set of modules will be used in different learning situations; in short intensive courses versus spread out and integrated with other courses, with- or without complementing education in the form of lectures and discussion groups. The performances under different learning situations will be tested and evaluated by the assessment team. The specific experiments and guiding questions are as follows:

Experiment 1: Navigating in complex learning environments

The goal of the proposed ICT-supported learning in bioinformatics is to make the students competent and professional in navigating through a complex space of information in order to solve a given problem. Here, we will study the way in which students search information and navigate among web sites when requested to solve a bioinformatics problem. The order and number of times the students visit a given set of web-sites will be recorded and analyzed in relation to the students prior education and in relation to his/her understanding of the subject. Here, a set of modules, which requires extensive integration of biomedical, mathematical and computational expertise, will be evaluated in different web-based environments.

The guiding questions for this experiment are:

- How do students with different backgrounds in biology, mathematics, and computer science navigate in a complex ICT-supported environment with many alternative sources of information to solve a given set of problems?
- How to pose a bioinformatics problem so as to stimulate students in biology and medicine to learn and understand algorithms and programming?
- How to pose a bioinformatics problem so as to stimulate students in computer sciences to learn and understand biomedical questions?

- Which kinds of presentation of data are supportive in order to develop student's ability to grasp the appropriate content to solve the given task in a bioinformatic problem?

Experiment 2: Local and global learning situations

How to create a forum for global learning that is independent of time and space? Communication and delivery environments based on Internet is not bound to physical locations and have the opportunity to be unbound in time as well, depending on communication mode, i.e. synchronous or asynchronous. Students in different areas, i.e. locally and globally, will share the same learning environment but not always share the same content depending on their disparate discipline background before entering a Bioinformatics course.

However, the delivery of courses and virtual learning environment has, apart from the content, to be filled with teaching and learning activities such as e.g. tasks and dialogues, in order to support the learning process. The interactive and module based learning environment provide not just channels for the interaction between student(s), teacher(s) and content it also provides grounds for a great variety of learning outcomes. The interactive vehicle also provides grounds for creating a great variety of time and space independent global learning forums.

The guiding questions for this experiment are:

- To explore whether the ICT-supported environment could be designed to support the students' ability to focus on the signified, relate and distinguish evidence and therefore help students' to organize and structure the content into a coherent whole.
- What kind of in-groups interaction (peer-to-peer, mentor-student, student-content) are the most supportive in order to develop students ability to grasp the appropriate content to solve the given task in a bioinformatic problem?
- Could the use of an interactive web-based curriculum be more supportive than a passive web-based curriculum or non web-based curriculum in terms of supporting students' ability to bring intellectual perspectives into the problem-solving process of a given task in a bioinformatic course?

Experiment 3: Integrating new modules in bioinformatics

Bioinformatics will most likely penetrate into all educational programs in molecular biology and biomedicine in the future. However, different universities and different programs may incorporate bioinformatics to different extents and chose different means of integration. Here, we will compare the same set of modules in two different learning situations: as packages in short intensive courses in bioinformatics or as distributed packages in conventional type of courses.

The guiding question for this experiment is:

- Is an intensive course with many modules more effective in terms of learning outcomes than the integration of the same modules into a series of conventional courses in biology and medicine?

Plan for deployment

The first part of the project involves the creation of modular facts. The modularized and portable content encourages the teachers and students to combine material from different sources into their own learning environment, to exchange point of views and to add their own contributions. The second part of the project involves evaluation of the modules under a wide variety of different learning situations.

Step 1: Creation of modules

In all new and rapidly evolving field of research, there are no or only few relevant textbooks. Within the context of the Swedish Learning Lab we intend to develop new web-based course material, which will be implemented and immediately evaluated by the assessment team. Thus, the project is based on a flexible and dynamic concept in which individual modules will continuously be developed and combined to form a library of information from which resources can be extracted and assembled in ways that may differ between courses and universities as well as between individual students in a given course.

A typical module may consist of four different types of flexible facts:

- Biomedical Background – Mathematical Algorithms – Computational Tools - Evaluation

The background information constitutes the entry point to a given module. The problem page defines a problem that the student is supposed to solve. In order to solve this problem the students will have to navigate through a set of Web pages in order to understand the algorithms/methods and to be able to use the tools and software available. A short report will be written and compared to a result page, which can only be accesses after successful completion of the module. Finally, the student will be evaluated about the extent to which he/she has learned the basic concepts of the module. Within each module, the flexible facts concerning backgrounds, problems and results are completely interchangeable. Thus, a student in medicine may choose to work on a medically oriented problem whereas a student in pharmacy may select a pharmaceutical problem. A variety of different entry points will then merge into the same algorithm and tool pages which are necessary to understand in order to solve the individual problems selected by the students. The pathway within the module can either be defined by the teacher or undefined so that the students has to navigate and select a set of “flexible facts” according to his/her own interest and background situation. The progress achieved using the defined versus the undefined pathways will be compared and evaluated under a variety of different learning situations.

Examples of modules and flexible facts that will be used in the experiments:

Introduction to algorithms:

Simple algorithms on graphs (connected components, minimum spanning trees,), time analyses, dynamic programming on strings (edits distance, maximum increasing subsequence), dynamic programming on trees (maximum weight independent set), the implications of NP-completeness (basically only an explanation of the concept).

Computational biology/Advanced algorithms in bioinformatics

Substitution matrices, Pairwise alignment (global, local, with various gap costs, space efficient, FAST, BLAST) multiple sequence alignment, algorithms for phylogenetic tree construction, algorithms for assembly and physical mapping, genome rearrangements, algorithms for Hidden Markov Models, structure predictions.

Extracting secrets from sequences:

Introduction to databases, DNA Sequence databases, Protein sequence databases, Sequence retrieval (SRS, Entrez), Database searches (BLAST); The students will learn to use the sequence retrieval system (SRS) for searching and using biological databases via the world wide web. The objective of this segment is to become familiar with NCBI database search tools (BLAST, Entrez etc) and to learn the intricacies of database searches. The module will include both theoretical and practical segments. The main lesson is that databases contain many discrepancies due to misnaming and multiple sources of entries. The more advanced level includes a non web-based segment using software to construct a searchable local database from FASTA sequence files and using local blast programs to search this database. This is to get practice in using command line-based tools and to get more insight into database searching.

Shotgun assembly:

Methods for assembly, Comparison of programs, Assembly algorithms, Assembly and editing using different assembly engines. This module describes methods for assembly, and characteristics, differences, advantages and disadvantages with different programs. A more advanced level includes assembly algorithms. The practical exercises consist of using different assembly engines and editors on a dataset that is supplied. Specific goals include evaluating the results and deciding on steps to finish the sequence.

Computational methods for gene hunting:

Codon bias and codon usage patterns, Nucleotide frequency statistics, Comparison of gene prediction programs (GRAIL, Genescan). Methods and principles for gene finding software will be discussed. The students will compare results from gene prediction programs (GRAIL, Genescan etc) and make decisions based on the accuracy of the results. The assignment includes evaluation of different programs and the realization that the available programs are often accurate but not always.

Sequence evolution:

Genetic drift and Neutral theory, Nucleotide substitutions: Models and rates, Substitution rates in mouse and rat (matdisli), Substitution rates in eukaryotic and bacterial genomes (matdisli).

Alignments and phylogenetic reconstructions:

Pairwise alignment: Theories for Needleman-Wunsch, Smith-Waterman, Pairwise alignment: Hidden Markov Models; Methods for multiple sequence alignment, Clusters of orthologous groups; The Pfam protein family database; Methods for phylogenetic reconstructions, Distance methods, Parsimony methods, Statistical tests of trees, Gene trees and Species Trees, Evolution of AIDS viruses.

Navigating the genome universe:

Patterns in DNA sequences: Signal sequences, Analyzing patterns in sequences (Patscan and tRNAscan); Multivariate analysis and chemometric tools. Comparative sequencing between species; Identification of expressed and regulatory sequences, Tools for comparative analysis of the mouse and human genomes (Alfresco and dotter), Combinatorics for biologists; Comparative analysis of gene order structures (GRS), Comparative analysis of genomic segments (Geco), simulations of genomic rearrangements (derange).

Navigating the protein universe:

Protein identification, Gene expression, Tissue distribution, Metabolic databases, Reconstruction of Metabolic Pathways, Identifying membrane proteins, Identification of function from structure, Protein folds, Secondary structure predictions, Searching for motifs, Tertiary Structure Modeling

Genetics of human disease: genetic epidemiology:

Study design for estimating genetic and environmental risk factors, estimation of relative risk and concordance rates, the heritability concept and estimation of genetic and environmental variance, segregation analysis for studying the inheritance of phenotypes and evaluating genetic models. The different inheritance models and their application to experimental data. Human genetic disease database

Genetics of human disease: parametric and nonparametric linkage analyses:

Genetic markers and their properties, theory of genetic linkage analysis, parametric methods for linkage analysis (the LOD score, parameters, assumptions and programs), nonparametric methods for genetic linkage analysis (ASP, TDT, programs, examples), multipoint mapping, analyzing data from genome scans, pros and cons of using animal models in mapping of genetic traits. Design of case-control and cohort studies, confounders and biases, multiple test problems.

Genetics of human disease gene mapping:

Construction of genetic maps from family data, web-based genetic map resources, merging genetic map resources from different sources, construction of physical maps, available physical map resources, correspondence between physical and genetic maps. Linkage disequilibrium mapping, identification and evaluation of candidate genes, large-scale expression analysis, integration of genetic and expression methods in gene mapping. Linkage and association analysis for complex disorders, genetic heterogeneity, interaction between loci.

Ethical aspect on biomedical science:

Genetic testing and its ethical consequences, establishment of population registers for medical research, identification of forensic evidence by genetic analysis, the ethics of human gene therapy, ethical consequences of the human genome project.

Legislative regulation of biomedical science:

Regulations for biomedical science in different countries, discussion of the “gray zone”, effect of existing or planned legislation on the progress in biomedical science

Ownership issues in bioinformatics:

Patent law in different parts of the world. What makes an invention possible to patent? Intellectual property rights in academia and industry?

Step 2: Implementation of modules

Based on the series of modules available, a series of experimental courses in bioinformatics will be generated and given. An experimental course project will have the following general steps.

- Selection of modules –flexible facts representing the curriculum.
- Definition of the learning issues to be addressed.
- Choice of technology base and comparison to be made.
- Development of an assessment framework to be applied during the course.
- Implementation of the technology and assessment features
- Execution of the course and evaluation of results.
- Publication of results obtained and revision of the guiding questions.

An example of an outline for an experimental course is given below (Figure 3). This is based on a course in basic bioinformatics, which is composed of modules X-Y and given at three of the campuses involved. This course is expected to be equivalent to four weeks of full time studies. The aim is to study the importance of technology base for the learning efficiency. To this end, the courses at the three campuses are designed to include the same curriculum, but the students are given different types of technological support. Similarly, course experiments will be performed to test the other factors above

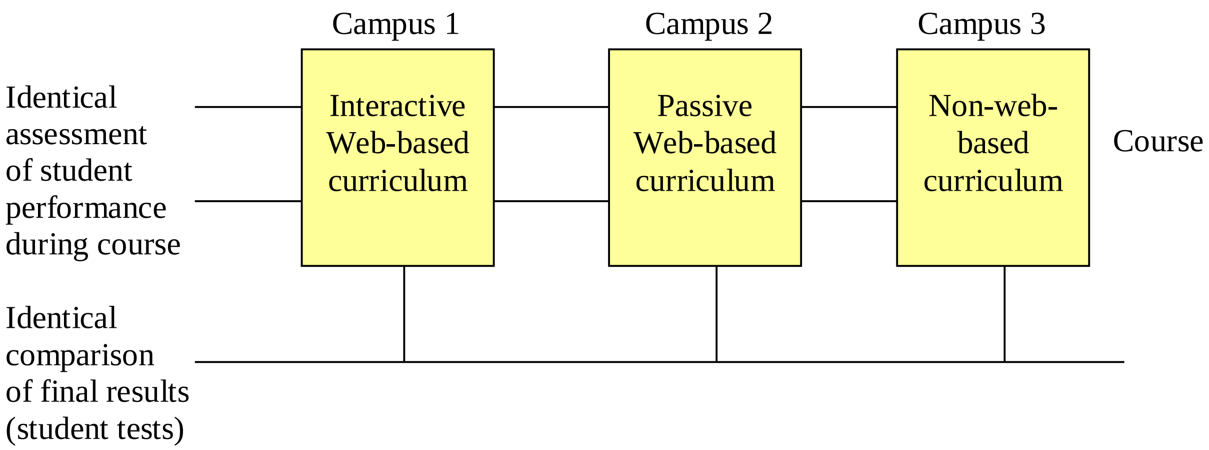

Figure 3. Schematic outline of the flow-chart of a project.

Infrastructure

An infrastructure for bioinformatics courses is already available both at Stanford University and in the Uppsala-Stockholm area. In addition, bioinformatics modules will be incorporated in traditional courses in molecular biology, biomedicine, mathematics and computer science at UU, KTH and KI. Below, we give a few examples of specific courses in bioinformatics, which will be used to test some of the guiding questions proposed in the experiments (the list is not exhaustive):

Bioinformatics, 10p, UU: This is a full-time course given at Uppsala University, which is part of an undergraduate training program in biology. The aim of this course is to provide an introduction to bioinformatics for students in molecular biology with no particular training in mathematics, statistics or computational sciences. The first seven weeks of the course is conventionally structured with both lectures (ca. 2 hours) and practical exercises (ca. 5 hours) each day. Lectures are given by both biologists and mathematicians and the practical computer work is conducted under the supervision of assistants familiar with computational biology. The first section is followed by an examination on the lectures and practical exercises. During the second section of the course each student performs a computer-based project involving data collection and analysis. The result of the project is presented in both written and oral forms as well as on the web.

Bioinformatics, 5p, KI: This is a part-time course given at Karolinska Institutet, which is part of an undergraduate program in biomedicine. The overall outline is very similar to the course above but the depth is less extensive. This course is finished with a large project work that the students have to perform either individually or two and two. This work has to be presented in both written and oral forms.

Bioinformatics, 5p, national distance course: This is a course in bioinformatics given by the Linnaeus Center for Bioinformatics at Uppsala University, which is flexible in time and space. The course is given entirely over the net and is open for undergraduate and graduate students at all universities in Sweden. The course is jointly organized and taught by lecturers and assistants at Uppsala, Stockholm, Umeå and Linköping University. The course is also open for students at foreign universities. Homework, exercises and communication with the teachers are performed over the net.

Bioinformatics, graduate course: This is a local course at Uppsala University for students accepted at the graduate schools in biology and biomedicine. The content of this course is similar to the national distance course, except that the information and exercises provided over the web is complemented by lectures given by teachers and invited guest speakers.

Assessment

The results and the activities of all the assessment will be used as one of the means to reach specific aims of this project. The assessment will also contribute to support the continuous development of the conditions for and the outcomes of student learning and learning experiences in Bioinformatics. It will also be used in order to evaluate teachers' experiences and professional development in this kind of ICT-supportive, complex, module-based and collaborative teaching environment. The assessment activities will of course also to be used as a tool in testing the predefined hypotheses.

Measurement consists of differentiating performance, ways of knowing and understanding, and or behavior, which includes how students tackle the chosen task or the task given to them. Evaluation involves professional judgment of the value or the worth of the measured performance. The final stage or component is how the assessment is used in the specific situation or course. In this phase the decisions concerning assessing performances, understanding and learning outcomes will be implemented.

The general educational objective can be broken into several components and for the Bioinformatics project the following are (suggested as) important components. The teaching and instruction in this project will be based upon activities that supports students' development of a trained mind, i.e. critical thinking, reasoning skills and an ability to think conceptually. The teaching will also focus on enhance students' ability to bring intellectual perspectives as well as problem-solving abilities to bear on relevant issues. The Bioinformatics project will be assessed and evaluated in a comparative study. The different learning conditions and situations of comparison will be embedded both in extendible and complex environments with integrated modules and also within traditional courses in Bioinformatics.

Time frame

November 1999	Begin development of the project
February - September 2000	Allocation, design and creation of modules
September - December 2000	Deployment of the project
January 2001	Evaluation of the project
March - September 2001	Redesign and recreation of modules
September - November 2001	Deployment of project
December 2001	Final evaluation of the project

Principal Investigator and participating partners

PI Swe-LL	Siv Andersson, Uppsala University (Linnaeus Center for Bioinformatics)
PI SLL	Larry Leifer, SLL
Cooperating Investigator	Russ Altman, Stanford University
Swe-LL partners	Karolinska Institutet Royal Institute of Technology (Nada) Uppsala University (Linnaeus Center for Bioinformatics) Swe-LL teams at UU, KTH and KI Student groups at KI, UU and KTH
Stanford University:	Stanford University, School of Medicine Stanford Learning Lab
Outside partners:	Stockholm university Umeå University Linköping University Växjö högskola Lund University Mälardalens högskola

Budget

	Years 1-2 (kSEK)	
Project Development	2,860	
Assessment	568	
Swe-LL staff	464	
Infrastructure	1,000	
Total Project Cost	**4,892**	
Estimated WGLN funding	410	(50,000 US$)
Total Cost for Swe-LL	**4,482**	

The Swedish Learning Lab World Wide Web site

Global Collaboration and Web Development

The Swedish Learning Lab has commenced collaboration with the Wallenberg Global Learning Network web development group at Stanford. The common ambition is to build a system of connected websites for internal and external information, communication and collaboration. Construction and maintenance of the global web will be distributed and separate areas of the common umbrella web will be the responsibility of different hosting labs.

The envisioned target groups are Swe-LL and WGLN staff, project staff, faculty, researchers, students, the corporate world as well as educators and students at all levels of the educational system worldwide.

The Vision

We believe that a true exchange of ideas on learning takes place in an informal knowledge network in which scholars, teachers and students participate on equal terms. We do not believe in the web as a signpost that delivers messages of common interest to everyone.

All our results and data have to be reviewed and journalistically processed to become interesting. Moreover, our audience will expect to be able to personalize the material they are exposed to and to be able to respond to the contents. Therefore, will we explore if a three dimensional, time correlated, virtual space on the web might serve the purpose of offering a complement to traditional dissemination and experience exchange through assessment reports, publications and web postings.

The Swe-LL learning site, which will carry features from advanced media applications, will attempt to incorporate the knowledge and experiences gained from project activities into one lifelike engaging virtual environment called the *Exploratorium,* which can be experienced alone or in study groups.

The Exploratorium is a virtual world which allows the visitor to get involved in intellectual interaction on equal terms with other scholars and students engaged in learning development and research through the sharing of aggregated content material from Swe-LL, SLL and WGLN projects and other relevant data. The environment of the Exploratorium will be inviting and challenging. The most important characteristic of the Exploratorium is that the visiting faculty or student will through actions, choices and comments on the site, expand the knowledge database and thus add to the value of the site.

Beside dissemination and experience exchange we consider the web site to be our central tool for information, communication, management and administration as well as an integrated carrier of our web based functions and materials. In this perspective the site is a development area rather than a homepage. The main purpose of the Swe-LL web design will be to integrate vital pedagogical, technical and administrative functions in one easily accessible, self-instructive web tool. High technical functionality and accessibility should mark the site.

The Swedish Learning Lab web site will be developed in three phases.

Phase 1 (Oct-Nov 99, 1 month)
Initial home page containing basic information about the mission of the Swe-LL, access data, organization plan and current projects

Phase 2 (1999-00)
Development area for internal and external information and communication, project management and administration. The web integrated educational platform will be used for web based course delivery as well as dissemination and competence development and electronic publishing (such as a prospective *Wallenberg Global Learning Journal*).

Phase 3 (2000-01)
Advanced communication and dissemination device consisting of a three dimensional virtual space called the *Exploratorium* for lifelike interaction between researchers, faculty and students.

Technical Considerations

We will adopt the recommendations of international recognized standardization organizations. This is important for the function and maintenance of all data in the Swe-LL projects. From the start we plan for the use of technical platforms, which allow for maximum flexibility and security.

Communication with the Swe-LL web site shall offer the same quality to all users and not require anything more than a common web browser.

Quality control of formatting, layout, images and pictures should be employed to achieve fast download speed.

Time frame

November 1999	Begin development of the project
Jan - March 2000	Deployment of the project and continuous development
December 2001	Final evaluation of the project

Participating partners

Swe-LL partners	Uppsala University Karolinska Institutet Royal Institute of Technology Swe-LL Web teams at UU, KTH and KI Student groups at KI, UU and KTH
Stanford partners:	Stanford Learning Lab, WGLN Web group

Budget

	Years 1-2 (kSEK)
Project Development	800
Assessment	189
Swe-LL staff	154
Infrastructure	350
Total Project Cost	**1,493**
Estimated WGLN funding	
Total Cost for Swe-LL	**1,493**

Collaboration

The Swedish Learning Lab has been established as a nucleus for the development of the learning process, which will operate through a national and an international partnership.

The fulfillment of the objectives described in this proposal requires collaboration between a large number of qualified and dedicated people. In some cases in the projects *Meeting places for learning* and *Bioinformatics*, these individuals have been found at universities and institutions not part of the Swe-LL initiative. These connections, as well as a current open dialogue with Lund University and Chalmers University of Technology, may turn out to be important links in the future development of the Swe-LL.

There are at least two reasons for us to seek collaboration with external expertise. One is that there should be no borders in the academic world to collaboration and joint research ventures. Second, in a national perspective, a gradual expansion of the partnership is part of the Swe-LL concept.

Visiting Scholars Program

The SLL proposal to the Wallenberg Foundation indicated the importance of a visitor exchange program. The program is created as a means of bringing together complementary strengths in support of a common agenda and the building of a community of expertise on learning.

The WGLN program covers costs for visiting scholars to the Wallenberg center and the SLL. Participation by Stanford faculty at the Swedish Learning Lab is not covered under the WGLN program though a parallel program for Visiting Scholars to Sweden is anticipated through Swe-LL. Such a program will require additional funding. In the current proposal we have allocated SEK 500 000 to initiate the exchange of scholars.

Budget

	Years 1-2 (kSEK)
Total Project Cost	**500**
Total Cost for Swe-LL	**500**

Overall budget for the Swedish Learning Lab

The total cost of the Swe-LL for the first two years 2000 and 2001 are estimated to be 25 MKr, including University overhead costs (appr. 20%), excluding government tax.

		Years 1-2 (kSEK)
Administration		3,000
Meeting pl. Experiment 1	5,316	
Meeting pl. Experiment 2	2,892	
Meeting pl. Experiment 3	6,572	
Total budget Meeting Places		14,780
Total budget Bioinformatics		4,482
Swe-LL Web project		1,493
Visiting Scholars program		500
Miscellaneous		745
Grand total		**25,000**