

Heuristic Simplification of Conceptual Models for Training Planning Students in Negotiation and Argumentation

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Abstract

Educational experiments during 2003-2010 at the Swedish School of Planning, Blekinge Institute of Technology, have developed conceptual models to support apprenticeship among planning students in the skills of negotiation and argumentation. The purpose has been to identify and test adequate degrees of heuristic simplification in conceptual models of professional practice.

Results indicate that considerable heuristic simplification can be achieved and reliably tested within a specific educational context. Simplified conceptual models of negotiation and argumentation tasks which reflect professional practice facilitate learning. They do so by helping students to focus on important dimensions of a professional task, providing feedback on their efforts to practise complex skills and help to interpret teachers' hints and corrections. A multi-criteria model of negotiation in planning has proved to be consistently effective in training professional skills. The simplicity of the negotiation model seems to have been adequate, stimulating student elaboration, which indicates progress in apprenticeship. A model of argumentation, on the other hand, needed further simplification of original assignments and target skills in order to produce satisfactory learning outcomes.

Software has been used in both exercises as a method to operationalise conceptual models. Results indicate that in the negotiation exercise software helps in externalising professional approaches, visualising outcomes, providing immediate feedback and helps to diagnose student errors. In the argumentation exercise software has presented operating difficulties, and may have led to cognitive overload for some students. The introduction of simplified paper forms representing modified assignments and target skills has eventually produced satisfactory learning outcomes in the argumentation exercise.

Conceptual apprenticeship is a term suggested for the training of this type of professional skills.

Keywords: Conceptual Models, Heuristic Simplification, Negotiation, Argumentation

The Basis of Professional Skills – Apprenticeship or Research?

How do planners, engineers and architects acquire their professional skills? A traditional answer is: by apprenticeship, learning from masters. Tasks are presented to beginners, which represent typical difficulties of the profession, but in an elementary form.

Apprenticeship is practised in many fields. A skilled craftsman – a carpenter, a welder – learns rules of thumb, imitates a master, and practises to achieve satisfactory results. Apprenticeship is also common in educated professions, among engineers, architects and medical doctors. The architectural student starts by designing a weekend hut and goes on to more complex design tasks. The engineer calculates appropriate properties of technical components and goes on to develop more complex constructions. The doctor learns how to diagnose common illnesses, and goes on to analyse more complex syndromes. They all need to apply available scientific knowledge as a basis for action. They are dependent also on a professional context: the guidance of more experienced colleagues, who know what scientific knowledge to apply, who can communicate and reflect upon this in a professional discourse, the acquisition of which is part of apprenticeship.

There is a problem, however, with apprenticeship. Professional knowledge is not reliable. Buildings rot, bridges collapse, money is wasted on huge and useless projects, patients die or become worse after medical treatment (Hastie and Dawes, 2001; Flyvbjerg *et al.*, 2003, 1998; Gigerenzer and Todd, 1999; Hall, 1982; Parkin, 2000; Rolf, 2008). Professional decisions are inconsistent, and experts often show unfounded confidence in their judgements (Plous, 1993).

Professions reserve the right to decide the standards of good practice. This can lead to young professionals learning only how to repeat the mistakes of older colleagues. There are also valid reasons for the unreliability of professional judgment, however. Professionals deal with complex, non-deterministic socio-technical systems, where the feedback of actions taken is delayed. This makes it difficult to learn from experience (Rolf, 2008). Social problems in modern housing estates, for example, often take a long time to emerge and are difficult to relate to the design of buildings and urban structure (Öresjö, 2004).

This uncertainty has led to demands for a broader and stronger scientific basis for professional judgment. Britton Harris was a pioneer who in the 1960s developed computer models for use in spatial planning. In his view, goal conflicts, great costs and often irreversible consequences mean that planning decisions should not be left to the judgement of individual professionals, however qualified (Harris, 1997). Formal models, preferably computer models, are needed to verify the consequences of recommended actions. Healey (1997) objects that formal models reflect fixed problem-framings and hinder continuous, mutual learning. They also tend to favour certain types of goals and consequences, which are easier to model in quantitative terms than others.

Recently, the demand for policy based on evidence has revived the debate on what is relevant knowledge for planning (Davoudi, 2006). According to her argument, an *instrumental* interpretation of 'evidence' assumes a too simplistic, linear relationship between

research and policy. This interpretation predictably calls for the development of broad databases, expert systems, and computer models to underpin policy decisions.

Davoudi questions the usefulness of this interpretation of 'evidence'. There are indications that decision-makers do not want more knowledge about issues. It makes decision-making more complicated. A valid reason for this may be that more information could make it more difficult to discover patterns and efficiently frame the problem, (Schön, 1983; Simon, 1997; Rolf, 2008).

Experts are not always impartial but could have self-serving professional agendas. Ideology and vested interests tend to demand knowledge that supports past decisions and may suppress opposing evidence. Davoudi advocates an *enlightenment model*. The purpose of scientific research is rather to 'illuminate the landscape within which policy decisions have to be made' (Davoudi, 2006, p.16).

Heuristics – Simple Tools for a Complex World

So what should young professionals do? They cannot always trust their masters, and there is not sufficient, or sometimes too much scientific, conflicting knowledge, to guide them.

In view of this dilemma, Rolf (2008, p.7) identifies a group of *intermediate* methods for decision-making, between what are called 'strong' and 'weak' methods. 'Strong' methods are used by professionals with expert domain knowledge, who can quickly reduce complexity by identifying relevant features of a problem – apprenticeship, in other words. The problem with these methods is the need to trust professional authority, with risks pointed out above, and difficulties in teaching these methods to beginners. 'Weak' methods are general, based on scientific knowledge. They are valid, open to all, but also difficult for inexperienced professionals to apply to specific cases.

Heuristics is a term to denote *intermediate methods*, relying partly but not completely on domain knowledge. Heuristics elaborates on *representations* in order to support the process of inquiry, to identify patterns, and to connect problem formulation to a final decision (Simon, 1997). 'Thus, heuristic methods are directed at managing processes' (Rolf, 2008, p.6, after Polya, 1957).

The student of architecture is instructed, for example, to make 'design experiments', working in the 'virtual world' of developing two-dimensional representations of three-dimensional designs, formerly on onion-skin paper, nowadays on the computer screen, evaluating the result, learning from it, modifying it in an iterative process that develops simultaneously the understanding of the problem and of the possibilities to solve it (Schön, 1983; Cross, 2006; Lawson, 2006).

Heuristics thus focuses on ways to *conceptualise* and *represent* problems; *conceptual models* could support effective apprenticeship, helping students to think as professionals. The models should be comprehensive enough that they realistically exemplify professional tasks, yet simple enough that they are possible to operate for inexperienced students. But how can they be more precisely defined and tested?

Experiments in Planning Education

Training skills in negotiation and argumentation

Heuristic methods have been developed and tested for a number of years in teaching negotiation and argumentation skills at the Swedish School of Planning, Blekinge Institute of Technology (BTH), with programmes of Spatial Planning and Urban Design at Bachelor and Master levels.

One reason for these experiments has been that teachers at BTH have felt a need to question the naive assumption of many students that spatial planning is mainly creative *urban design*. Teachers have wanted to introduce the professional view that planning is also *conflict*, *negotiation* between different interests and *analysis* of arguments for and against planning proposals (Forester, 1989, 1999; Healey, 1993; Törnqvist, 2006). Planners need the ability to construct and evaluate chains of argument. Some interests are more important than others, because of more valid arguments. Planning tasks are complex, requiring knowledge from many disciplines. Analysing chains of arguments is essential for *conceptual clarification*, reducing both *conceptual* and *epistemic* uncertainty, (Rolf, 2006, 2007a). 'What kind of problem is this, and what do I need to know in order to solve it?'

Negotiation and argumentation skills need both theoretical knowledge and practise. Fisher and Ury (1981) argue the merits of *principled negotiation*, emphasising interests rather than positions. Successful negotiation should aim to invent options for mutual gain, not one-sided 'victories' of one party over the other. This requires insight, conviction and experience.

Likewise, evaluating arguments and successfully using them needs both logical reasoning and debating experience. The theory of argumentation analysis is well developed and has been implemented in methods for teaching elementary reasoning skills, including software tools (Eemeren and Grootendorst, 1992; Scheuer *et al.*, 2010).

Research Question

What is adequate simplification of conceptual models of professional practice in training for negotiation and argumentation skills in spatial planning?

Method

Collins *et al.* (1989) have suggested ways of applying apprenticeship methods to the training of professional skills of this nature. In describing methods of *cognitive apprenticeship* they emphasise the need to teach the *processes* experts use, not only having expert-teachers evaluate and correct the *outcomes* of apprentices' efforts. To do this teachers need to develop and transmit *conceptual models* which help students to make observations of the expert way of solving a problem. Such models help students to organise their attempts to practise the desired skill, and provide an interpretative structure for making sense of coaching: feedback, hints and corrections (Collins *et al.*, 1989, p.456; Bransford *et al.*, 1999). This is how students can move from a 'naïve' level of understanding to become 'novices', able to follow instructions, furthermore to become 'apprentices' relating knowledge to the real

world, discovering new aspects of a problem and becoming aware of different methods to address it (Mansilla and Gardner, 1998).

The educational experiments undertook:

- To develop conceptual models of negotiation and argumentation processes.
- To define criteria of successful negotiation and valid argumentation.
- To measure learning outcomes on the basis of these criteria.
- To modify the degree of simplification of the models according to observed learning outcomes.

Collins *et al.* (1989) in their early paper foresaw that the core techniques of *modelling* and *coaching* could be formalised in computer software, suggesting that it could make a previously limited style of learning cost effective and widely available (p.491).

Software has been tested in the educational experiments as a way to operationalise the conceptual models, for the following reasons, suggested by Rolf (2008).

- Standardising the presentation and operation of the conceptual model through software is assumed to facilitate evaluation and comparison of learning outcomes in different groups of students.
- Standardisation is assumed to make it easier to calibrate the degree of simplification tested in the experiments.
- Software is assumed to facilitate learning by providing immediate feedback of student attempts to practise a complex skill.

Conceptual Models in Negotiation and Argumentation Exercises

A *conceptual model* is used here to mean the description of a planning situation in which professional skills are to be trained. It necessarily represents a simplification of a real planning situation. The numbers of actors and stakeholders are limited, the numbers of planning issues, subject to negotiation and argumentation, are limited.

The *assignment* is the task set for students within this conceptual model: for example, to negotiate an outcome which the negotiating parties can accept, to organise and evaluate arguments in a planning case.

Target skills are the skills the assignment intends to develop with the help of instructions and tools. The target skill can be to defeat an opponent in negotiation, maximising gain at his/her expense, or to find negotiation outcomes for maximum mutual gain. The skill can be to organise and evaluate all presented arguments in a logically consistent way, or to identify only the strongest arguments and present them in support of a decision. *Criteria* for measuring *learning outcomes* vary with the assignments and the target skills defined in the various experiments and will be detailed below.

Instructions are written and oral information which describe the conceptual model, the assignment and provide guidelines, coaching, feedback, advice and corrections in teachers' interaction with students.

Tools are software and paper forms providing forms of representation, both of the conceptual model, and for the presentation of student results.

Heuristic simplification is applied in describing the conceptual model, the assignment, the target skill and tools.

The Negotiation Exercise

The *conceptual model* in this exercise was a planning situation where a private property developer would negotiate with municipal planners on the terms of developing a central piece of land: a former hospital with a surrounding park.¹ According to the model, preliminary discussions had resulted in agreement that the parties would meet to negotiate on four parameters:

land use, with the alternatives housing, offices, park, or a mix

plot ratio, gross floor area/land area of the site

land rent, to be paid by the developer to the municipality

start date

Data collection

The negotiation exercise has been carried out each year during 2006-10 among some fifty fourth year students.

The class has been divided into teams of three or four students, half of the teams representing planners and the others the developer. They received written *instructions*, including the weights for each parameter and utilities for each value. For example, the planners would have a weight of 60% on land use, and a utility of '100' for a mix of housing and offices. The developer would have a weight of 80% for this parameter and a utility of '60' for this mix. The *assignment* was to find out how each party could make gains of utility, while making limited concessions. The conceptual model and the assignment have been the same, but the weights and utilities of negotiation parameters given to the teams have varied over the years, as well as between negotiation rounds each year. Negotiation outcomes of previous years consequently cannot influence student results, only the target skill to find the combined maximum gain with current weights and utilities.

After negotiation the teams reported the mutually agreed values for each parameter. The teacher fed this data into a software *tool*: [Athena Negotiator](#) software which is based on a mathematical model for multi-criteria decision analysis, calculating the maximum combined gain possible with given weights and utilities for each party (Raiffa *et al.*, 2002).

¹ The original model was developed by Göran Cars at The School of Architecture and the Built Environment, KTH (Royal Institute of Technology), Stockholm.

On the computer screen the students could immediately see how close to this optimum outcome they had come. In the first round, several teams failed to reach their maximum gain, realising that they had given unnecessary concessions to the other party. In the second round, teams switched roles, and in that way learned of the priorities of the other party. In a third round, students were allowed to set their own weights; this was in response to a suggestion from students one year.

Results of the negotiation exercise

Students have shown consistent improvement of negotiation outcomes in these experiments. After three rounds they have approached the maximum mutual gain, moving their results toward the top right corner of the diagram showing possible outcomes. This is how the improvement of learning outcome was evaluated (see Figure 1).

Earlier negotiation outcomes closer to origo showed suboptimal gains for each party; results close to either the y- or the x-axis revealing gains for one party at the expense of the other.

In evaluation students indicated that they quickly learned how to exploit the different priorities of each team, but complained that negotiation involved too much calculation. They wanted to make better use of their persuasive and creative skills! The teacher explained that in real negotiations there would be plenty of opportunities for this, both before and after the simplified and tightly structured negotiation practised in this exercise. There would be discussion, for example, about which parameters should be subject to negotiation. Planners would argue with councillors before negotiation about possible land-use and plot ratios, presenting creative designs that combined high plot ratio and land rent with attractive housing qualities, setting the utilities accordingly. After agreement on land rent the developer, on the other hand, could suggest payment in kind, like financing extra landscaping.

Student evaluations of this exercise consistently have been very positive. In contacts with students at other Swedish schools of architecture, BTH planning students have suggested that this kind of negotiation exercise should be included in the curriculum of other schools.

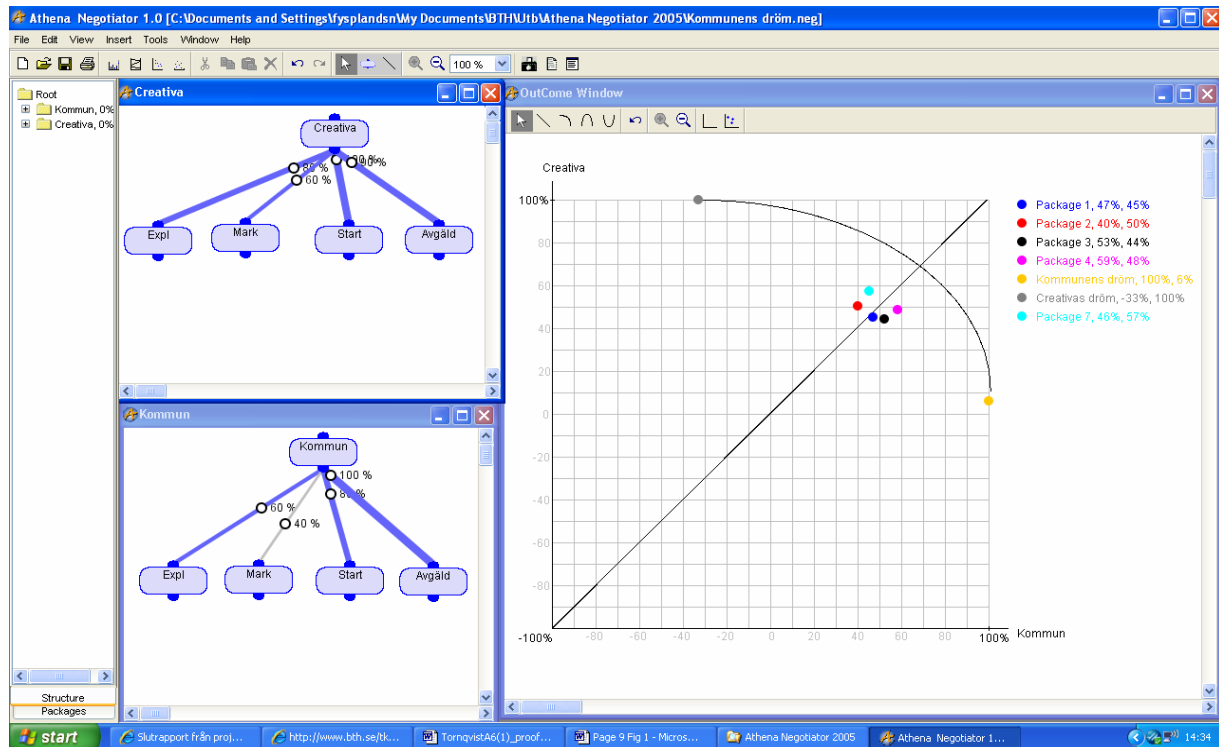


Figure 1 Athena Negotiator software showing parameter weights of each party (left) and negotiation outcomes after three rounds (right)

The outcomes of all teams are now concentrated in the top right corner, close to the position of maximum mutual gains, as calculated from the priorities of the negotiating parties: developers and planners.

The Argumentation Exercise

The conceptual model in this exercise was based on a complex planning case that had been appealed at all administrative and judicial levels and finally decided by the Swedish government. The documentation of the case was provided by the National Board of Housing, Building and Planning, in a report on how the planning system handled conflicts concerning workplaces (Boverket, 1995).

Municipal planners in this case had proposed a plan allowing for densification of an old housing estate, originally built at the end of the 19th century for workers at the adjacent steel plant, still in operation. The buildings had been modernised, but the housing estate was still considered uniquely preserved and a valuable part of the industrial heritage.

The rationale for densification was the need to finance renewed technical infrastructure and to provide a broader population base for social and commercial services. There was pollution in the form of dust and noise from the steel plant, occasionally exceeding national norms. The current plan had provided for these health hazards by restricting new development to areas farthest away from the plant. A court order had also required the plant to eliminate dust emissions by encapsulating certain industrial processes within three years. The National Heritage Board considered that new development according to the plan was possible without impairing the cultural heritage qualities of the estate.

In preparation teachers extracted twelve arguments presented by stakeholders and authorities during the long planning process, as documented in the report (Boverket, 1995). The conceptual model of the exercise proposed that the student would play the role of an expert civil servant at national government level, weigh the evidence, and recommend a decision to the Minister of the Environment.

Data collection

The *assignment* for the students then was to structure and evaluate the list of arguments, initially with the help of [Athena Standard](#) software, specially developed for argumentation analysis (Scheuer *et al.*, 2010). The software made it possible to visualise and describe arguments in a diagram, to set numerical values on their acceptability and relevance and to connect them with other arguments in pro- or con-relations (see Figure 2). The software also made it possible to filter out the weakest arguments (the strength based on the product of values of acceptability and relevance). In that way the students could verify whether their evaluations of single arguments supported their main thesis – a decision for or against approving the plan for densification.

Instructions included a list of guidelines for applying numerical values of *acceptability* and *relevance* to arguments. This list was set up as a result of discussions with professional planners with experience of planning at the municipal, as well as regional and national levels.

It was agreed that *relevance* should primarily be related to legal rights and obligations of authorities and stakeholders to take part in the planning process. The arguments of neighbouring landowners, the County Administrative Board, expert government agencies, like the Swedish Environmental Protection Agency, consequently would have high relevance. *Acceptability* on the other hand would depend on the factual basis for their arguments. Arguments referring to measurements of noise levels as compared to national norms would have high acceptability, for example, whereas mere opinion on environmental disturbance or quality would have less acceptability.

After some introductory experimentation, the conceptual model including twelve presented arguments, and the guidelines for evaluating acceptability and relevance have been constant for the last five years (2006-10). Different tools have been used: the Athena Standard software, Mind Manager software and simplified paper forms (see Appendix A for an example of a simplified form used during 2008-10). The learning outcomes of the experiments can be studied in Figure 2 and Table 1.

Table 1 Argumentation Exercise, Experiments 2006-10

Year	2006	2007	2008	2009	2010
No of students	49	47	54	27	54
Tools	Students first make an individual evaluation of arguments on a paper form. Then groups of 3-4 students make the same evaluation with Athena Std.	Students work in parallel groups with Athena Std, Mind Manager and a paper form.	Students work in parallel groups with Athena Std, and two paper forms, one simplified.	All students work with the simplified paper form.	All students work with the simplified paper form.
Errors in student presentations	B1: 52% A: 31%	A: 57% B1: 56% MM: 60%	A: 33% B1: 33% B2: 17%	B2: 19%	B2: 22%

A = Groups using Athena Standard software.

B1 = Groups using a paper form with list of arguments and instruction to value each arguments according to acceptability and relevance and recommending a decision.

B2 = Groups using a simplified paper form with list of arguments and instruction to indicate the three or four strongest and weakest arguments and explaining their recommended decision.

MM = Groups using the general purpose visualisation software Mind Manager and recommending a decision.

Errors are of two kinds

1. Pro-con errors. Athena Standard software requires that the pro-con relation refers to the nearest argument above in the tree, not to the main thesis, which many students assumed. When filtering out the weakest arguments, this may lead to the result that the student's strongest arguments do not support the main thesis and the recommended decision. If the student doesn't realise this, it is considered a thinking error.

2. Logical errors. For example: two arguments are connected, which seem to have no logical or factual relation; or one argument is presented as support for two opposing arguments. A strong counter-argument obviously weakens the first presented argument. If acceptability and relevance values of the first argument are not then adjusted, it is a logical error. Logical errors can occur when using other tools than Athena Standard. The figures indicate the percentage of students with one or more of these errors.

Results of the argumentation exercise

Students have had difficulties using Athena Standard software to structure and evaluate arguments in the planning case. Some students were able to build clear argument trees, identifying chains of arguments, gaining insight in the planning process, detecting weaknesses in arguments and the need for additional evidence. Many students seemed confused, however, by the assignment to build argument trees, and revealed thinking errors. Some errors may have been due to insufficient understanding of the requirements of the software, primarily that pro- and con-relations should be related to the argument immediately above in the argument chain, not to the main thesis (see note in Table 1).

Other errors seemed more fundamental, like connecting arguments that seemed to have no logical or factual relationship, or marshalling one argument in support of two opposing arguments. Several students also failed to understand that strong counter-arguments

weakened the acceptability of other related arguments, which led to inconsistency and insufficiently founded recommendations for a decision on the case.

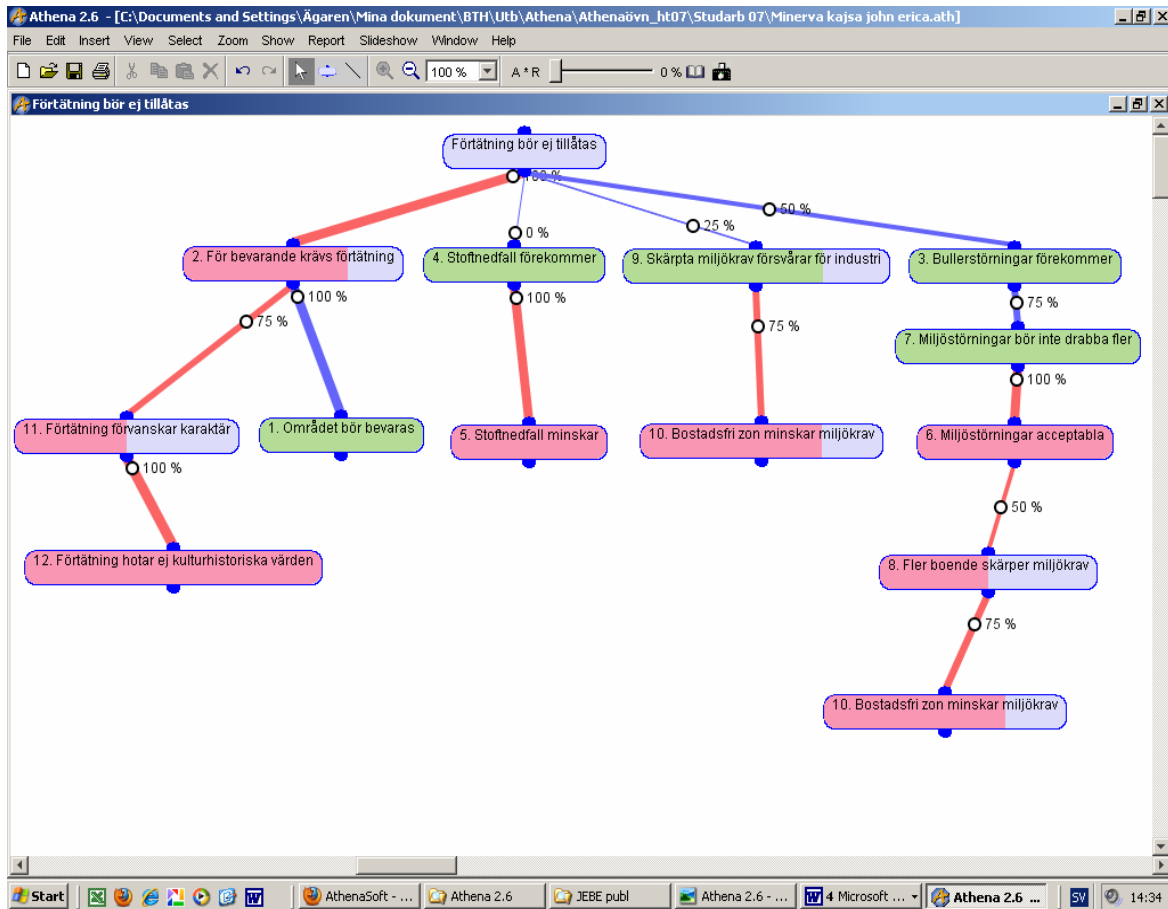


Figure 2 Example of argument tree in Athena Standard

Fully green-coloured nodes signify highly acceptable pro-arguments. Red nodes signify counterarguments. The width of connecting lines indicates the relevance of the argument to the argument immediately above. Filtering out the weakest arguments shows if the main thesis on top receives support or not. In this tree, strong counterarguments lead to defeat of the thesis that densification should not be allowed.

The software diagrams produced by the students in earlier experiments made it easy for teachers to discover errors and indicate corrections.

Usually a majority of the students came to the same conclusion as the government in the actual planning case, on which the conceptual model was based. This was revealed to students after the exercise and discussed in evaluation. The students and teachers agreed that this fact as such was not decisive when evaluating the student results and learning outcomes. The government and government agencies cannot be assumed always to make acceptable and relevant evaluations of arguments.

It should be noted that the conceptual model gave room for slightly different evaluations of the arguments. Some students did differ with the government decision on the basis of good, consistent arguments, which was the main criterion. On the other hand, it should be

recognised that civil servants at this level are usually well educated and have long experience in weighing evidence in their professional field. The general conformity with the government decision could be seen, therefore, as small corroboration of the soundness of reasoning among most students.

Student evaluations of using Athena Standard software in this exercise generally have been negative, however.

The software operating difficulties led in the following years to the introduction of paper forms, where students were asked to make the same evaluation of arguments, but without having to build visual argument trees with the help of software. The results were inconclusive. Significant thinking errors were found in all groups, whether using software or paper forms in the year of 2007 (see Table 1).

In 2008 a radically simplified paper form was introduced. Students in one group were only asked to indicate the strongest arguments, without rating their acceptability or relevance, and to recommend a decision. The low rate of thinking errors observed in this group led to the experiment in the final years 2009-10, that all students would use only this simplified form, and in addition explain their way of thinking when evaluating the arguments and recommending a decision. This experiment was partly intended to serve as a base-line indication. How would students reason in a planning case, with a minimum of instruction and tools to help them to structure and evaluate the arguments?

The result was unexpected. The rate of thinking errors, when using this simplified form was almost the lowest among student presentations during the whole testing period (Table 1, 2009-10). When describing their thinking process, a strong majority of students demonstrated consistency in evaluating arguments, relating them to a clear hierarchy of values, e.g. that concerns of health and protection of the environment were more important than economic interests. Professional expertise was considered more credible than expression of partial interests. A majority of students identified at least two levels of arguments, realising that a strong counter-argument weakened the strength of a previously presented argument. For example, dust pollution at the housing estate would be substantially reduced in three years as a result of the court order, strengthening the argument for densification.

A majority of students also claimed inconsistency in arguments of the Swedish Environmental Protection Agency on the case. The agency argued that existing levels of pollution were acceptable, but still disapproved of densification if more people would be exposed to pollution. Students argued that if pollution was acceptable for some people, then it should be acceptable for all and vice versa.

Discussion

Consistently satisfactory learning outcomes in the **negotiation exercise** seem to verify the usefulness of a conceptual model, which although simple, reflects a complex professional context, and stimulates student elaboration. The simplification, of course, consists in including only four negotiation parameters and providing numerical weights and utilities for

these parameters and their values. This makes the conceptual model an easily operated, predictable system, which in combination with immediate feedback, facilitates learning according to several studies (Rolf, 2006). The fact that this feedback has been visual as well as numeric and verbal may also have contributed (Tufte, 1983). Students experienced no operating difficulties in this exercise since it was the teacher who fed the data into the software model.

That the conceptual model was adequately simple was supported by the fact that students quickly suggested elaborations, such as varying the weights of the parameters according to personal preferences. They also asked for the opportunity to develop their persuasive and creativity skills further, for example, as teachers suggested, by introducing additional parameters in the model. This appears to confirm their progress in apprenticeship, learning to question presented methods and making them a basis for further improvement (Collins *et al.*, 1989; Mansilla and Gardner, 1998).

The improved learning outcomes also give support to common principles of negotiation, claiming that increased understanding of the interests and priorities of one's opponent, as well as of one's own, facilitates mutually satisfactory outcomes (Fisher and Ury, 1981).

The learning outcomes of the **argumentation exercise** have been more varied and give rise to questions concerning the stability of the educational context, the adequacy of the conceptual model, definitions of target skills, forms of representation and effects of features of software and other tools.

The educational context seems to have been stable during the test-period of five years. The conceptual model and the teachers have been the same. The motivation and the ability of the students may have varied, however, as well as the amount of teacher instruction and student interaction. The improvement of learning outcomes in 2006, when students first individually used a simple paper form, and then in groups used the Athena software to model chains of argument, may have been a result of several factors: practise by repeating the exercise, group interaction and intensified teacher instruction in using the software.

There has been stable recruitment of students over the years to the Master's programme of Spatial Planning, with no difficulty to fill the quota, but no obviously sharpened competition, which could have increased the number of students with better scholastic merits and potentially better reasoning skills.

The experiment in 2009 gave an opportunity to test for possible variations of student ability. The results of the argumentation exercise were matched with evaluation from teachers in other courses of the ability and dedication of students in the class. Several students who were considered poor performers by other teachers, nevertheless did well in the argumentation exercise. The few students demonstrating weak reasoning skills in this exercise also were poor performers according to this evaluation. The conclusion is that the possibility of higher student ability does not explain the improved learning outcomes in later experiments.

Another factor to have influenced the improved outcomes with the simple paper form in 2009 and 2010 could be better understanding of the planning process by students. In earlier experiments teachers noted that difficulties in organising arguments in graphically clear argument trees could stem perhaps from insufficient knowledge of the Swedish planning process, where planning proposals are subjected to several reviews and appeals in a complex system. After only one year of study this could be understandable.

In 2009 the coaching of students indicated to teachers that many students now seemed to have a better grasp of the planning process. An observed high level of student interaction in the studios this year could explain this. It could also be due to improved teaching in other courses during the first year. This, of course, would be difficult, although desirable to verify. In conclusion, there is not sufficient evidence that possibly better understanding of the planning process could explain improved learning outcomes.

The difficulty some students had in understanding and using the Athena software is in line with the suggestion by Scheuer *et al.* (2010) that using software to model argumentation may lead to cognitive overload. The BTH teachers considered the Athena software easy to use, practically self-instructive. The planning students could also be considered proficient in using GIS-, CAD- and other software, taught in other courses of the programme. Nevertheless, several students had difficulties as mentioned in using Athena for structuring and evaluating the listed arguments. The satisfying outcome of using a simplified paper form in the latest years seems to support the notion that the software was unnecessarily demanding and contributed to cognitive overload for some students.

The observation that some students using the graphic possibilities of Athena software developed a deeper understanding of the planning issues and the nature of the evidence seems to match the results of Suthers and Hundhausen (2003). They compared student groups using a *graph* representation with *matrix* and *text* representations of issues and arguments. They found that while matrix users represented and discussed a greater number of evidential relations, graph users may have been more focused in their consideration of the relevance and acceptability of the evidence. But this could be mere coincidence and one must agree with Rolf (2007b) that educational contexts are so different when testing software and other tools for training reasoning skills, that one should assume no clear relation between features of such tools and learning outcomes. Eliminating software operating difficulties may have contributed to improved learning outcomes with simplified paper forms but cannot fully explain them.

Another explaining factor may be the fact that the simplified paper form also represented a modification of both the target skill and the assignment. In the latest experiment students were not asked to organise and evaluate the complete provided list of arguments, but to indicate only the three or four strongest and the three or four weakest arguments and to use this evaluation as the basis for a decision.

In view of the discussion above, there are reasons to believe that this simplification may have been the decisive factor. Studies of practical decision-making indicate that decisions are usually made on the basis of a few factors and arguments only (Davoudi, 2006). Rolf (2007b)

cites evidence that natural ability to identify and evaluate long chains of argument is indeed not common. Developing this ability normally requires long and specialised training, for example in the fields of philosophy, natural science and law.

For planning students the relevant target skill may be that they show an ability to evaluate consistently a limited number of arguments and express their reasons for the selection and the evaluation of these. The latest educational experiments confirm that this is what students manage to do, when presented with a sufficiently simplified conceptual model and assignment.

Distinguishing between the *acceptability* and the *relevance* of an argument seems fundamental in argumentation analysis. Nevertheless, several students in the earlier exercises neglected instructions to evaluate arguments in these terms and to build argument trees with Athena software accordingly. Even when they did, many failed to draw the proper conclusions, for example, that a highly acceptable counterargument should weaken the acceptability of related arguments.

In line with this was the observation that hardly any students, when explaining their thinking in evaluating arguments on the simplified paper form used during 2009 and 2010, explicitly mentioned either *acceptability* or *relevance*. One could, however, identify an implicit evaluation of arguments in these terms. Most students, when explaining their reasoning, declared that they gave stronger weight to arguments presented by expert government agencies, than to arguments from private interests, like an industrial company or neighbours. From their formulations it seemed that the reason for this was both an assumed higher degree of expertise (acceptability) and a higher degree of impartiality (influencing both acceptability and relevance). Whether this confidence by planning students in government authorities is well-founded is one thing. It could reflect an early developed professional bias. After all, government agencies could be future employers.

What is important is whether this way to evaluate arguments is logically consistent, which it is. Consequently, simplification in this respect, not distinguishing between acceptability and relevance, does not seem to weaken learning outcomes in view of the modified target skill.

Conclusions

Simplified conceptual models facilitate learning and support apprenticeship in learning professional skills. They do so by helping students to focus on important dimensions of a professional task, providing feedback of their efforts to practise complex skills and help to interpret teachers' hints and corrections. Results indicate that heuristic simplification can be carried far and reliably tested within a specific educational context. The models should be comprehensive enough that they realistically illustrate professional tasks, yet simple enough that they are possible for inexperienced students to operate. Measurably improved learning outcomes can be related to a defined degree of simplification of the models, tested in repeated educational experiments.

The advantage of using software to represent and operate conceptual models needs to be balanced against operating difficulties. Software helps teachers to identify thinking errors and

indicate corrections. A few students each year were able with the help of software to demonstrate a high level of understanding and to discuss planning problems at a professional level. Operating difficulties for other students motivated further simplification of the assignment, target skills and tools. Learning outcomes at this level were eventually satisfactory, but opportunity for a professional dialogue between teachers and students may have been reduced.

Using software to visualise negotiation outcomes has consistently improved **negotiation skills**. The results confirm findings in other cognitive studies that exercises providing immediate and predictable feedback facilitate learning. Switching roles and clarifying personal preferences are also helpful in negotiation exercises.

The results of the **argumentation exercise** underline the importance of defining the target skill. After evaluation the target skill was modified, also resulting in improved learning outcomes.

An interpretation of this result is that perhaps it is not necessary for planning students to achieve the ability of court lawyers to structure and evaluate complete chains of arguments. It could be sufficient that they identify the strongest and weakest arguments in a case, that they are able to discern at least two levels of arguments and counterarguments, to discover fuzziness in arguments of stakeholders, and to make consistent evaluations of arguments leading to a reasonable and transparent decision. This was what a majority of students managed to do, in final experiments documenting a minimum of thinking errors.

The *negotiation exercise* has indicated that heuristic simplification may have been carried too far, therefore spurring students to suggest elaborations of the *assignment*.

The effects of modification of the *argumentation exercise*, in a complementary way, have demonstrated that the complexity may initially have been too great. Successive heuristic simplification of the *assignment*, *target skills* and *tools*, consequently have led to improved learning outcomes.

Conceptual apprenticeship is a term suggested for the training of this type of professional skills.

There are indications from the experiments that it may be more difficult to structure and visualise arguments of others than to list arguments to support a thesis of one's own. Further studies should test this, instructing students to identify on their own, arguments from planning documentation, and to structure and evaluate these arguments with the help of different tools, software and others.

Acknowledgement

This paper is based on research by Bertil Rolf, School of Management, and Anders Törnqvist, Spatial Planning, Blekinge Institute of Technology. Recently the research has been financed by a grant from the Swedish Environmental Protection Agency (Naturvårdsverket) to Rolf and Törnqvist: *Tools for Reasonable Deliberation*.

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Appendix A

Form B2 in the Argumentation exercise

(Used 2008-10, see Table 1)

Name: _____ Email: _____

Evaluation of arguments in the Minerva planning case

A number of arguments have been presented during the long process of reviewing the plan for densification of the Minerva housing estate. Your assignment is to evaluate and weigh these arguments and recommend a final decision. You shall also present the reasoning behind your evaluation and recommendation, for the benefit of stakeholders whose interests and comments could not be fully accommodated.

My recommendation:

The Minerva estate can be densified according to the plan YES____NO____

My reasons:

The following three or four arguments are the strongest ones in support of my recommendation:

Arg no Comment:

The following three or four arguments are the weakest ones and can be disregarded

Arg no Comment:

Presented arguments:

- 1. The Minerva housing estate has cultural heritage qualities and should be preserved according to the Swedish National Heritage Board.**
- 2. Preservation requires increased number of residents to finance necessary renewal of technical infrastructure.**
- 3. The estate is exposed to industrial noise which occasionally exceeds acceptable levels established by the Swedish Environmental Court.**
- 4. The estate is exposed to dust pollution which occasionally exceeds acceptable levels established by the Swedish Environmental Protection Agency.**
- 5. According to a ruling by the Swedish Environmental Court, parts of the industrial process must be encapsulated within three years to reduce dust pollution.**
- 6. Current environmental pollution in the form of noise and dust are acceptable according to the Swedish Environmental Protection Agency.**
- 7. An increased number of residents should not be exposed to current levels of environmental pollution according to the Swedish Environmental Protection Agency.**
- 8. An increased number of residents could lead to further complaints and requirements for reduced environmental pollution.**
- 9. Requirements for reduced environmental pollution could lead to difficulties and increased costs for the industrial company.**
- 10. A no-development zone closest to the industrial plant will reduce the number of residents exposed to environmental pollution.**
- 11. The local residents' association claims that densification will impair the cultural heritage qualities of the estate.**
- 12. The Swedish National Heritage Board considers that densification according to the plan will not impair the cultural heritage qualities of the estate.**

Describe your way of thinking when you evaluated these arguments!