

## Argumentation From traditional humanities to IT

### Abstract

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The arts of argumentation and reasoning are central to higher education. Argumentation has been linked to the old elite university, small seminar groups and a homogenous secondary education. In the modern mass university, argumentation cannot be taught as a personal transmission of tradition. Information technology related to argumentation might help to bridge the gap between the old elite university and the modern mass university.

The project aims at extracting methods and principles from argumentation and critical thinking. These principles will be used to develop IT-tools and test their use in undergraduate education.

The outcome of the project is software; help files, www-links and text files, including tutorials, teacher's instructions and examples. The package is intended to help teachers in higher education build courses or course modules in argumentation and/or critical thinking.

The software will help students structure their arguments and evaluate strong and weak points. The first software models will comprise informal logic of argumentation. This includes Naess' idea of pro et contra/pro out contra argumentation. Later development will focus more on aspects of rhetoric, in particular some of its cognitive aspects.

The software is integrated with a course in argumentation, comprising informal logic, rhetoric, credibility and negotiation. The course has been taught since 1994 at the University of Karlskrona/Ronneby. The software will be tested in the course. An important aspect is to make students participate in developing the use of software in the course.

The project began July 1, 1999 and ends June 30, 2002.

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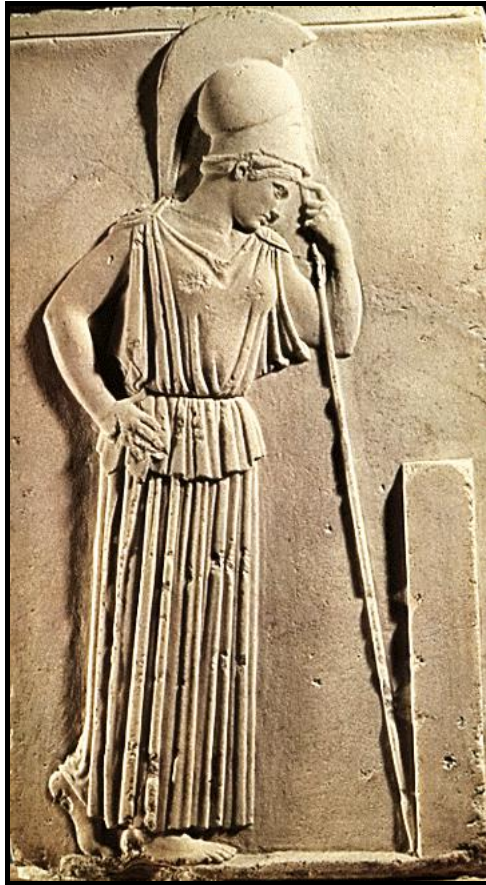
## Progress

During 1999-2001, the project has stabilized features of the software connected to its role in the course module. The graphical interface has reached a final form. The distribution via an applet has been replaced with a JAVA-application. It has been found desirable to include a report generator. The first course module - a kind of argumentation duel - has also reached a final form. Student evaluations are highly favourable.

The development of the project continues along three lines. First, the program is developed. This includes polishing the experimental version of the program. Furthermore, more advanced non-elementary features are added to the program. These include elementary calculations designed to weigh evidence, criteria or reasons for a standpoint. This is an important part of decisions and negotiations, which are also part of the course and a natural expansion from the programming point of view, using calculative capacities of the computer.

Second, we generalize the concept to new educational settings. The program has been introduced in other courses at Blekinge Institute of Technology. One new application is a course where intensive text reading and argument analysis is used in a philosophical setting. The program is tested as a support for educational games in seminars during the fall of 2001. Furthermore, course modules have been developed to test the program in support of elementary economic argumentation in business administration.

Third, a unified educational approach has been developed to clarify the integration of educational games and software features. This approach underlies the first attempts to disseminate the concepts. During 2001-2002, an Internet site is being developed (<http://www.athenasoft.org/>) and various conferences are attended where the software and its underlying educational assumptions are presented. The project began July 1, 1999 and ends December 31, 2002.



**ATHENA**  
**ARGUMENTATION**  
**FROM TRADITIONAL HUMANITIES TO IT**

**FINAL REPORT OF PROJECT 103/98**

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**AIMS AND ACCOMPLISHMENTS**

**Overview**

The Athena course concept and the Athena software have been developed to teach the arts of reasoning and argumentation to students in higher education. The project was conducted between 1999 and 2002 with the purpose of extracting methods and principles from argumentation and critical thinking and to develop software support for argumentation. The project has been sponsored by The Council for the Renewal of Higher Education, at the Swedish National Agency for Higher Education, Grant number 103/98.

The project has been developed integrating course design and software development. Main actors during the whole project have been Bertil Rolf, professor of philosophy at Blekinge Institute of Technology, acting as domain expert, course designer and teacher in argumentation, and Charlotte Magnusson, doctor of technology, at Lund Institute of Technology, Sweden acting as

technical designer and programmer of the prototypes. The programming of the EASA version of the software has been performed by a group of students at Blekinge Institute of Technology. The Athena Website has been designed and developed by Peter Anderberg, Certec/LTH.

The course concept with software includes the third generation of our software. Previous versions of the prototypes have been tested in eight courses altogether, by some 160 students, drawn both from undergraduate and postgraduate courses, from intramural and extramural courses and from courses where argumentation and reasoning are the topic, of course, and from courses where argumentation is a means of learning and examination.

Athena software is directed at students in higher education, less and moderately advanced in reasoning. It presupposes more logical sophistication than Belvedere and less than Genie, both software packages originally produced in Pittsburgh. The educational level suitable for Athena is comparable to that of Reason!Able, built at the University of Melbourne. There are no commercial interests related to the software and it is distributed freely for non-commercial uses.

Student reception of the software and related teaching has been positive. Roughly 2/3 of the students estimate that learning has improved with Athena software in relation to teaching methods using pen and paper and roughly 1/3 report no change.

### Project aims and achievements

The aims and achievements of the project are shown below:

The aim of the project (From application)	Accomplishments of the project
The project aims at extracting methods and principles from argumentation and critical thinking. These principles will be used to develop IT -tools and test their use in undergraduate education. The outcome of the project is a CD-ROM with software, help files, www-links and text files, including tutorials, teacher's instructions and examples. The CD-ROM is intended to help teachers in higher education build courses or course modules in argumentation and/or critical thinking. The CD-ROM contains materials underlying such courses.	The project has implemented software packages based on methods and principles from argumentation and critical thinking. The software packages represent some of the basic cognitive principles of reasoning and argumentation. These principles have been integrated with educational modules teaching the social aspects of argumentation in various settings. The software has been developed in 4 generations. The software is of top international quality in its kind. The software and the course concept have been tested in 9 courses with some 170 students. The test results indicate that 65% estimate positive effects on their learning with the use of software, 2% negative effects and the remaining 33% neutral. The educational material and the software (*.exe-file and *.iso-file for the production of CD-rom) can be downloaded free of charge from the site <a href="http://www.athenasoft.org">www.athenasoft.org</a> .

Fig. 1. Comparison of aims and achievements.

### The software produced

Athena Standard 2.0 has the following properties.

1. The graphic tree structure use nodes to represent the conclusions and the premises. Lines are used to represent the logical relations of an argument. Each subordinate node may have several superior nodes. Circularity is excluded.
2. The nodes distinguish between name, specification and content. Large amounts of text can be held in each node. The nodes can be cut, copied and pasted.
3. Nodes can be dragged and dropped. Parts of the structure can be hidden.
4. Several windows can be opened and contain different arguments for comparison. Branches can be selected and copied between windows. Larger arguments can be built by copying parts between windows.
5. The strength of arguments can be graphically evaluated using the concepts of "Acceptability" and "Relevance". Values are assigned from 0 to 100 using a slider. The user him/herself must stepwise perform the calculation of superior levels from subordinate levels. The weakest arguments can be filtered out if the product of Acceptability and Relevance is less than a user set threshold.
6. Reporting facilities are improved in this version, including a page for Title, author and background plus a page for evaluation of acceptability, relevance, robustness and structure. The content of the arguments can either be presented as lists, as tables sorting the content of arguments into Pros and Cons respectively or as Pro aut Con tables presenting best reply to an attack. Copy and paste of argument (parts) between windows now follow WYSIWYG standard.
7. A tutorial is included. The user's evaluation process is guided via the report generator.

Of these properties, 2, 4 and 6 are unique for Athena in relation to comparable software packages targeting the same user groups. Without these properties, software packages are in practice restricted to student-teacher communication in analysis of arguments. The properties 2, 4 and 6 underlie Athena's success in support of argument production. Large amounts of text can be preserved and used in various reports or handouts underlying oral presentations.

Athena was developed in the system independent language Java and tested for use on Windows 98, NT4, 2000 and XP platforms. To run the Athena program one needs a PC with 64 Mb RAM (128 Mb recommended) and an 8x (20 x recommended) CD player. To install the Athena program on your computer a minimum of 50 MB of free disk space is needed.

Athena's main interface is shown below.

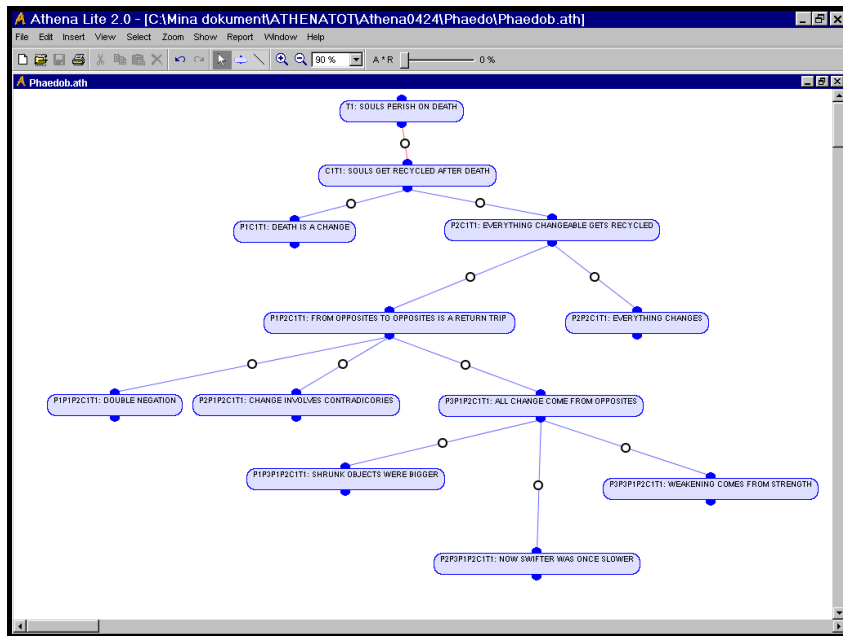


Fig. 2. Athena interface.

### Athena Website produced

The Athena Website contains pages for:

- Homepage with content description.
- Project description.
- Software download.
- Documents with educational modules for students and teachers.
- Links to sites for reasoning, argumentation and informal logic.
- Contact and a mailing list.
- Information about the goddess Athena

The graphical interface is shown below:

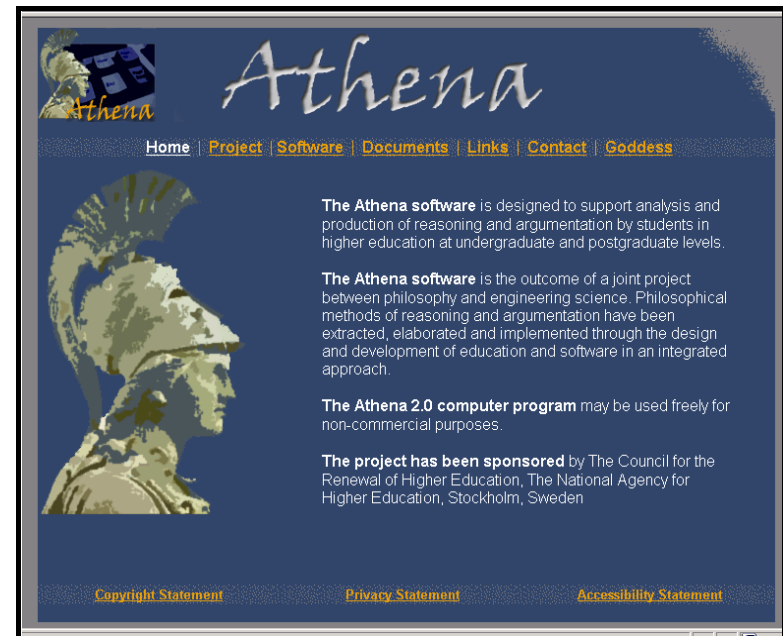


Fig. 3. Athena Website [www.athenasoft.org](http://www.athenasoft.org).

### Courseware produced

The following public courseware has been produced:

- *Quick start instructions*. Located at [www.athenasoft.org](http://www.athenasoft.org)
- *Tutorial*, included in the program.
- *Internalizing stations of reasoning*. A document explaining criteria of good reasoning with examples drawn from Sherlock Holmes. Located at [www.athenasoft.org](http://www.athenasoft.org).
- *Following Reason to a Conclusion*. A document explaining the step-by-step use of Athena in the analysis of the cyclical argument for immortality from Plato's Phaedo. Located at [www.athenasoft.org](http://www.athenasoft.org)
- *Practising public reasoning*. A document with teacher and student material describing the rules of the game for oral expert duels plus argumentation reports. Located at [www.athenasoft.org](http://www.athenasoft.org).
- *Athena Main Ideas*. Power Point demonstration of the capacities of Athena. Located at [www.athenasoft.org](http://www.athenasoft.org).

### Research papers and material for reflective practitioners

The following research papers and material for reflective practitioners have been produced:

- *Athena. Datorstöd för argumentation*. Paper for Högskoleverkets kvalitetskonferens 2001.

- *Developing the art of argumentation. A software approach.* Paper for the 5th Conference of the International Society for the Study of Argumentation (ISSA) Amsterdam, June 25-28, 2002.
- *Educating Reason: From Craft To Technology.* Contribution to the 6th International Conference on Computer Based Learning, Cyprus 2003.
- *Athena Easa Final. If Athena is the answer, what was the question?* Power Point presentation for the finals of EASA - European Academic Software Award, Ronneby November 2002.
- *Vad gör Athena och varför?* Power Point presentation at LTH/CERTEC May 2002.

All of these papers/presentations can be downloaded at [www.athenasoft.org](http://www.athenasoft.org).

## THE COGNITIVE FIELDS OF REASONING AND ARGUMENTATION

### The concepts of reasoning and argumentation

Reasoning and argumentation are closely related. Reasoning is a cognitive activity, argumentation is reasoning, exercised in a social context.

Reasoning is a process or activity in which an actor constructs, analyses or evaluates inferences. To have “good reasons” for a standpoint is to base it on inferences lending it good support. Reasoning can be seen as the exercise of an art, which can be conducted with greater or lesser skill. (Voss, Wiley & Carretero 1995): To be good at reasoning involves the capacity of producing good inferences.

Argumentation is a kind of reasoning, conducted in a social setting where the actors recognize that they are partaking in a social activity. Argumentation is not necessarily connected to effects on *any* audience. There are audiences unswayed and unswayable by reason. In such situations, reasoning and argumentation are a waste of time. Argumentation does have a place in social arenas, but only where reasoning has a chance. A common definition states:

Argumentation is a verbal and social activity of reason aimed at increasing (or decreasing) the acceptability of a controversial standpoint for the listener or reader, by putting forward a constellation of propositions intended to justify (or refute) the standpoint before a rational judge. (Emeren et al. 1996 s. 5)

To be good at reasoning is a necessary condition for being good at argumentation. It is not a sufficient condition, however. Rewards for skills of reasoning are reaped in social arenas. There are obvious motives for teaching not merely the art of reasoning to students, but also the social skills of argumentation, suitable for the social arenas where the former student will act in his mature career. For most students in higher education, this arena is one external to science and higher education. Reasoning coupled with the social skills of argumentation will be advantageous for the majority of students.

### What characterizes the Athena approach to reasoning and argumentation?

The Athena approach to reasoning and argumentation involves an integration of software and argumentation games. Athena software supports the cognitive structuration of reasoning through building argument trees and evaluating their parts. Argumentation games emphasise the social skills necessary for argumentative performance through role-play. The games have a competitive nature and involve more or less confrontation with other students or student groups. Several types of games can be supported in various kinds of reports in printed output from the software.

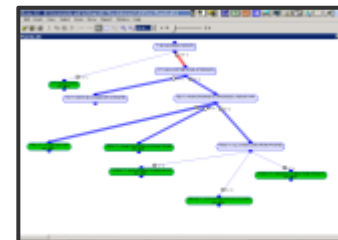
## MOTIVATION FOR PROJECT DEVELOPMENT AND ACCOMPLISHMENTS

### What Athena does. A typical way of using some of Athena’s features

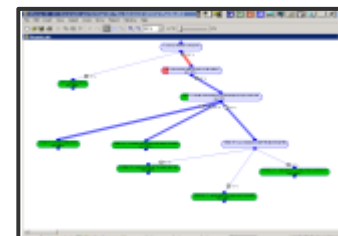
Athena software can be coupled to several different procedures of argument elaboration. A simple use is as follows.



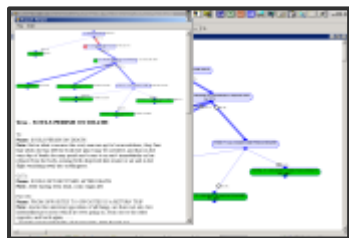
1. BUILD AN ARGUMENT TREE.  
Start with a conclusion.  
Add premises and premises of premises.  
The result is an argument tree.



2. EVALUATE THE TREE STEP BY STEP.  
Assign acceptability to premise nodes.  
Assign relevance to connections of logical relations.



3. FILTER AWAY YOUR WORST PREMISES.  
Pull the filter lever to set the threshold.  
Your worst premise nodes and their connections disappear.



4. REPORT.  
The report wizard delivers a HTML-report for handouts or import and elaboration in word processors.  
The \*.ath-file can be sent to teachers, students or colleagues.

### How and why does Athena work?

There are a number of reasons why Athena contributes to teaching and learning reasoning and argumentation.

All texts are mainly linear in time (speech) or in space (writing). But all arguments rely on a non-linear underlying structure. Such structure is hierarchical and recursive and therefore often complex.

In order to understand arguments, one needs to grasp some of the underlying structure. Understanding arguments of others is notoriously difficult. Students have considerable difficulty in extracting argument structures from texts.

These difficulties are easy to explain. Grasping complexity holistically is not feasible. Man's ability to survey the interaction of elements in complex issues is normally very limited. (Dawes 1988)

Athena's role in understanding is to provide graphs enabling analysis and synthesis of complex, qualitative issues. The diagrams facilitate reasoning. (Larkin & Simon 1987): They externalize and visualize interrelations between the building blocks of a complex standpoint. (cf Hutchins 1995, Norman 1993, Norman 1999) Furthermore, the process of reasoning is also broken down to a manifest step-by-step procedure that an actor or a team can perform.

Internal private thought processes are replaced by external, public step-by-step procedures. Athena building process and the resulting trees are observable. Students and professionals can experiment and teachers or supervisors can give direct feedback.

The basic idea of such diagrams is threefold. First, an inner mental representation is replaced by an external, visual representation. Second, inner operations of inferring and concluding are represented by intersubjectively observable moves on a screen. Third, group collaboration and teacher interaction is facilitated by the use of a common symbolism for representing logical units (premises and conclusions in the form of nodes) and logical relations (connections between nodes). There is evidence that such diagrams facilitate reasoning far more than traditional methods. (Reimann 2000, van Gelder 2000a,

van Gelder 2000b)

Athena analysis procedures enable smooth transition from linear texts to hierarchical structure. Athena synthesis module enables smooth transition from hierarchical structure to linear presentations integrating graphs and text.

### What Athena can be used for. Actual uses

Athena can be used for reasoning and argumentation in several different contexts:

- Solitary puzzle solving:
  - Solving a hairy intellectual or practical puzzle
  - Sorting out the pros and the cons of a complex issue
- Reasoning in the context of education or research:
  - Intensive text reading of scientific or philosophical reasoning
  - Teaching text-analytic techniques in computer lab
  - Computer aided seminars of text interpretation
  - Commenting and correcting student home work
  - Computer supported presentations of state-of-art lectures
- Civic reasoning:
  - Public oratory and public debate
  - Grass root political schooling
- Professional context:
  - Qualitative decision making
  - Counselling

Of these contexts, we have actually used Athena in a number of contexts, some of them in educational tests with students users, some use for research issues.

- Solitary puzzle solving:
  - Sorting out the pros and the cons of a complex issue.
- Reasoning in the context of education or research:
  - Intensive text reading of scientific or philosophical reasoning. (Educ. Test)
  - Teaching text-analytic techniques in computer lab. (Educ. Test)
  - Computer aided seminars of text interpretation. (Educ. Test)
  - Commenting and correcting student homework. (Educ. Test)
  - Computer supported presentations of state-of-art lectures.
  - Civic reasoning:
    - Public oratory and public debate. (Educ. Test)
- Professional context:
  - Counselling. (Educ. Test)

It is important for the future of Athena that the software is not conceived of merely as a tool for undergraduate students or introductory courses – in

philosophy often dubbed “baby logic”. Such courses have notoriously low status and the use of Athena would be restricted to such courses forever.

Instead, our aim has been to design for use Athena in both undergraduate and graduate courses. The software can be used for the presentation of research issues as well as for elementary uses. If researchers and professionals can benefit from the use of Athena, a wider spectrum of elementary undergraduate courses can be attracted as well.

For instance, Athena’s features for producing reports far exceed those of otherwise comparable software packages. These features can be used to produce handouts and visually appealing lectures presenting complex research positions in the form of trees where the oral argument exhibits the various branches.

### **The background course before Athena**

A typical course would be given to students in their third year of higher education, drawn mainly from professional programmes in programming and business administration at Blekinge Institute of Technology. Roughly 25 students participated. The course comprised 5 weeks of student work, offered yearly, half time for ten weeks in the autumn term. Its content was divided into four modules:

- Informal logic and reasoning, culminating in student role-play in expert duels
- Rhetoric and methods of influence
- Credibility
- Negotiation, culminating in student role-play in negotiation games.

Course assignments for grading students would typically comprise:

- Argument plans for expert duels.
- A popular essay about professional uses of rhetoric, or the nature and importance of credibility.
- Negotiation plans, evaluation of outcomes of negotiation and instructions for negotiators.

The quality of student planning and post-analysis varied considerably. To some extent, this depended on differences in writing skills. Students in economics have comprehensive training in composing reports while the students in software engineering far less so. But a major cause of the variation was simply variation in quality and in the amount of labour put into pre-preparations and post-analysis. The very game aspect and role-playing dominated the preplanning and post-analysis. The expert duels had a dramatic appeal in which ill-prepared aggressive showmen could gain an upper hand over well-prepared but timid students. The duels were exciting but there was a definite risk that facts and serious arguments would lose out to domination and aggression. One might surmise a gender aspect in this as well.

In such expert duels, there was a risk of conflict between the two types of basic skills behind argument – the cognitive skills and the social skills. Students could circumvent the learning of cognitive skills by taking the short cut of showy verbal aggression. They would perceive themselves as “winners”, which they were in terms of initiative and demonstrated staunchness. Of course, such short cuts could be punished in the post-analysis and feedback by the teacher – which was done. But the words of a teacher, representing an age long passed, might have less of a learning effect than the triumphant feelings of subduing an opponent.

### **After Athena. Types of courses between 1999-2002**

When the project received its grant in 1999, the project manager decided to try out the program versions and the teaching methods on as many groups as possible. From 1999 to 2002, Athena and her predecessors have been used in eight courses altogether.

Various social games have been construed to train argumentation in a number of social settings.

- Expert duels. The students are given the assignment of delving into in a controversial topic they know little about, such as, “Allowing euthanasia” or “Allowing gene modified organisms”. The subject matter is sensitive and the ability to take a reasonable position is based on expert knowledge. After 60 hours of work, the groups of students appear as members of an expert panel in a public debate and speak for or against the topic. They meet as stubborn, tough opponents who will demonstrate the great amount of expertise they have on the subject. They are to successfully attack their opponents’ moral points of view and defend their own. The next day they trade places.
- The seminar game is based on distributed literature, such as a chapter or a book, or on the students’ own reports. The opponents and respondents prepare their arguments and a handout with the main arguments, clarifications and pro/cons.
- The organisational game is a simulation in which a manufacturing company has received a complicated offer from a possible customer. Should they accept or reject it? Two student groups write memorandums, one for and the other against, and present oral arguments before the company’s executive management team. It is important that the arguments are economically sound. In preparation, the students are forced in their group efforts to work out the key concepts in the course literature.

Common to these three types of adversary argument settings have been:

- A task is assigned to groups of students with one side arguing pro, the other con. The task is of a kind that students might encounter in further studies or in their professional careers.
- The task involves preparation in which their argument is structured using Athena software. The students present an argument plan based on the output of Athena.
- Oral argumentation occurs in a plausible social setting: the public arena, the seminar room or the marketing division. Feedback is given to the students concerning both their cognitive reasoning and their social action.



- Students are evaluated on the basis of written materials: argument plans, handouts or memorandums. This ensures that thorough preparation pays off more than aggression, charm or successful improvisations in the argument games.

The argumentation is a module in a more comprehensive course. The embedded module can be devoted to argumentation and negotiations. Or the argumentation module can be a type of examination of student ability to apply course concepts in oral and written arguments.

More than 160 students have tried the program (or one of its predecessors) in preparation and analysis of the games. The distribution of these students, relative to the games are as follows:

		Number of students		
		Argument game	First year students	Postgraduate students
Embedding course	Argument and negotiation	Expert duelling game	61	69
	Philosophy of mind and scientific explanations	Seminar game	11	6
	Basic concepts of business economics	Organisational advisory game	26	0

Fig. 4. Number of student participating in the various course modules.

### Student effort, accomplishment and experience

Students put much effort into this kind of course or course module. Caution should be exercised in looking at averages over different types of courses, but the figures we have indicate that some 75 to 90 student hours are put into the expert duelling module. Comparing our course with others, students report that the workload demanded is far greater than in their average course. The students put this effort into the course in spite of the fact that it is not mandatory in their educational programmes and that it runs parallel with other courses that are.

The expert duels are an exciting challenge to students. Their excitement concerns not only duels in which they are actors but also duels in which they act as coaches or chairpersons.

What do students accomplish? Firstly, via their tasks in Athena, they will have gained much experience in discovering hierarchic structure in writings and speech. Preparing the argument duels, they are forced to think about which branches of the argument they had better not to get into and which branches they should try to stay in. During the expert duels, they are forced to keep track of how the arguments of the respective teams move up, down or across branches in the argument tree (or more exactly: in one of the argument trees representing the argument terrain). By “chunking” large portions of texts into hierarchic representations (“the poor countries issue” or “the self-determination

argument”), it becomes possible to preserve cognitive orientation in previously unknown territory.

Secondly, students will acquire a better capacity for reading a social situation and seeing which openings can be exploited. During the two duelling days, one sees considerable improvement in performance the second day. Furthermore, the advice from the coaches is more to the point. The initial comments on the first day are often dominated by good intentions but are not that constructive. After having observed, commented, and listened to evaluations of the debates, students become more perceptive and their comments acquire considerable perceptiveness and depth. This is what we would expect. The rules and tactics of social games can be picked up via observation and analysis of performance of other actors.

Thirdly, students gain considerable knowledge on a topic such as euthanasia or genetically modified organisms. The topics are assigned so as to preclude students from having much previous knowledge in the fields. Their knowledge in these areas is not a collection of facts but is more of the relevance structures typical of argumentation. Expert facts are selected and structured in relation to moral and political norms.

Fourthly, students have acquired a general method and a proper attitude for collecting information in controversial fields, sifting through it and structuring it to support moral and political claims. Many of the students have a background in natural science or in technology and it is a new experience for several of them to find themselves able to support each of two conflicting standpoints with good arguments. Many of them are baffled by the difficulty of settling their minds once they face the complexity of the issue.

Post-course evaluations among the students indicate that the expert duelling module produces one of the most rewarding learning experiences they have had during several years of study. Overall satisfaction with the course is high.

Course evaluations indicate that students’ estimation of the learning outcome is favourable. Roughly 2/3 replies “better” and 1/3 “just as good as” to the question:

By using ATHENA, my learning was

- better than if we had worked with pen, paper and newspaper articles.
- just as good as if we had worked with pen, paper and newspaper articles.
- worse than if we had worked with pen, paper and newspaper articles.
- have no opinion

Of more than 160 students in various courses, only 3 have reported “worse”. It should be mentioned that these figures relate to different courses on different levels, using different generations of the software in intramural and in extramural settings. The tendency is clear, but there is little point in elaborating on the statistics. To control for possible teacher effects could not be done within this project.

### What has changed in the educational process?

The traditional teaching of argumentation normally assigns to the student texts to be analysed. At lower levels, the teacher selects the texts. The teacher presents techniques of analysis and then checks student analysis via their written tasks. This has been part of the Scandinavian tradition and, to judge from Anglo-Saxon textbooks in argumentation, their tradition is similar. (Naess 1960, Toulmin 1958, Scriven 1976) At postgraduate levels, students are expected to be able to search for new information and to structure it, unaided by teacher comments. The introduction of Athena brings about a number of changes to the educational process.

The course starts with a short course presentation and then a morning lecture introducing the nature of good argumentation, based on “Internalizing Stations Of Reasoning”. The class is then divided into work groups of three students each. The students are given newspaper articles to read for analysis. These articles are distributed on paper as well as in digital form – HTML or Word format.

After lunch, the class meets in the computer laboratory, each group seated in front of one computer. The learning threshold for using Athena is low. After having read through the tutorial and experimenting with one of the sample argument trees, built by the teacher, the student group is ready to go.

From the assigned article, they will copy and paste textual passages, name them and arrange them in a hierarchic argument structure. The groups discuss how to break down the articles into arguments, pro or con. The teacher moves between the groups, discussing their analysis.

This way of “seeing” and “building” argument structure from a linear text is quite a new experience to them. A comment expressing the mood of an astonished student would be: “I can do it but I don’t know what I am doing.” It is well known from studies of student learning that the hierarchic analysis involved in reading does not come naturally to them. The capacity for good argument analysis involves a kind of gestalt in seeing or pattern recognition. The hierarchic, logical relations are abstract concepts but their textual representations can have physical boundaries. In a well-structured newspaper article, it is often possible to point to the beginning and end of the first counter argument to the second pro argument. The student task is unsolved until each group has demonstrated its ability to render a tolerable reconstruction of the logical hierarchy of the argument in the articles.

*Work tools and work medium add a touch of elegance to routine jobs.* Athena represents an improvement over the pen and paper approach and material taken from printed newspaper or magazine articles. Instead, computers with software applications and material in HTML files are used. One can cut, paste and save elements instead of writing them out in a word-processing program. This enhances basic group co-operation and discussion since the end product looks good. Routine work is made easier such as making copies of arguments or constructing tables.

*Clarity of communication* is a major change that Athena introduces to the procedure of analysis. The nodes and connections of the software provide something akin to stylistic conventions for representation. Students receive both a printed and a digitised text. They deliver an acceptable Athena tree representing their reconstruction of the logical structure. Instead of students producing more or less muddled diagrams, the interpretation of which is doubtful to the teacher and to themselves after a few modifications, the Athena graphs enables the teacher to decode students’ attempts to render the structure. Students’ conjectures about interpretation are unambiguous and the teacher comments as well.

*An experimental approach to interpretation.* Athena software makes it easy to form conjectures about the logical structure of the text and to revise those conjectures. All textual analysis of arguments involves a tentative process, forming hypotheses of interpretation and modifying them on the basis of other clues in the text or the teacher’s comments. In the program, a hypothesis interpretation is represented by drawing a line. The interpretation is rejected by deleting the line. Larger modifications can be carried out with the undo button or by retrieving previously saved Athena files. The ease of framing interpretations and modifying them helps foster a tentative approach to interpretations of argumentative texts. Relations between parts and wholes can be controlled in Athena by folding parts of the structure, by zoom functions or by copying parts of argument trees between windows. Formerly, such work was done on paper by drawing arrows and erasing them if rejected.

*Insight into students’ work processes.* All students have the same computerized workspace containing both the text and the student analysis of the text. The teacher moves between the student groups that ask for his attention whenever there is a murky point to discuss. A large number of groups can be tutored simultaneously because of the standardized workspace. The groups can see one another’s trees and the teacher’s feedback to one group provides information for the others. Smart solutions spread between the groups. It is easy to formulate hypotheses on the structure of texts and to discuss them within the groups. Since the teacher sees the work process and discussions of the groups, he can intervene, offer advice and comments when a group seems to be receptive. Previously, the “work space” of a group of students was a heap of papers, obscure to a teacher. It was almost impossible for a teacher to look into the student process of building arguments.

*Searching for information is facilitated and the work tempo increases.* Collecting electronically stored material from the Internet is much faster than trying to locate and borrow printed material from a library. The students are exposed to more material and have to make more evaluations of the material’s quality and usefulness. In some cases, digital material is complemented with printed books containing material of particular importance or effective formulations. Books and editorials do not appeal to everyone, but they still manage to carry out a number of assignments. They encounter special problems

and begin to understand that it is not only a question of right or wrong, but of developing a handful of good solutions.

### **Athena and computer based collaborative learning**

An extensively researched field since the early 1990's concerns the notion of computer based collaborative learning. (Veerman 2000, Veerman et. al 1999) There are several notions of computer based collaborative learning, some wider, others narrower. (Dillenbourg 1999)

Athena is relevant for some of these notions. Our results concerning collaboration during phase one of the project suggest a distinction between two dimensions of collaboration. One dimension concerns software capacities for task synchronicity, the other dimension concerns software capacities for task integration. Task synchronicity as a property of software is related to a synchronic collaboration between students simultaneously working on the same aspects of the same tasks, using different PCs. Task integration is related to capacities allowing a division of labor where different students work on different subtasks decomposed from the major task and then integrated.

Software capacities for externalized representations are essential to both dimensions of collaboration work. Different kinds of software support and different task structure relate to the two dimensions of computer based educational collaboration. Athena permits the integration of material constructed at distance but not real time collaboration where students elaborate on the very same elements simultaneously. On the other hand, there exists software that enable students to work from different PCs simultaneously but not to work with several (parts of) arguments simultaneously. What we found was that in the kind of courses we use, integrative capacities are essential but synchronic capacities did not seem to matter.

Task synchronicity relies on a feature called Computer Mediated Communication (CMC). CMC is an important method for studying student learning activities. From an experimental standpoint, it is advantageous to use computers to control and record all student activities in communication and problem solving. But when it comes to effects on learning, it is an open matter whether CMC has any beneficial effects on learning argumentation. (Baker et al. to appear) In comparing CMC with face-to-face interaction, there is a worry that CMC deflects student's attention from the task to the management of communication. (van Boxtel and Veerman 2001) Software with CMC-facilities can have positive learning effects but it seems that these effects could derive from other software features such as diagrams and features of work processes that per se are unrelated to CMC. (Reimann 2000, van Gelder 2000a, van Gelder 2000b)

Our project has not aimed at making any contribution to the kind of studies using CMC. One reason is that much student effort in CMC goes into the management of communication and it is a problem to design software and tasks so as to make students focus on tasks rather than managing the communication channel. Another reason is that Athena development was conducted within

an existing course with real students, taking the course for credits, rather than used with experimental subjects. A third reason is that educational effects are not only hard to measure, it is also difficult to isolate their causes and possible interaction between causes. This is so especially since well-designed software should enable users to perform genuinely new tasks, not merely perform the old tasks better than a control group. Finally, we deemed it essential for transfer effects that the tasks that the students were assigned in the course be similar to tasks they might face in their professional career.

## **THE DEVELOPMENT PROCESS**

### **Phases of development**

#### **Phase 1. The Naessie Applet. The Internet Connection**

In the fall of 1999, four months after the project had started, the first version of the software was tried out in a course of argumentation and negotiation. The program was a Java applet, presented in an Internet browser from a server. This arrangement was due to the fact that it was impossible to obtain permission to install any programs on school computers.

From a user point of view, the Java applet was not an elegant solution. Files were stored on a central server. Users had to be online. Student reception of the program differed between two equally large groups. Those from software engineering were enthusiastic whereas those from business administration were cool. Students used to the conditions of programming accepted the roughness and bugs of the first version; the others did not.

The Internet connection, however, opened another interesting possibility. Why not have the students locate information on the Internet? Why not design tasks for students, making them search for digitally stored information on the Internet emanating from organisations such as those for Catholics against euthanasia or state authorities pronouncing on genetically modified organisms? By searching and copying material from the Internet into Naessie/Athena, the students could build arguments of their own, using large amounts of text.

The initial version of the program allowed for collaborations over the Internet. A structure could be accessed by several users at different locations and times. The program was not fully collaborative in the sense that users working on the same structure would see the changes made by the others - instead a user would simply get a warning when he or she tried to save an argument that had been altered by somebody else in the meantime. This allowed the user to save the work under a new name, and to go back and inspect the changes made by the other person (s). Also the fact that all arguments were stored on a server made it possible for users to inspect different arguments designed by different members of the group.

It turned out, however, that the collaborative options in the program were not really important in the actual educational setting. Instead it turned out that real-life collaboration - i.e. the students (or students and teacher) sitting

together by the same computer - as well as the standardized presentation of arguments were the important key elements. All in all, the type of collaborations that arose could just as well be supported by an ordinary application, where the users could save arguments to files and then send these files to other users. Observation of the way students interacted with the program furthermore made us focus on the importance of copy/paste operations, and the need for multiple editing windows. This allows users to build different parts of an argument tree and paste the parts together.

No version of our program has been truly collaborative in the sense that several users could work on the same argument simultaneously from different PCs. But student user groups spontaneously started working at a distance, building different parts of their arguments. Observing these student innovations made us redesign the program so as to allow several windows and several files to be used simultaneously on one computer. This allows users to build different parts of an argument tree and paste the parts together.

### **Phase 2. The Athena application. The CD prototype**

Athena was rebuilt as an application, to be run from a CD-ROM. Students were given a copy of a CD containing the Athena program, the necessary JAVA package, demonstration files, explanations, instructions and help files. Other course material such as lecture notes in the form of PDF files and HTML were included.

The redesigning of the program aimed at permitting cut, copy and paste functions between windows. Text output was improved in order to enable students to copy text into a word processor for their reports. The possibility of filtering out bad arguments was introduced.

The program was stable. This version has been used in education with minor modifications from the autumn of 2000 to the autumn of 2001.

### **Phase 3. Athena standardized. The EASA version of April 2002**

Now in the spring of 2002, Athena has been rebuilt by a group of programming students at Blekinge Institute of Technology. Managing a larger software project is part of the education these students are receiving. The students defined their requirement specifications on the basis of the Athena Prototype and on a list of user demands formulated by the Athena project. The Athena program in the EASA context is literally written by software engineering students.

User experience and suggestions from the prototype led to some major improvements. First, the EASA version will be a Java application that does not betray its applet origin. Second, more sophisticated printing of graphs, combined with texts has been deemed desirable. The students prefer producing reports from within Athena to copying them from Athena into a word processor.

The latest version of the software differs much from the first. Improvements of the program are based on feedback and evaluations from students, along with observations of their group processes during time in the

computer laboratory with Athena.

Conversely, the program has had considerable impact on methods and working processes for collecting materials, analysing, representing and building arguments. Properties of the program open unexpected possibilities of use to improve tasks and working methods, e.g. those described under the Internet connection.

The initial phases of the design process were highly iterative, and the specialists involved (Bertil Rolf and Charlotte Magnusson) developed a common understanding of the problem. In the later stage, when program implementation was performed by a group of students, this understanding was mediated through a working program. (the Phase 2 version). Also, the person who programmed the early prototypes (Charlotte Magnusson), was present and served in some sense as an interpreter between the programmers and the specialist (Bertil Rolf). Both used the Phase 2 prototype as a requirements specification, and the presence of an interpreter turned out to be of great importance. At a more general level the process can be described in the words of Schön (1991) as reflection in action and reflection on action, where the action in question has been both the interaction between user and software and the programming itself.

### **Project elaboration**

The project has been conducted during three years and a number of discoveries, some possibly known by others, have been made.

During the project, we have come to realize that a sharp distinction needs to be drawn between features that advantageously can be given IT-form and those that cannot. Our tentative conclusion is that the use of IT is mainly restricted to software, allowing student activities that cannot be otherwise performed. But where conventional, non-IT methods can be used to present material, conventional methods are often preferable.

For instance, it was initially assumed that material in HTML-form rather than paper versions would increase student interest and access to the material. This assumption was false. In the choice between HTML hypertexts in which students could navigate and printed texts, students preferred printed texts. Contrary to our expectations, they prefer to meet a material selected and structured by the teacher, presented in conventional form. All HTML-material needs to be supplemented with paper copies for the students. However, teachers can benefit from storing material in \*.pdf-form and students accept that lecture notes are distributed as such.

During the project, the focus has been concentrated on software integrated with course modules. One reason is that design and development of software is time-consuming. Once the software has been developed, it is natural to try to extend its use to other educational modules. A more interesting reason is that the software opens up new ideas for educational use that previously were unthought of. When those educational ideas are implemented, new demands for next generation software arise.

To give an example, the present version of Athena allows users to construct argument trees, to filter away their worst subarguments and to copy branches between windows. This enables users to construct three argument trees: Thesis, Anti-thesis and Synthesis, where the Synthesis is had by filtering, copying and pasting from the Thesis and the Antithesis. This conception was first tested in guest lectures by Bertil Rolf given at the School of Architecture in Oslo. The thesis was “Optimism: Learning from experience is generally possible”, drawing on such notions as “tacit knowledge” (“förtrogenhetskunskap”) or “sensomotor experience”. The thesis was countered by a pessimistic Antithesis based on widely known research findings from cognitive psychology. The two were merged into a Synthesis of balanced pessimism. In a next stage, students at Blekinge Institute of Technology were given a similar task as part of their examination. Their results indicate their difficulties and hence new ideas for software development for support.

During the project, the idea of student participation has been modified. Initially, we were optimistic about the production of a wide range of material by students. It turns out that only a small group of students – less than 20% – seem to be able to make novel contributions to direct educational material with a quality sufficient for use and re-use. Such contributions are used in the course, but generally require teacher elaboration to integrate with the general concepts of the course. Indirectly, however, students contribute to the next generation of software or course modules in that the teacher can observe how and why students do not make optimal use of their knowledge.

An example is that students seem to have difficulties integrating precepts given in oral teaching or in written instructions when working with the software. A key failure in argumentation is that students tend not to make their claims precise, in spite of numerous teacher recommendations. The students themselves are not aware of their recurrent flaws in this respect. The only way to improve on their performance seems to use the software to steer their work process through such elaborations.

During the project, the teacher role has been redefined. Before the project, the teacher role was more that of a lecturer and leader of argumentation games. The introduction of Athena has focused student labor to preparations of tasks, defined by the teacher. An extension of the previous teacher role is that more teacher work has gone into the definition of the tasks, the correction of them and the supervision of students learning Athena tasks in the computer lab. As a consequence, Athena courses should largely be teachable by non-experts in argumentation.

The student roles have shifted away more towards project work preparing and executing argumentation. The value and the burden of good preparations as well as the means for such preparations are a major outcome. This was always emphasized but in practice students seldom fully realized its importance.

During the project, the division of labor between educational and technical development has evolved. Ideally, this process is iterative with a

mutual exchange between technology and education. If education gets too dominating, technology will be used mainly to implement ideas invented independently of new possibilities offered by technology. The resulting software would merely enable users to perform the old tasks in a new way, not open up new tasks. If technical capacities get too dominating, education is reduced to a role of teaching the use of fancy software features. The proper perspective behind an integrated development is to conceive of a number of preferred tasks, functionally defined, and try to conceive of ways in which software plus education would enable users to reach a level of proficiency including capacities for solving those tasks.

This project competence has taken considerable time to evolve. Mere benevolent declarations will not put it into effect, only workable procedures of design and development will. The last phase of the project has opened up this perspective by shifting much of the educational and technical development to other parties. Direct course development now takes place in the Department of Spatial Planning at Blekinge Institute of Technology. The latest version of the software has been built by students of software engineering. The resulting software is now internationally competitive, shown e.g. by the fact that Athena reached the EASA-finals and is beginning to gain international attention. Thus, the project center of Bertil Rolf and Charlotte Magnusson has been freed to dwell more on combined conceptual issues in the light of results achieved.

A kind of metaunderstanding of this kind of project has evolved. This kind of project involves two interacting phases of development, one educational, and one technical. The technical phases are relatively fast and their scheduling is relatively independent of other activities. In contrast, the educational pace of development is slow and has cyclical components, being tied to the recurrence of courses. Normally, the software would have been used only three times, when the course was given in 1999, 2000 and 2001. This pace of development was deemed unacceptably slow. Instead, course modules have been broken out of the original course, developed and transplanted into other courses.

The technical development has seen several versions. We had expected the final version would arise from additions to previous versions, but in reality, there have been both additions and subtractions steered by and coordinated with educational needs drawn from various courses or course modules.

### **Patterns of distribution and future projections**

The software can be freely downloaded from the Athena Website. From May to December 2002, almost 1000 downloads of the software have taken place. There was one peak of downloads in May when the Athena Website and the first public versions were introduced. The EASA contest in November seems to have started a new peak of downloads. Little about these users is known.

Three patterns of controlled distribution have been used. The first copies or transfers elements from some of Bertil Rolf's course modules to others of his course modules. This mode of distribution has been under complete project control and it has been eminently successful. All of Bertil Rolf's courses

now contain some module involving Athena. This is possible for several reasons. First, Athena is quite general. Second, his courses direct themselves to non-philosophers who need training in philosophical proficiency, coupled to the ordinary course content.

The second pattern of distribution has been on collegial basis. Curious and interested colleagues have been using Athena in the development of courses they themselves teach. Such a mode of distribution is, however, highly vulnerable. For instance, when teachers leave the institution or transfer to other courses, Athena is no longer used.

A third institution-based pattern of distribution started in the spring of 2002 as an attempt to introduce Athena into several different courses in the Department of Spatial Planning, Blekinge Institute of Technology. User modules and the examples used in Athena are chosen from spatial planning, e.g. the interpretation of local and central directives underlying development planning and authorization. The structure of Athena is then linked to professional norms of acceptability and relevance. Teachers in spatial planning develop and modify instructions underlying the use of Athena. Students in spatial planning will in the future meet with applications of Athena at various stages in their education. The recurrence of the theme of argumentation and critical thinking will hopefully make a deeper impact than a single course.

Two commercial forms of distribution have been rejected. One possible pattern of distribution would be marketing Athena software packages similar to textbooks. Given the small market for this kind of textbooks, student's cost sensitivity to textbooks and the overwhelming costs for maintaining and updating software, this pattern has been deemed hopeless. In comparison to the enormous amount of give-away or free-to-use educational software, the proportion of packages that have made break-even is hardly distinguishable from zero.

Another possible pattern would be to distribute Athena as part of consultancy services. Such a pattern would rely on a large number of coincidences and therefore highly unreliable unless conducted on a sizeable market with organizations as large sellers and buyers. Even so, most buyers would be unable to distinguish between low cost, low quality packages and high quality, high cost packages. Under such conditions, development costs of Athena would be hard to recoup.

Even though Athena now has a stable form, more or less continuous development would be needed to fit the software to new user groups. The experiences on which Athena is based are still new and few. Increased use will create competent users with increased demands on functionality. The resulting development costs are high.

It is hard to see any other future development than an institution based approach where Athena is seen as a strategic asset. Athena and similar packages could perhaps be made part of a university profile emphasizing software as a way of implementing the traditional tacit knowledge of the elite university in

forms suitable for modern mass education. As such, they could be important for recruiting new groups of students and new groups of teachers.

Projects of Athena's kind are precarious. Their costs per student can almost never be recouped. In the practice of the development of educational software, a major problem is that there are few secondary users. The innovations do not spread beyond the narrow circle of the inventors themselves. Massive investments in technical development are often coupled to hazy notions of educational benefits. (Alexander 2002) As a consequence, major investments in competence and costs are wasted, except possibly as symbols of progress.

One possible explanation for such failures to penetrate into secondary users could be lack of project duration and endurance to implement a promising strategy. This very project is an example. Three years duration of this kind of project is too short to yield any educational results beyond those of the project leader. While its technical development could be driven at a high pace, had it been independent of education, educational development is slow and partly cyclical. It will, perhaps, never be known if or how secondary users could benefit. After having taken almost three years to develop a level of combined educational and technical competence, the project now closes down. Only a fortuitous chance can prevent competence and costs from being dispersed, their preservation being the real responsibility of nobody.

This kind of projects would, if successful, benefit by having two stages. During the first stage, the fundamental ideas could be conceptualized and implemented. If they are deemed sound, a second phase could open up the results for other users, in particular for institutions as stakeholders.

## **THE INSTITUTIONS OF REASONING AND ARGUMENTATION. FROM CRAFTS TO INDUSTRIES**

### **Changing institutional settings of reason**

In the western tradition of learning, reasoning and argumentation are old practices of universities, research and higher education. From its Greek origin, the Western academic tradition was established in the Roman world. The opposition between philosophers and orators, so prominent in Athens, was downplayed by Cicero and Quintilian who wedded Greek speculation to legal and political practice and education to such practice (Kimball 1986). Via monasteries, secular schools and continuous contacts with Islamic scholars, remnants of the antique traditions were preserved in Italy and in Spain. When the medieval universities were founded in Bologna, Paris and Oxford, the antique methods of thought emphasising reason, came to challenge faith. Paris saw the clash between new scholastics under the banners of Pierre Abelard's (1079-1142) *Sic et Non* and the older scholastic tradition where reason was treated as a subservient maiden to faith. The generations following Abelard kept that intellectual and moral tension between faith and reason alive.

This tradition is multifaceted. Reasoning and argumentation have taken various forms, both as to social setting and cognitive content. Some parts have the characteristic of oral contests or duels, e.g. represented by Aristotle's *Topics* or *De sophisti elenchi*. Others are more characterized by the solitary thinker, reconstructing the logical skeleton of a body of thought, e.g. represented by Aristotle's *Prior Analytics* or *Posterior Analytics*.

The basic skills of academic and professional traditions have been maintained through teaching, evaluating and exercising knowledge and judgement. The exercise of reasoning has largely been maintained through tradition rather than taught as the application of a theory. At present, no such all-encompassing theory exists.

In the elite university, this tradition was maintained in small groups and classes, largely selected from students homogenous as to race, class, culture and gender. The tradition was preserved and reproduced largely through selection and implicit cultivation.

Elite universities some 50 years ago enrolled up to 15% of the age group, mass universities 15%-40% and universal higher education more than 40% (Trow 1973, Scott 1995). The almost inevitable results of growth of higher education are large classes, drawn from heterogeneous groups with shifting educational prerequisites. The implicit methods of the elite university for transmitting basic skills of argumentation and reasoning will hardly work in such settings.

In research seminars, where groups are small and homogenous, such methods for transmitting culture can still be maintained. The traditions of argumentation and reasoning would still be preserved, though restricted to a research setting.

However, a withdrawal of reasoning from undergraduate education means giving up the peculiar character of higher education. If higher education is to be "higher", rather than merely "longer" than secondary education, a more advanced stance towards knowledge is a precondition. That cultivation of reasoning and reflection on knowledge is essential to the quality of education has been convincingly argued by Barnett (1990) and Björklund (1996).

When a policy of mass education is decided upon by a political body, we may assume that the goal is to give a larger part of the population such knowledge that before has been associated with higher education. If an expansion of the higher education system leads to the loss of those qualities that makes that education higher, this effect is presumably unintended (if not unforeseeable).

A political body in a democracy will, in fact, have strong motives for traditional skills of reasoning. Skills of reasoning do not grow naturally or through professional experience (Dawes 1988). There is evidence, however, that reasoning skills generalize between domains and that they can be improved through the teaching of the philosophical art of reasoning (Kuhn 1991).

Faced with the problem of opening up to the masses what has previously

been an elite tradition, the educational part of a solution might be to edify traditions of reasoning and argumentation. By edification of an educational tradition, we refer to open standardizations of traditional rules, partly through information and communication technology. Rules previously stored mentally or as social group norms and procedures, can be transferred via software, embedded in course modules.

#### **Reason grown in traditions, cultivated in institutions, implemented in software**

Reasoning is, in Popper's fortunate words, embedded in a *second-order tradition*. In this tradition, he sees the roots of modern science:

My thesis is that what we call 'science' is differentiated from the older myths not by being something distinct from a myth, but by being accompanied by a second-order tradition—that of critically discussing the myth. 'Before, there was only the first-order tradition. A definite story was handed on. Now there was still, of course, a story to be handed on, but with it went something like a silent accompanying text of a second-order character: I hand it on to you, but tell me what you think of it. Think it over. Perhaps you can give us a different story.' This second-order tradition was the critical or argumentative attitude. It was, I believe, a new thing, and it is still the fundamentally important thing about scientific tradition. If we understand that, then we shall have an altogether different attitude towards quite a number of problems of scientific method. We shall understand that, in a certain sense, science is myth making just as religion is. You will say: 'But the scientific myths are so very different from the religious myths.' Certainly they are different. But why are they different? Because if one adopts this critical attitude then one's myths do become different. They change; and they change in the direction of giving a better and better account of the world—of the various things which we can observe. And they also challenge us to observe things which we would never have observed without these theories or myths. (Popper 1963 p.127)

To exercise one's reason is not the same as holding a specific set of first-order beliefs. The skills of reasoning consist of a method for reaching, refuting and suspending lower-order beliefs.

Traditions are systems of rules, rules of conduct and rules of thought. He who masters a tradition, masters rules enabling him to act, speak and think in a manner intelligible to other members of the tradition. Like a language, traditions have a diachronic structure, bridging past and future.

Reasoning skills are largely transmitted through traditions. These traditions were preserved and cultivated, initially among small groups of people. Later they were embedded in the institutions of learned societies and universities. This culture was transmitted through traditional apprenticeship, leading to implicit knowledge exhibited in the skilful performance of a person who exercises reason. In the words of Michael Polanyi:

...the novice accepts apprenticeship to a community which cultivates this lore, appreciates its values and strives to act by its standard. (Polanyi 1957 p. 207)

Traditions, in his view, can be seen as large systems of implicit rules, similar to those behind the exercise of a language. They can sometimes be formulated, although the rules often precede their formulation, just as in a grammar for a natural language.

By articulating such rules of reasoning and by reflecting on them, we can improve the rules. We can standardise new, improved versions of them, and deliver these versions back as new forms in which to cast one's thoughts. Simple rules can be extracted and used to define cognitive and social operations in adversary games. (Rescher 1977).

Edification through technology means that rules, previously internal or implicit, will be represented through external means. The use of software enables a good many activities to shift from inner mental processes to external procedures. Thus, the way they operate becomes easy to inspect, teach and comment on.

Not all aspects of skills can be represented by software today. Social skills cannot be thus represented; neither can lower-level aspects of mimicry or gestures, nor higher-levels of strategic social planning and enactment. We can, however, use games to standardize situations where such skills are exercised and we can partly standardize methods for giving feedback to performers in such games. (cf Argyle 1986)

Previously, it has been possible to preserve traditions through hard artifacts like buildings and physical machines or soft artifacts like language, customs and institutions (Shils 1981, Rolf 1991).

Software presents a new way of doing so. It does so if supplemented with meaningful educational tasks. Some of these can involve the oral exercise of reasoning in the form of games in a social arena. Others can be written tasks of analysis. Argument structures can be communicated in the form of Athena files. We conjecture that an easy way for teachers and students to exchange views about the structure of a piece of reasoning would be to interchange Athena files via e-mail. Reasoning diagrams are more easily inspected than argumentative essays.

Athena software thus opens up not merely a better way of solving the old tasks, but new kinds of tasks as well. What these tasks might be, the authors of this report do not know. The only persons who can provide the answer to that question are innovative researchers, teachers and students of higher education.

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