

Computer-Supported Argumentative Writer

**An authoring tool with built-in scaffolding and self-regulation for
novice writers of argumentative texts**

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by

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1. Introduction

Argumentative writing is a valued genre in a range of disciplines and curricula because it requires that writers develop relationships between ideas and build a deep and multifaceted understanding of the topic. Due to the multifaceted demands, and inherent structure and conventions of argumentative writing, it is also among the most difficult to master. The aim of this thesis is to create a prototype of an authoring tool that can help novices (13-19 years old) of argumentative essay writing construct better arguments and improve the overall structure and linearization of their texts. Embedded within this goal is the attempt to provide a framework representative of an argumentative essay, and a derivative application that reflects current theories and practices in the instruction of argumentative writing within a user-centred design.

The research and development of the C-SAW prototype used design-based research, systems design and user-centred design approaches executed in a series of three phases that involved (1) looking at theoretical models of writing processes, (2) research on writing instruction and supports, (3) interviews and usability tests with teachers and students, and (4) user needs analysis and modifications based on the preceding items, prior to the start of the each phase.

C-SAW is not designed to be auto-didactic. It is intended for use within a classroom setting and is a tool to be used to support lesson plans involving the composition of argumentative essays. The design of C-SAW investigated and implemented scaffolding and self-regulatory approaches to help novices of argumentative writing to:

- Focus and reflect on the construction of sound arguments
- By imitation learn to imitate the structure once the tool is no longer there
- Review and revise their texts
- Receive visual feedback on their progress

All argumentation consists of a similar set of dimensions: *object* (topic of debate), *reasoning*, *medium* (written, oral, pictorial, etc.), *activity* (social situation, cscl, individual, tutored, etc), and a *goal* (global purpose) (Andriessen, Baker & Suthers, 2003). This project focuses on the middle three dimensions, leaving the object and global goal to be defined within individual lesson plans.

In researching and developing the XML-based framework ArgEssML (Argumentative Essay Markup Language) and the C-SAW (Computer-Supported Argumentative Writer) application, the main aims were to explore the considerations and approaches that should be used in the design of a computer-supported authoring tool to help novices improve the structure and quality of their argumentation as well as the global structure and linearization of their texts. The intention was to provide a tool ready for experimentation, rather than a tool ready for use within a classroom setting.

2. Research approaches in the design of instructional technologies

The needs of research on the design of instructional technology can be fully answered by neither scientific methods that focus on narrow research questions and isolated variables, nor by technology design methods that focus on the how the system can meet the technical requirements of the tasks that need to be supported by the system. These two approaches leave a huge gap where the requirements and effects of the context, the users, and the variables entailed within the situation must be considered. Research approaches to the design of instructional technologies have been proposed to take these into account. Three somewhat similar and overlapping approaches will be discussed.

2.1. USER-CENTERED DESIGN

Evolving from the need to address issues arising from Human-Computer Interaction (HCI): the study of “phenomena that surround” “the design, evaluation and implementation of interactive computing systems for human use” (Hewett et al., 1992, p.5), *user-centred design* uses ethnographic and qualitative research methods to gather information on user-needs and requirements within the design of a system, in order to meet them. User-centred design uses real users in real contexts as active participants in the design, development and testing processes of an end product. User-centred design has been widely applied in the development of commercial and business applications and has gained attention and become an integral part of design-based research methods applied to the development of instructional technologies.

2.2. SYSTEMS DESIGN

Systems design, similar to user-centred design and design-based, research uses sociotechnical systems theory that considers a *system* as a technology that is inseparable from the user and the context. A systems design approach relies on “user participation throughout the development process” and an “analysis of all stakeholders” during the design of the interface and functionality of a technological tool and on sociotechnical systems theory to analyse the effectiveness of a system in achieving its organization goals, while finding the right balance between *control* (imposition of rules and structures) and *enhancement* (facilitation of autonomy) factors (Dillon & Morris, 1996, p.16-17).

2.3. DESIGN-BASED RESEARCH

Debate among some Instructional Technology researchers on the value of basic (fundamental) research vs. applied (contextually driven problem-solving) research has lead to the endorsement of design-based research as a research approach to answer critical questions on how to best resolve specific problems in instructional technology (Reeves, 2000). Also referred to as *development research*, *design experiments*, and *formative research* among others, (van den Akker, 1999, p.3) design-based research is characterized by Collins (1992) (in Reeves, 2000, p.8-9) as:

- addressing complex problems in real contexts in collaboration with practitioners,
- integrating known and hypothetical design principles with technological affordances to render plausible solutions to these complex problems, and
- conducting rigorous and reflective inquiry to test and refine innovative learning environments, as well as to define new design principles.

Design-based research is shaped by specific development goals:

Researchers with development goals are focused on the dual objectives of developing creative approaches to solving human teaching, learning, and performance problems while at the same time constructing a body of design principles that can guide future development efforts (Reeves, 2000, p. 7).

The design-based research seeks to answer whether the development of a 'product' *may* present solutions to a practical problem or alter an existing problematic practice, rather than testing the application of a particular theory (van den Akker, 1999).

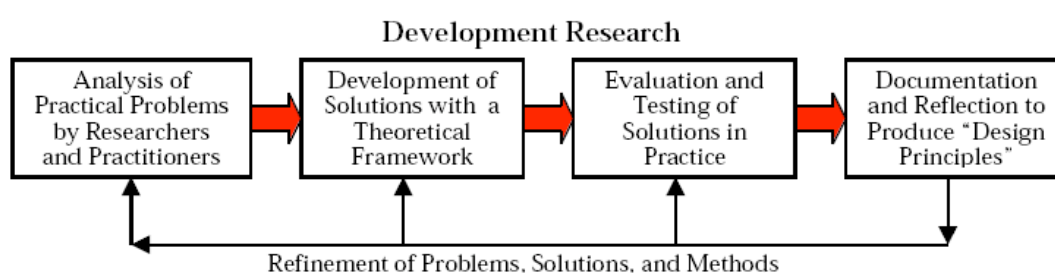


Fig. 2-1 Development approach to IT research (from Reeves, 2000, p. 9)

A comparison of some design-based research methods reveal certain common processes. Collins & Brown's (in Collins, 2004) approach to design-based research is to provide an extensive proposition of strategies and considerations to guide design research phases (iterated processes) rather than stages (consecutive processes), but the essential processes including *analysis of an existing problem*, *construction of a theoretical framework*, *testing* and *reporting* are present in van den Akker's (1999), Collins' (2004), and Reeves' (2000) suggested approaches. It is the emphasis and positioning of the design modifications that appears to vary. Van den Akker and Reeves do not specify explicitly at which point in the iteration of the process the design should be modified. Collins specifies that modifications can occur at any point but each modification begins a new iteration of the process (Collins, 2004, p.33).

Elements from all three approaches to the design of a technological tool can be found in the design processes used in the development of C-SAW. This is discussed further in sections 6 and 8.1.

3. Background: theoretical models and research on argumentation and argumentative writing

In a design-based research approach to development one goal is to provide a theoretical foundation upon which future similar development efforts can build. One key element of such a foundation is a careful consideration of existing research and theories that can inspire or influence design decisions.

3.1. ARGUMENTATION

It would be amiss to propose any possible fundamental framework for argumentative writing without examining the long history of argumentation theory and practice. The two most popular models of argumentation were examined for similarities and guidance in the development of the ontological framework of C-SAW's argument model as represented in ArgEssML.

3.1.1. Models of argumentation and reasoning

ARISTOTLE

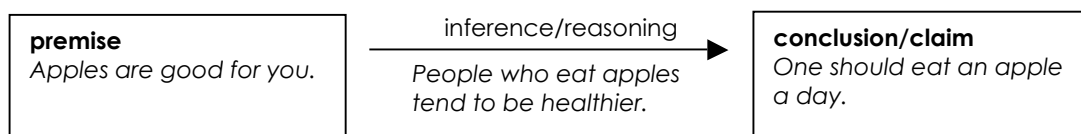
Argumentation as a discipline and arguments as the building blocks of persuasive discourse has its roots in Aristotelian logic. Aristotle's syllogisms form the basis of many argument models developed in the western tradition (Warnick, 1989, p.99). A syllogism takes on the form of

major premise - a general statement that is presumed true: *Apples are fruits.*

minor premise - a specific statement that may need evidence: *Fruits are good for you.*

conclusion - a reasoned outcome based on the two premises: *Apples are good for you.*

A basic argument that aims to persuade, includes premises and a conclusion. To link the premise and the conclusion or *claim*, an *inference* must be made, usually put forth in the form of *evidence* to support or prove the conclusion.



TOULMIN MODEL

Stephen Toulmin (1964) proposed the model that is widely accepted as more descriptive of argumentation in a wide variety of contexts. The Toulmin model contains six parts.

The *warrant*, *data* and *claim* are the backbone of the argument (comparable to the premise, inference, conclusion respectively), with the *qualifier*, *backing* and *rebuttal* acting to validate and solidify an argument.

Claim: the statement the arguer wishes to have accepted or to prove.

Data: evidence to support the claim.

Warrant: connects the data to the claim. This is the reasoning upon which the data relies.
This connection may be implicit or made explicit.

Backing: further supports the *warrant*. This is not always included or made explicit.

Qualifier: defines the importance or the extent of certainty of the claim.

Reservation (Rebuttal): may anticipate a counter-argument or prescribe circumstances that may allow for exceptions.

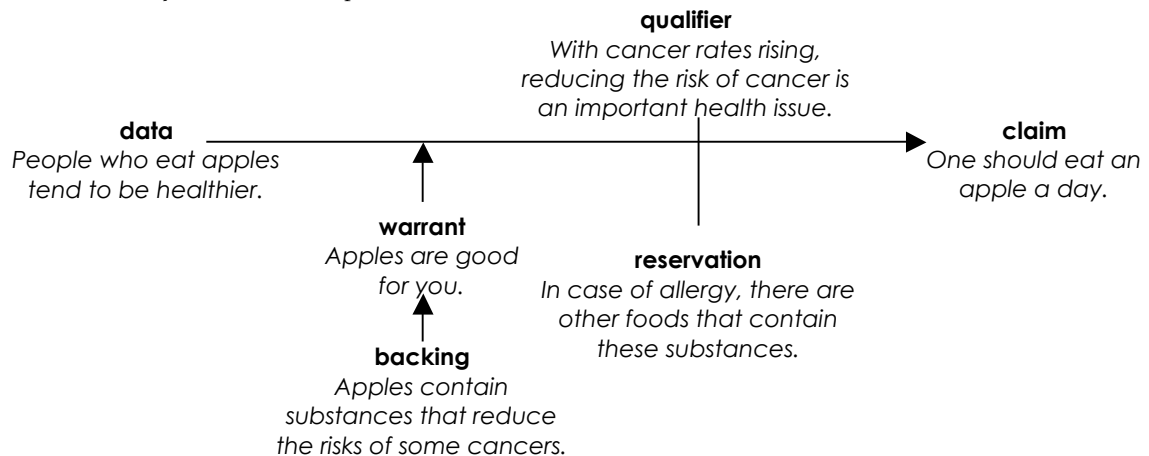


Fig. 3-1 Toulmin's diagram showing the relationships between the components with an inserted example (Adapted from Toulmin in Warnick, 1989, p. 167)

A persuasive argument's components based on the Toulmin model can be reduced to the *claim*, *evidence* and *reasoning* to support the claim, anticipation of a *counter-position* and a *response or rebuttal* to this counter-position.

Claim or proposition defines the point to be debated and proven. Claims are divided into three types: those that argue facts (judgement), those that argue points from within a defined belief system (value), and those that argue for change in behaviours and policy (policy) (Warnick, 1989, p. 57-59).

Aristotle categorized claims according to the effect they have on the audience defined by the processes to which they appeal. Arguments can appeal to *logos* (evidence and reason), *pathos* (emotions, beliefs, values) or *ethos* (authority) (Warnick, 1989, p. 282).

Evidence to support the claim can come in the form of **facts** derived from personal or common experience, as in knowing that *inhaling smoke is unhealthy*. It can be put forth in the form of documentation (reports, statistics), examples, illustrations or physical evidence of an occurrence (artefacts). A second form of evidence is that presented as **opinion as to fact**: relying on expert testimony. E.g.: *Dr Lung maintains that smoke of any kind is harmful* (Warnick, 1989, p. 70).

Reasoning binds evidence to the claim driving the inference that will be made. It explains why a piece of evidence is proof of a claim and underscores its relevance. It tests the validity of evidence and by extension the claim. Toulmin's *warrant* and to a lesser extent the *qualifier* are the reasoning mechanisms of his model. Warnick defines types

of reasoning processes or inferences that can link evidence (data) to the claim: *analogy* (comparison to a similar situation), *generalization* (extending the particular case to the whole), *cause and effect*, *sign* (particular phenomena as proof of a condition) and *authority* (citing authoritative sources) (Warnick, 1989, p. 102- 114).

Anticipation of a counter-position further supports a claim by considering the opposing view and answering its counter-claims or points of dispute (Harvard Writing Center,2006). A counter-argument aims to appear to disprove a claim by engaging in a dialectical argumentation, in an examination of the arguments or by pointing out the contentiousness of arguments (logical fallacies) (Aristotle, 350 BC, part 2).^{1 2}.

Rebuttal aims to dismiss the counter-argument. Three strategies may be used. An argument can be *refuted* (inherent logical fallacies may be pointed out), *acknowledged* as valid in certain circumstances or to a limited degree and consequently dismissed, or the arguer may *concede* and readjust the claim to accommodate the opposing argument (Harvard Writing Center,2006).

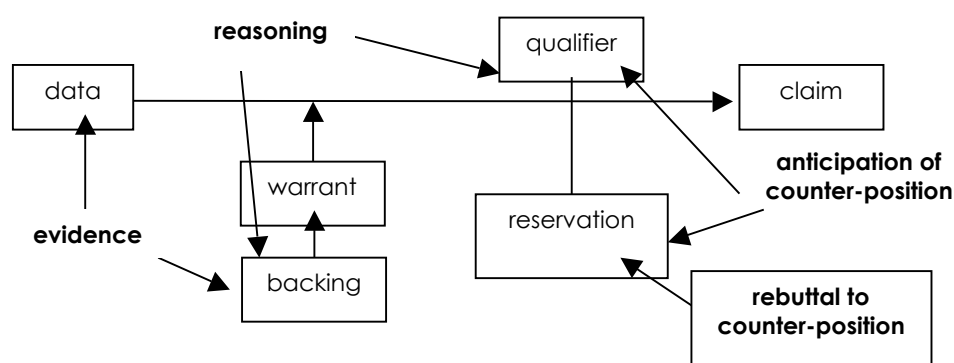


Fig. 3-2 Persuasive argument components applied to Toulmin's argument model.

From the Aristotelian based model and Toulmin's model the *claim > support > relate > counter-argument > comeback* model used in C-SAW was derived. This is discussed further in Sections 7.3.4 and 9.

3.2. WRITING

In recent decades two main theoretical approaches have transformed the way writing is taught and used within education. Writing has moved from being defined by the textual product to being defined by the processes involved in producing text. This has led to the recognition that writing is integral to learning, rather than just a by-product and proof of

¹ Aristotle (350 BC) in *On Sophistical Refutations* describes 13 fallacies that an argument can contain: seven are language independent: *accident*, *affirming the consequent*, *non-sequitur*, *ignorance of refutation*, *begging the question*, *false cause*, *many questions*. Warnick lists *false analogy*, *generalization*, *false cause*, *personal attack*, *popular opinion*, *appeal to authority*, *appeal to tradition*, *non-sequiturs*, *straw man* and *slippery slope*. Among the language dependent fallacies are: *ambiguity (equivocation)*, *amphiboly*, *combination and division of words*, *accent*, *form of expression* and *emotive language*. (Aristotle, Warnick, p. 128-144)

² An extensive list of fallacies and classifications is posted on [changingminds.org](http://changingminds.org/disciplines/argument/fallacies/fallacies.htm) (<http://changingminds.org/disciplines/argument/fallacies/fallacies.htm>)

learning. As a result, the focus has shifted to the particular processes involved in writing and their role in learning.

3.2.1. Writing to learn

The writing-to-learn movement states that the process of writing has positive effects on the learning process. Writing-to-learn means engaging learners in writing tasks that will incite critical and analytical thinking and improve learning and communication skills. Writing Across the Curriculum (WAC) is an instructional approach that encourages writing as a cognitive aid by using writing-to-learn activities in all disciplines. The processes involved in writing-to-learn and their benefits have been greatly researched. Some models and research results will be subsequently discussed.

WRITING AS A COGNITIVE PROCESS

Flower and Hayes put forth a model to describe the psycholinguistic processes involved in learning to write. They dismissed former linear 'stage' models of writing: *pre-writing* (idea-generation and planning), *writing* (filling out) and *re-writing*, that were defined by the type of text produced, to put forth their *Cognitive Process Model* of writing: defining writing according to the types of thought processes involved which may occur at any time in the composing process (Flower and Hayes, 1981).

Writing involves three elements: *task environment* (external to the writer), the *writer's long-term memory* (knowledge of topic, environment and task), and the *writing process* (Flower & Hayes, 1981). The writing process involves:

Planning: a) generating ideas, b) organizing and categorizing ideas and c) setting a rhetorical goal—defining the purpose for writing, the intended audience and the problems inherent in attaining the goal.

Translating images, concepts, ideas into formal syntactic language and a linear text.

Evaluation and revision of text produced.

Monitoring these processes throughout the composition of a text and switching from one process to another as the need arises.

For Flower and Hayes, writing is essentially goal-driven, with goals focussed on either the writing process or the content. Goals in turn inspire sub-goals until a network of ideas is created during composition. The hierarchical and recursive nature of this model means that each process can contain sub-level processes. Evaluation and revision can inspire changes in the translation or even in the planning. Problems in translation can lead to revision, rethinking elements of the planning or even new ideas. This can happen on the general or sub-component level. What distinguishes good writers from poorer ones is their capacity to set specific goals and sub-goals relevant to the rhetorical goal (Flower & Hayes, 1981, p. 377).

KNOWLEDGE-TRANSFORMING VS KNOWLEDGE-TELLING MODELS OF WRITING

For Bereiter and Scardamalia (1987a, 1987b), the rhetorical goal of a written text incites exploration that leads to discovery of new ideas and the construction of knowledge. Two processes are used, depending on the capacities and knowledge of the author:

KNOWLEDGE-TELLING: ideas that respond to a topic and suggested genre are retrieved from long-term memory and transferred directly into written text. The text produced may then spur the retrieval of further associated content leading to a coherent structure. This free-flowing process of writing is used by novice writers limiting themselves to what they know. No new learning occurs during this process. It is possible for topic and genre experts to also engage in *knowledge-telling* under non-discursive circumstances.

KNOWLEDGE-TRANSFORMING: ideas fitting to the topic and genre are retrieved from memory and transformed by the effort to resolve a conflict between the ideas and the rhetorical goal set by the writer, resulting in the generation of new ideas, further content and a deeper understanding of the subject. Writers that lack expertise in the topic of the text being produced that become involved in *knowledge-transforming*, engage in a learning process.

WRITING AS KNOWLEDGE-CONSTITUTION

Galbraith sees writing as “a process of discovery” and introduces writing as a *knowledge-constituting* process (Galbraith, 1999), where content is derived from a “*dispositional dialectic*” (Galbraith 1996 in Galbraith, 1999, p.146): the *translation* process of putting to text the writer’s representation of an idea, that takes place during a cycle of spontaneous articulation of thought occurring during text production as the writer responds to the stimulus of the emerging text (Galbraith, 1999).

The text produced during the cycle provides feedback that stimulates further thought and ideas. The subject and the translation task at hand invoke a network of ideas referred to as *units*. If an idea is satisfactory, other ideas are suppressed. If an idea does not meet the needs of the task at hand, other ideas are examined. During the repetition of this cycle there is an emergence of new or contradictory ideas that lead the writer to a broader and deeper understanding of the subject. Galbraith points out that rhetorical planning is only a “reorganization of existing ideas”... “retrieved from episodic memory” (Galbraith, 1999, p.140). The resolution of rhetorical problems in and of itself, leads to neither a deeper understanding, nor the development of new ideas. However, once a thought has been articulated it becomes part of the episodic memory and can become available to the rhetorical goal planning and solving processes (akin to knowledge-transforming) or as input to be used in the next cycle of “spontaneous articulation” (Galbraith, 1999, p.144).

The process and the number of times the cycle will be repeated is dependent on the author's knowledge of the subject, which determines the quantity of ideas generated and the complexity of the semantic network invoked, and the author's capacity to express the ideas linguistically. The product will also be affected by the *translation* strategies used by the author, i.e. the form in which ideas will be represented. The type of planning used for the writing process, (outline vs. free flow), the format of the output (notes, prose, graphic) and the rhetorical goal will all play a determining role in which ideas will be selected and developed (Galbraith, 1999, p.147-148).

WRITING STYLES

Galbraith in 1996 (Galbraith, 1999) looked at the writing processes of different personality types. Based on Snyder's scale of personality types (in Galbraith, 1999), he divided subjects into *high self-monitors* (those who regulate their behaviour based on

stimuli from their environment) and *low self-monitors* (those whose behaviour is regulated by their inner state). He found that high self-monitors tended to generate most of their ideas during note-taking prior to writing, while low self-monitors generated most of their ideas while writing. They reported that greater gains in knowledge correlated with a greater number of shifts in ideas. High self-monitors simply translated ideas retrieved from episodic memory produced during note-taking (Galbraith, 1999, p. 151). This would indicate that high-self monitors in some way censor the ‘dispositional dialectic’ that occurs during the writing process, inhibiting new ideas that may conflict with the rhetorical goal.

DUAL-PROCESS MODEL

Novices (low-self monitors) can generate new ideas from writing, showing that even what appears to be simple knowledge-telling can involve a “dispositional dialectic” and can lead to idea-generation and new knowledge (Galbraith, 2000, p.2), whereas knowledge-transforming is concerned with the evaluation and organization of ideas to satisfy a rhetorical goal (Galbraith, 1999, p. 155). Content can come from problem solving (knowledge-transforming) or knowledge-constituting processes but learning occurs in the latter.

GENRE HYPOTHESIS

The genre hypothesis states that the type of discourse effects the ideas generated and the text produced. The production of argumentative texts in particular forces information and ideas to be organized in a way that reveals relationships between the presented ideas and the subject (Klein, 1999).

FORWARD SEARCH HYPOTHESIS

The permanence of a written text allows for revision of ideas presented which invokes new ideas and promotes learning (Klein, 1999).

BACKWARD SEARCH HYPOTHESIS

Learning is a result of the process of resolving problems to attain a rhetorical goal (Klein,1999).

Recognizing that all of the writing processes described above can play a significant role within the composition of an argumentative text, within the design and development of C–SAW a conscious attempt has been made to not favour one writing process over another and to support all the writing process to the fullest extent, within the scope of the development goals.

3.3. RESEARCH ON ARGUMENTATIVE WRITING

Argumentative writing appears to be one of the most difficult writing genres for novice writers. Because of the varying demands and benefits believed to be inherent in the genre, it remains one of the most venerated genres in writing-to-learn.

Genres such as argumentation are thought to require students to process information deeply and to construct relationships among ideas, thereby attaining increased understanding and recall of curriculum material (Klein, 1999, p. 230).

3.3.1. General problem

The writing of argumentative or discursive texts is a difficult task for most novice writers. Due to a limited capacity for reasoning and a difficulty in recognizing causal relationships between events and ideas, writers before 11 or 12 years of age have great difficulty recognizing the bias of a statement in an argumentative text (Brassart, 1996). They can, however, discern bias as early as 8 years old if the classification is simple (e.g.: good or bad) (Roussey & Gombert, 1996).

Young writers have difficulty generating arguments that are varied, valid and developed. Children under 10 have difficulty conceiving and considering an opposing point of view (Golder & Coirier, 1996, Brassart, 1996), as they are not likely to have reached the level of development that allows for “psychosocial decentering” that increases with age and maturity (Golder & Coirier, 1996, p.279). The cognitive load involved in considering diverging points of view and a rhetorical goal during the composition of a text is overwhelming (Roussey & Gombert, 1996). The process of constructing cohesive arguments is further hampered by their underdeveloped linguistic capacities in the use of necessary connectives (thus, but, therefore, etc.) to link and structure ideas (Akiguet & Piolat, 1996).

3.3.2. Situating argumentation

In discussing argumentation, Andriessen, Baker, and Suthers (2003) distinguish between the types of learning that argumentation can engender. Although they are mainly referring to argumentation within a collaborative learning environment, these types of learning can be extended to what has been referred to as the ‘silent debate’ (Householder) in which a writer engages during the writing of an argumentative text.

- *learning from debate* (topic specific),
- *learning about debate* (expanding perspectives on a topic),
- *learning to debate* (learning the structures and language of argumentation).

The product-related activities involved in argumentative writing are:

- the production of counter-arguments (expanding perspectives and knowledge on the topic),
- the addition or removal of claims (reflecting change in one’s representation of a topic),
- new knowledge construction (from interaction of opposing views).

(Andriessen et al., 2003, p. 9-10)

3.3.3. Demands of argumentative writing

Literature reviewed contains certain common characteristics that define and mediate the processes and strategies writers undertake when structuring and composing argumentative texts.

GOAL SETTING – Whether it serves as a driving factor in the search for content to fulfill the rhetorical goal (Bereiter & Scardamalia, 1987b) or is only a parameter that defines the formal (structural) aspects of the composed text (Galbraith, 1999), written argumentation implies and demands **planning towards a rhetorical goal**. Goal setting is reiterated at sub-levels as writers fix sub-goals, find support and/or re-evaluate arguments. These goals must take the reader and the context into account, create links and make sense of the ideas, and adhere to the formal structures of the genre (Flower & Hayes, 1980).

KNOWLEDGE OF THE STRUCTURE OF DISCOURSE, its components and the formal aspects of the argumentative writing genre is key to the production of coherent and argumentatively sound text and improves the quality of the text produced (Hillocks in Kieft & Rijlaarsdam, 2003). What Karoly (1993, p.34) refers to as *activation and use of standards* and Bereiter and Scardamalia refer to as *executive structure* (1987c, p.18), includes the internalization of the conventions of the argumentative genre. Structures are learned through social interaction with the environment that provides mediating effects to encourage the development of appropriate processes and strategies (Vygotsky, 1978) until learners incorporate the structures and develop a capacity to self-monitor and self-regulate their cognitive activity so that they can accomplish tasks independently.

SELF-MONITORING as the capacity to monitor one's progress and engage in the appropriate cognitive process as needed, incites writers to switch to an idea-generating process when available ideas don't meet current goals, review composed text to check for coherence, or restructure content to meet the demands of the task. Novice or immature writers lack the capacity for self-monitoring during writing (Flower & Hayes, 1981, p. 374). While it seems likely that low self-monitors will lack the capacity for self-monitoring resulting in poorer text quality, the over-regulating self-monitoring of high self-monitors may lead to limited idea-generation and therefore also lead to poor or limited argumentation. It follows that the same person may engage in different self-monitoring modes during different processes of writing and within a process. Expert writers may in effect be better able to regulate the self-monitoring process switching from low to high self-monitoring as needed, while novices would benefit from guidance as to when to do so (Flower & Hayes, 1986).

SELF-EVALUATION – That self-evaluation can be beneficial in specific circumstances is confirmed by Bereiter & Scardamalia (1987a), Schunk (1996), and Flower & Hayes (1986). Self-evaluation spurs revisions, problem-solving to meet goals, and further planning and translation (Flower & Hayes, 1986). Comparison between established criteria of the activated standard and the writer's product can motivate problem-solving and task completion (Karoly, 1993, Schunk, 1996). Schunk found that self-evaluation is more successful when aimed at learning goals—the condition that correlates to higher motivation and learning outcomes. Self-evaluation of both process goals and learning goals, however, leads to increased “self-efficacy, skill, motivation and task orientation”. (Schunk, 1996, p. 377) Even low self-assessments can lead to increased motivation or change in strategy, provided that self-efficacy is high (Schunk, 1996, p.377).

META-COGNITIVE SKILLS allow writers control over the writing process. Self-efficacy—the belief that one is capable of accomplishing the task at hand—correlates strongly with how long a writer will remain at task, the learning outcome and the quality of the product (Karoly, 1993, Schunk, 1996). The capacity to prioritize goals and apply the appropriate process towards the goal at hand, i.e. selecting the appropriate cognitive strategy, differentiates poor writers from good ones for Bereiter & Scardamalia (1987c). Rijlaarsdam, Breetvelt & van den Bergh (1994) showed that it is not only which cognitive activity is applied to solve which problem that matters, but also at what moment in the writing process it is applied. This indicates that the role of meta-cognitive skills in the writing process is not only very important but also very complex.

The demands placed upon writers in the production of argumentative texts needs to be well understood in order to apply the appropriate intervention to minimize these demands and overcome the problems they present for novice writers.

3.4. RESEARCH ON THE ROLE OF STRUCTURAL SUPPORT FOR TEXT COMPOSITION (USE AND EFFECTS OF STRUCTURAL AIDS)

The role and effect of structural support has been quite extensively studied using different formats to support the structuring of individual arguments and the overall structure and linearization of argumentative texts. Two types of structural support need to be identified: *structuring support* serves to aid with the semantic cohesiveness of (a) the argumentation or (b) the global text; *linearization support* aids the ordering of (a) the components and elements of arguments or (b) the linearization of arguments within the global text. Novices of argumentative writing exhibit difficulties with both, structuring and linearization, on the local and global level of composition.

3.4.1. Difficulties of novice writers

Research on writing has revealed particular difficulties of novice (and to a lesser degree, expert) writers that are critical in the attempt to provide a computer-based support for writing argumentative texts.

Novice writers have difficulty with structuring and setting rhetorical goals (Bereiter and Scardamalia, 1987c). They tend to set superficial goals focussing on the procedural aspects of the task (e.g.: write essay on capital punishment for class, include 3 arguments). Expert writers, in contrast, refer to the purpose of the task when setting their goals (e.g.: convince fellow classmates that capital punishment is useless). (Flower & Hayes, 1980, 1981) Engaging writers in setting criteria (defining structure and goals) and evaluating writing improves text and idea-generation (Hillocks in Kieft & Rijlaarsdam, 2003).

Writers under 14, like low self-monitors, produce and elaborate ideas during text production (Isnard & Piolat, 1993, Schnewly, 1996). Novices are 'content centred', and have difficulty setting and answering a rhetorical goal (point of view and audience) (Flower & Hayes, 1986). Over 14 years old, writers seem better able to control the different cognitive processes of text production (planning, idea-generation and elaboration, composition) (Schnewly, 1996).

Structuring argumentative texts demands strategies used by *high self-monitors*. Production of argumentative texts (idea-generation) demands strategies used by *low self-monitors*. Guidance should help the latter in their rhetorical planning after writing an exploratory draft and the former should be encouraged to take part in idea-generating activities (collaborative debates, free-flow writing) (Rijlaarsdam et al., 1994).

In a study on the effects of types of planning by Isnard & Piolat (1993), more ideas were added between *idea-organization* and *sentence-production* phases than *note-taking* and *idea-organization*, indicating that perhaps text written in pursuit of a rhetorical goal (associated with organization/planning processes) can also in-turn invoke *forward-search* processes and thus lead to idea-generation and knowledge-constitution. Isnard and Piolat suggest the “idea-organization phase plays an essential role in the framing and organization of ideas into a hierarchical and temporal structure.” (Isnard & Piolat, 1993, p. 129) They found that a greater number of ideas were added over all when writers used a hierarchical outline (vs. free flow or concept map) to organize their texts, leading them to conclude that “mandatory structuring... allows writers to discover new ideas” (Isnard & Piolat, 1993, p. 130), but they admit to not having evaluated the quality of the final text produced under different conditions. This would appear to concur with Bereiter & Scardamalia’s knowledge-transforming model and supports Galbraith’s dual process model. Though only idea-generation processes involve the construction of new knowledge, and idea-organization involves the use of ideas generated during text production and retrieved from episodic memory, it is probable that any activity that results in text generation (including knowledge-transforming and backward-search processes) can invoke idea-generation.

Klein (1998) sees argumentative essay writing as good for *learning-to-write* but questions its utility in *writing-to-learn*, as most of the learning will happen during idea-generation, in activities outside of structuring and rhetorical goal pursuit.

3.4.2. The role of scaffolding

(The educator) calls upon the services of powerful forces in the environment, directs them, and places them in the service of education.

Education is realized through the student’s own experience, which is wholly determined by the environment, and the role of the teacher (tutor) then reduces to directing and guiding the environment. (Vygotsky, 1926, 1997 p. 50)

Aiming to increase Vygotsky’s *Zone of Proximal Development*—the difference between what a learner can do independently and what the same learner can do when tutored (Vygotsky, 1978), Wood, Bruner and Ross (in Langer & Applebee, 1986) list characteristics of effective tutoring as: *recruitment, reduction in degrees of freedom, direction maintenance, marking critical features, frustration control*, and *demonstration*. These are aimed at engaging and keeping the learner to task. Four phases to describe the internalization process of a scaffolded instruction can be derived from Bruner et al.’s work with children/adult language learning activities: (1) learner and tutor have different representations of the task (2) learner mimics the structures presented by the tutor without full comprehension (3) learner needs less direction, tutor is available to offer solicited guidance, (4) the structures necessary to complete a task have been internalized, self-regulation takes the place of the tutor.

These phases can be simplified to two: helping when needed, and the eventual fading out of support, termed *contingent teaching* (Wood & Wood, 1996). That they are essential to learning is generally agreed upon by the literature reviewed (Bereiter & Scardamalia, Flower & Hayes, Kieft & Rijlaarsdam), but it is the variation in the form and circumstances in which this help should be made available that has led to the variety of tools and instructional approaches to scaffold argumentation and argumentative writing.

Bereiter and Scardamalia define two types of scaffolding. *Procedural facilitation* introduces self-regulatory mechanisms into the writing procedure through the use of 'cues' to scaffold a task. (Bereiter & Scardamalia, 1987a, p. 254) From Bereiter and Scardamalia, Langer & Applebee (1986, p. 184) derive a checklist of options to scaffold cognitive strategies:

- Simplify and imitate mature writers monitoring process
- Reduce cognitive load by setting up structures to help self-monitoring
- Limit choices
- Structure should help by-pass immature writing processes (knowledge-telling)³
- Make cognitive process visible
- Provide labels to categorize and organize tacit knowledge
- Procedures should be tailorable to the learner's level and needs.

Substantive facilitation provided can reduce the burden of the executive structure (Bereiter & Scardamalia, 1987a, p. 256)

Research on how best to scaffold argumentative writing focuses on 3 general aspects: *idea-generation*, *structural help* and *linguistic help*. The evidence with respect to the positive effects of the scaffolding structural and rhetorical processes of argumentative writing is mixed.

Instruction in argumentative discourse and its components (*substantive facilitation*), with no direct aid during writing, improved the argumentative complexity of children 10–12 years old. They showed an improvement in the generation and elaboration of evidence and in linking arguments. The inclusion and elaboration of a global rhetorical goal increased, as did the inclusion of opposing views and the use of linguistic markers to introduce them (Dolz, 1996).⁴ Dolz also had positive results using didactic sequences that instructed on the use of causal markers (*thus, as a result, consequently*), organizers (*if*), and linguistic markers (*in this respect, I believe, Most people agree*).⁵ Linguistic markers were also found beneficial in the formulation of scientific arguments (Bell, 2000).

Textual markers in the form of generalized cue cards referring to structure and content (rather than topic specific) during the writing process, can scaffold cognitive activity and improve quality of arguments (Bereiter & Scardamalia, 1987c, Bell & Davis, 2000, Bell, 2000). Structural aids during composition also appear to lead to better global coherence and cohesion of a text (Green, 2001).

³ In Galbraith's knowledge-constituting model this could prevent new ideas from emerging especially if presented during text composition (Rijlaarsdam et al. 1994)

⁴ Ibid.

⁵ See Dolz (1993) for a detailed description of the didactic sequence used to teach argumentative writing or Dolz 1996 for a summary.

However, scaffolding offered by structural aids during the composition phase can also increase self-monitoring and cognitive load and inhibit the generation of ideas to solve emerging problems (Bereiter & Scardamalia, 1987a, p.254). As noted by Rijlaarsdam (1994), it seems much still needs to be investigated as to what type of cognitive support should be given at which point in the writing process and in what ways the support needs to take the individual writing styles and processes into consideration.

Salomon, Zellermayer, Globerson and Givon (1991) tested the presentation of solicited vs. unsolicited guidance to scaffold the writing of argumentative texts to determine their effect on enhancing metacognitive activities during writing, expecting that only novices would benefit from unsolicited guidance. They found that both novices and experts benefited from unsolicited guidance, not corroborating with the prediction of the effects of an increase in cognitive load predicted by Bereiter & Scardamalia (1987a).

3.4.3. Connectives

Connectives are important to the linking of ideas and overall cohesion of written texts. Argumentative writing demands precise use of connectives, as they can be crucial to the development and expression of reasoning used to link claims and evidence. Akiguet & Piolat (1996) showed that writers as young 9 years old are capable of using simple connectives (*thus*, *but*) in composition. Furthermore, argumentative writing encourages correct use of connectives. Crewe finds that connectives in novice and ESL writers are frequently misused and overused, partly putting the blame on the use of connectives for stylistic purposes. (Crewe, 1990) Instructing writers on the semantic and syntactic distinctions between connectives, not only on their grammatical function, may prevent students from using them interchangeably (e.g.: *thus* and *therefore*, *but* and *however*) (Zamel, 1983). Crewe (1990) suggests three approaches that should be integrated into explicit instruction on the use of connectives:

Reductionist - limit the students' use of connectives to a small sub-set of relatively comprehensible ones;

Expansionist - encourage the 'phrasal expansion' of the connectives so that the logical links become more apparent;

Deductionist - make consideration of the logical progression of the argument an integral stage in the writing process.

3.4.4. The role of visualization

THE USE OF VISUALIZATION AS A SCAFFOLDING DEVICE

Offering a variety of representations of argumentation is seen as a way to enhance learning. (Baker et al. 2003)

Noticing that their argument *diagramming* tool was used only as a visual representation and did not stimulate further discussion or idea-generation as hoped, Erkens, Prangma, Jaspers & Kanselaar suggest:

When a diagram reflects the discussion itself, it can be a valuable starting point for writing the text, and of benefit to textual structure. If a diagram is

used to report on the contents of the text, it can still have a structuring function during the revision of the text. (Erkens et al. 2002b, p.135)

Unfortunately, they provide no references or evidence to support this.

Two types of approaches to scaffolding through visual representations can be taken: (1) structuring approaches can be used to suggest possible and desired interactions⁶ ahead of interaction or (2) regulation approaches making discrepancies between desired and current states visible as interaction occurs. (Jermann, Soller & Lesgold, 2005)

THE ROLE OF VISUAL REPRESENTATIONS IN SELF-MONITORING AND SELF-EVALUATION

Visualizations can be thought of as “artefact(s) that can support and shape their reasoning”. (Bell, 2000) It has been suggested that visualization can make problems, and weaknesses explicit and draw attention to areas that need attention (Boxtel, Drie, Erkens & Kanselaar, 2005).

Visualization, by mirroring progress and metacognitive activity can ‘guide’ the writer to engage in the type of process and activity necessary to achieve the goal of the interaction (Jermann et al. 2005). Janssen, Erkens, Jaspers, and Broeken (2005) found that visualization of participation in collaborative activities stimulated longer, more in-depth discussion and decreased off-task discussion.

3.4.5. Linearization

The importance of linearization in argumentative writing is highlighted by Kanselaar, Erkens, Prangma, & Jaspers’ (2002) incorporation of results from studies on the effects of separating idea organization and linearization within the CSCL environment of the COSAR project. (COSAR is discussed in Section 4.2)

Aids in the linearization of text tend to come under the category of structural aids. These can come in the form of cues (Bereiter & Scardamalia 1987a), frameworks presented in the form of outlines (Bell & Davis, 2000), or in the simple instruction of underlying frameworks (Dolz, 1996), including models of linearization for argumentative writing. However, linearization is, and should be, seen a separate writing activity as it involves different cognitive processes than structuring (Kanselaar, Erkens, Prangma, & Jaspers, 2002).

The results of studies on structural support on the whole agree that facilitation on all structural aspects can improve the quality of the argumentation and the global text of novices. Some studies appear to be, however, contradictory (scaffolding aids, while at the same time increasing the cognitive load) and there appears to be some debate on how much and what types of support should be given for what purposes and in which format. All the research outlined here was considered and attempts were made to apply findings in the design and development of the different support systems of C-SAW.

⁶ Though Jermann et al. refer to interactions between learners, mediated and reflected by the system; their distinctions also apply when the interaction is between a learner and the system (a learner initiates an action with or acts in response to a system and the system responds to the learner’s actions).

The review and analysis of theory on argumentation and its models was essential to the building of a theoretical foundation upon which to base the theoretical and practical framework and design process of C-SAW. Theory and research on writing processes, difficulties encountered by instructors and learners, and research on proposed remedies were influential in the design of the structural support embedded within the framework and the methods used to implement it within the design.

4. Current uses of instructional technologies to support argumentative writing

A review of current frameworks and research using computer-supported tools used in argumentation activities was conducted to determine what could be incorporated and perhaps improved within C-SAW and more importantly to determine what needed facilitation these tools were not offering that could be offered within C-SAW. This included a review of the relatively few markup languages for representing argumentation and an evaluation of computer-supported cognitive tools (individual and collaborative) and comparative analysis of their relative strengths and weaknesses.

4.1. MARKUP LANGUAGES/Frameworks

XML-based schemas have been written to represent ontological frameworks for argumentation. These schemas were mostly designed to support computer-supported argumentation tools. They and the tools they support will be discussed as they have influenced the design and development of ArgEssML, the semantic mark-up language used to represent C-SAW components and C-SAW functionality.

AML and **Mini-ArgML** were consulted for a detailed analysis of how an argumentation framework could be translated into an XML-based framework.

ARGUMENT MARKUP LANGUAGE (AML) was developed to support a collaborative argumentation tool (SEAS) and sponsored by Stanford University's SRI International. (AML) is an XML schema designed to represent argumentation in analytic decision-making and draws on law terminology for its framework but claims to be capable of representing any argumentation tool.

MINI-ARGML⁷ (a DTD) was developed for the Belvedere groupware project of Suthers and Paolucci (1995). It focuses only on the components of a stand-alone argument based on the Toulmin model (Suthers, 1995).

4.2. COMPUTER-SUPPORTED COGNITIVE TOOLS FOR ARGUMENTATION

EUCLID is one of the earliest attempts at providing a computer-based tool to “enhance reasoned discourse” (Smolensky et al., 1987, p.215) and “provide a unified environment for working out an argument and expressing it in text” (p. 219). Argumentation Representation Language (ARL) was developed to represent reasoned discourse as it occurs in a variety situations, from policy-making to colloquial conversation. Like other semantic representation markup languages, it was developed on the principle of separating information on structure from content. While graphically not as advanced as Belvedere, COSAR or DREW (discussed below), it is based on the *box and link* principle—inserting text in a graphical container and linking statements via their relationship or function within the argumentation. It allows for the expansion of ideas

⁷ Suthers (1995) refers to Mini-ArgML as a simplified version of ArgML “which describes the logical and rhetorical structure of an argument” (p.2) but does not indicate the origin of ArgML.

into arguments and then further into full text. Writers can then view their argumentation in an outline view that maps out the argument, as it is developed, and then select to view the entire text or a detailed view of individual arguments with components (e.g.: *claim*, *contradict*, *refute*) marked up semantically (structural function).

EUCLID's prototype design was based on a cognitive process model of writing referring to processes of *dump* (idea-generation), *reader-preprocess* (define rhetorical goal, audience, context), *organize* (link ideas), *fill-in* (build and structure arguments), *linearize* (re-ordering of arguments), and *edit prose* (built-in basic text editing) (p. 227). Rather than seeing writing as a serial stage process, it acknowledges that these processes can occur at any time during writing and allows continuous access to any of the processes.

BELVEDERE⁸ (Suthers, 1995, Paolucci, 1995) is a graphic argumentation tool that allows for a visualization of collaborative argumentation. Its goal is to engage students in critical thinking and to help students formulate sound arguments and hypotheses. In its simplest use, it allows for the stating of an argument or hypothesis and the development of data and reasoning (rationale) *for* and *against*. Arguments and data are graphically linked. Different shapes and colours are used to visually code the different components and the stance they support. Feedback and guidance on partially developed and faulty arguments are given in the form of an automated tutor (*Advisor*). Belvedere offers no guidance on text production or linearization.

MILDRED & SENSEMAKER – In designing Mildred, the guidance (scaffolding) component of their Knowledge Integration Environment (KIE), Bell and Davis based their guidance system on Bereiter & Scardamalia's findings (1987a) that indicated that general domain-specific cues were beneficial in guiding learners' cognitive activities. They found that Mildred was effective in helping students select effective cognitive strategies to solve problems and identify weaknesses in their knowledge (Bell & Davis, 2000). The Sensemaker component allows for the rating of evidence and claims, resulting in visual feedback on the state of their argumentation. Bell's observation that this led to further discussions between students, suggests that visualization of status may have the potential to enhance metacognitive activity (Bell, 2000).

COSAR (Computer Support for Collaborative and Argumentative Writing) is an all-encompassing tool that supports idea-generation, planning and structuring, text composition and linearization in a collaborative environment. It has an individual **note area**, a **chat**, a shared **text editor** for collaborative writing, a **diagram tool** for "for generating, organizing and relating information units in a graphical knowledge structure comparable to Belvedere" (Erkens, G., Kanselaar, G., Prangma, M., Jaspers, J. 2002b, p. 16) using the 'box and link' approach to generate, relate and visually distinguish the simplified components of the argumentation produced (*information*, *position*, *argument pro*, *support*, *argument contra*, *refutation*, and *conclusion*) (Erkens et al. 2002b, p. 17), and an **outlining tool** for generating and structuring "units as an outline of consecutive

⁸ From Belvedere's homepage at Sourceforge.net <http://belvedere.sourceforge.net/> "Originally developed by Alan Lesgold, Dan Suthers and colleagues while at the Learning and Resource Development Center at the University of Pittsburgh, the third and fourth generations of Belvedere were engineered at the Laboratory for Interactive Learning Technology (LILT) at the University of Hawaii under the direction of Dan Suthers. Belvedere 4 was programmed by David Burger. Several other experimental versions of Belvedere also exist at LILT

subjects in the text”. An *Advisor* (an information sheet) gives help on how to use the organiser and linearization tools but is not context sensitive and must be solicited.

They studied and reported on the effects of the different tools used in various combinations. The diagram tool appeared to be used more as a visual representation of the status than as an idea-generation tool as intended (Erkens et al. 2002b, p. 91). The *Advisor* helped improve the overall structures of the outlines, texts and individual arguments (Erkens et al. 2002b, p. 92). They deduced that the planning tools “stimulate a more structured dialogue” (Erkens et al. 2002b, p. 125). They also found:

Explicit argumentation on content, coordination, and metacognitive strategies is related positively to text quality, whereas argumentation on technical aspects of the task and on non-task related topics is related negatively to text quality. (Erkens et al. 2002b, p.125)

This concurs with theories on the positive effects of self-regulation and self-monitoring, so long as they are not oriented to procedural aspects of the task (Schunk, 1996).

DREW (Dialogical Reasoning Educational Web tool) is part of the European SCALE (Support Collaborative Argumentation-based LEarning)⁹ project, whose goal is to “is to develop a web-based tool to promote the development of the debating skills of 16-18 year old secondary school students, as well as the process of argumentation-based learning”. DREW is an online collaborative argumentation tool that offers a large variety of ways to generate ideas, content and graphic representations. A **whiteboard** allows collaborative graphic making, a **chat** for discussion and problem-solving, a **collaborative text editor** for text production and linearization, a **graph editor** similar to the concept mapping tools of Belvedere and COSAR, a **structured argumentation discussion board** that offers connective phrases to facilitate the construction reason-based arguments, and a **voting** feature to allow peer review and feedback.

THE WRITING PARTNER used in a study to compare the effects solicited vs. unsolicited guidance, is only briefly described in the authors’ study as providing text editing and procedural facilitation based on Bereiter & Scardamalia’s work (Salomon et al., 1991).

EMMA (Electronic Markup and Management Application) developed within the English Department at the University of Georgia, where a course in writing composition is mandatory for first-year students, combines the teaching of the structure of argumentative writing with write-to-learn practices. The aim of the EMMA Working Group was to develop a semantic markup language that would be conducive to a process model of writing (Desmet et al, 2005). Students compose essays in Open Office. They then choose amongst a variety of schemas for different writing genres and students are required to ‘markup’ their essays imported into EMMA, by putting the appropriate XML tag around the different parts of their essay using a text-based XML editor (jEdit¹⁰) and a selected DTD appropriate to the genre in which they are

⁹ At the writing of this document the links to the homepage of the project (<http://www.euroscale.net>) were no longer valid. The onlineDREW environment formerly made available for use at Ecole Nationale Supérieure des Mines Saint-Etienne is no longer supported, though DREW is still available for download and installation at <http://scale.emse.fr/download/drew.html>.

¹⁰ jEdit is an open source text editor <http://www.jedit.org> used for programming

writing. Tags vary from formal functions such as <sentence> or <paragraph> to structural such as <thesis> or <argument>. Instructors can use the *commenting* and *track changes* features of Open Office¹¹ that are imported into the EMMA environment. The marked and commented essay can be shared and opened to peer review and saved in various file formats. The working group aims to eventually instruct students on how to create their own DTD's from the templates provided by EMMA.

4.3. REVIEW SUMMARY OF TOOLS EVALUATED

In developing and testing cognitive tools it appears argumentation is almost unilaterally chosen as the genre framework to work with, as it allows for “activit(ies) that involve confronting cognitions and their foundations” (Andriessen, Baker & Suthers, 2003).

Research on how best to scaffold argumentative writing focuses on 3 general aspects: *idea-generation*, *structural help* (*planning and linearization*) and *linguistic help*. While significantly helping with the first two aspects, CSCL tools have been largely concerned with providing a medium that fosters generation of ideas, debate, evaluation and collaboration and offer little or no help with the linearization process and linguistic aspects that are partly at the root of writers' difficulty in incorporating ideas into the structure demanded and defined rhetorical goal (Brassart, 1996, Akiguet & Piolat, 1996).

When the goal is to convince, justification (presentation of data and warrant) increases and negotiation decreases (Andriessen, Baker & Suthers, 2003). If contextual factors structure the argumentation, their definition along with the possibility to self-regulate and self-evaluate in this respect, may influence quantity of arguments and counter-arguments. With the exception of EUCLID, little emphasis is given to contextual factors (purpose of task, targeted audience, context of discourse, what is at stake), which can include both learning goals and process goals and determine level of justification and negotiation. These factors are left to the lesson plan.

¹¹ Open Office is a multi-lingual open-source office suite (<http://www.openoffice.org/>)

5. Research goals

An informal evaluation of the noted projects that support the process model of writing and aim to enhance cognitive and metacognitive writing activities, revealed that none of these tools were aimed at or capable of meeting the goals of the C-SAW project.

Tools reviewed fall along a spectrum that puts *CSCL debate expansion and elaboration* tools at one end, and *text structuring and linearization* tools at the other. C-SAW tends towards the latter though it addresses and incorporates the functions of the former to some extent.

5.1. WHAT'S MISSING?

With the exception of Sensemaker that allows for a representation of self-evaluation and the progress made in fulfilling argument requirements, visualizations are limited to the diagramming of arguments as they are constructed using the 'box and link' style of concept maps.

EUCLID, EMMA, DREW and COSAR all include some form of linearization help with the possibility of exporting the product (DREW and COSAR offer little more than a text editor leaving text linearization entirely to the writer), but these were also the most complicated of the tools evaluated making them inaccessible to young writers. These also offer little or no help with linguistic markers that are found to be beneficial to the structuring processes (Akiguet & Piolat, 1996).

Belvedere and Mildred, the two tools aimed at children, include linguistic help in the form of domain specific cues to enhance reflection but lack explicit help in producing a linear text. They are also aimed at scientific argumentation thus focussing on the development and backing of hypotheses, a form of argumentation in its own right, but not encompassing the scope of C-SAW.

All of the CSCL tools use diagramming of argumentation as a cognitive aid though only the COSAR project looked at whether the graphic representations were having the effect they predicted and they noted no benefit beyond its capacity to be a visual representation of the procedural status of the argumentation (Erkens et al. 2002b, p. 125).

All the tools evaluated offer varying degrees of explicit support to scaffold the activity of argumentation and all may be used individually, although not all are designed for this purpose.

	CSCL	individual	diagram	structure	visualize	explicit scaffold- ing	linear- ization	linguistic help	self- evaluation	Secondary school level
Word processor	X	●	●	X	X	X	●	●	X	○
COSAR	●	●	●	●	○	●	●	X	X	○
Belvedere	●	●	●	X	●	●	○	●	X	●
Mildred & Sense-maker	●	○	●	X	●	●	○	●	●	●
EUCLID	○	●	●	●	○	●	●	X	X	○
Writing Partner	X	●	X	n/a	X	●	n/a	n/a	n/a	n/a
EMMA	●	●	X	●	X	●	●	X	X	○
DREW	●	○	●	●	●	●	●	●	X	●
C-SAW	○	●	●	●	●	●	●	●	●	●

Table 5-1: Shows the different cognitive activities and modes supported by the tools reviewed. MSWord is included as a starting point of reference. ● supported, ○ not explicitly supported i.e. not intended, ● limited support, X not supported, n/a. not evaluated due to lack of information

The design and development of C-SAW aims to increase Vygotsky's *Zone of Proximal Development* by providing scaffolding in various forms during the writing of an argumentative essay. The general development goals of C-SAW as determined by the literature review and user testing is to improve the argumentative writing skills of novices of argumentative writing aged 13-19 years old by helping them:

- learn the components of an argumentative text,
- generate arguments in stages,
- engage in sound reasoning,
- broaden and deepen their arguments,
- structure and organize their texts linearly,
- better understand the subject of their written texts,
- produce a text in a digitized format that can be saved, edited, revised and printed.

5.2. RESEARCH QUESTIONS

None of the evaluated current technologies used in argumentation cover the spectrum of functions and considerations determined as necessary by the literature reviewed and the preliminary user-testing conducted to achieve the development goals as defined above. To arrive at a prototype that could satisfy these needs it was necessary to answer several key questions that

would form the basis of the design process and drive decisions on how to best serve each goal within the design of a computer-supported authoring tool for argumentative writing.

The first question is outside of the goals but was central to defining the methodology used in the development and assessment of the design experiment.

1. *What design processes and methods can be used in the design of a computer-supported “authoring tool” that will help improve texts written by novices of argumentative writing?*

Questions 2 and 3 aimed to define the design of the framework and functions specific to the structuring and elaboration of argumentation with a focus on context and domain specific cognitive aid.

2. *What features and functions should be included in order to facilitate the generation of ideas and arguments?*
3. *What features and functions should be included to enhance the quality of written arguments as measured by (a) the scope they encompass: their variety from an epistemological point of view (Baker, Quignard, Lund, Séjourné, 2003) and function within the argumentation (support and/or negotiate) (Dolz, 1996), and (b) their depth: the inclusion of counter-arguments and conclusions (Brassart, 1996)?*

Questions 4, 5, and 6 (and partly 7) were concerned with what types of cognitive activity should be encouraged and enhanced within the environment to favour the internalization of the structure of argumentative texts and their underlying schema.

4. *How can the design of a computer-supported authoring tool help novices to improve the overall structure and linearization of their argumentative texts?*
5. *The proper use of connectives is crucial to the structuring of individual arguments, the overall organization of arguments and the development of conclusions. (Akiguet & Piolat, 1996). What can a computer-supported authoring tool offer to facilitate the use of connectives during the structuring and linearization processes during writing?*
6. *How can the design of a computer-supported authoring tool help novices internalize the components and conventions of the schema inherent to argumentative writing?*

Question 7 guided the investigation into the design approaches that could be used to guide metacognitive activities through self-regulation and how they could impact the structuring and linearization processes.

7. *What devices can be implemented to enhance self-regulation and motivation during writing?*

Also outside of the scope of the experimentation, question 8 is fundamental to any design-based research approach.

8. *What design features would favour the integration of a computer-supported authoring tool for argumentative writing within existing lesson plans?*

5.3. WORKING HYPOTHESES

Literature, research and current instructional technologies concerned with argumentation and argumentative writing suggest that a system that includes support with idea-generation (Galbraith, Flower & Hayes), structure (Bereiter & Scardamalia, Dolz, Brassart, Baker et al. Akiguet & Piolat), linearization (Dolz) and self-regulation (Karoly, Jermann et al.) will improve the writing of argumentative texts.

To arrive at a prototype that could satisfy these requirements it was necessary to define the ways in which a computer-supported authoring tool could accomplish the development goals. These are broken down into three working hypotheses that were investigated during the development of the C-SAW prototype.

1. **A computer-supported authoring tool based on a schema inherent to written argumentative texts can help improve the texts written by novices of written argumentation:**
 - a. in the quantity of arguments produced
 - b. in the quality of arguments produced
 - i. scope
 1. variety of arguments
 - a. epistemological point of view (Baker, Quignard, Lund, Séjourné, 2003)
 - b. function of the argument (support and/or negotiate) (Dolz, 1996)
 - ii. depth
 1. inclusion of counter-arguments and conclusions (Brassart, 1996)
 - c. structural quality of arguments and text as a whole
 - i. use of connectives (Akiguet and Piolat, 1996)
 - ii. organization of arguments
 - iii. conclusions
2. **Through the use of a computer-supported authoring tool that offers structural and cognitive aid, novices will learn to recognize the components of the schema inherent to argumentative writing.**
3. **Feedback resulting from self-evaluation and procedural progress in the form of an actualized visual representation can enhance motivation, self-regulation and improve text structure and linearization.**

6. Methodology

To determine what design processes and methods can be used in the design of a computer-supported authoring tool that will help improve texts written by novices of argumentative writing reference was made to literature on *systems design* (Dillon & Morris, 1996), *design-based research* (Collins, 2004, van den Akker, 1999, Reeves, 2000) and combined with qualitative research methods (embedded within the design-based research approach) and *user-centred design* approaches. A *needs analysis—theoretical framework—design—test—report* loop was iterated in three phases with targeted users.

NEEDS ANALYSIS – based on literature on user-centred design (Poirier 2005, Axup, 2002) and design-based research (van den Akker, 1999; Reeves 2000, Collins 2004) the first step was to determine the current practices and problems in the instruction of argumentative writing and to determine user attitudes and expectations of a computer-supported solution. This was followed by an analysis of literature on writing and argumentation and more specifically, the instruction of argumentation, to find congruencies and discrepancies between theory and practice, including an evaluation of the current state of the art of computer-supported environments that facilitate argumentation and argumentative writing.

THEORETICAL FRAMEWORK – To allow investigation into a computer-supported tool based on a schema inherent to written argumentative texts, it was necessary to first design a framework for argumentative writing. A theoretical framework was built in successive phases relying on previous research on selected aspects of C-SAW's design, particularly writing processes, scaffolding of cognitive and metacognitive activities and self-regulation, while refining the overall executive structure inherent in C-SAW as represented by ArgEssML, C-SAW's ontological framework. (Appendix A)

ADAPTATION OF PROTOTYPE – Modification and adaptation of the design of a prototype¹² and its framework based on the results of the needs analysis and theoretical framework developed, as well as any testing and reporting that may have been done in the previous phases, helped refine C-SAW to achieve the above defined development goals and allow further testing.

TESTING – Testing and interviews with users and stakeholders were conducted in each phase. The C-SAW authoring tool prototype was tested with one teacher of secondary school students (16-19 years old) during the first 2 development stages and with 2 students (aged 17 and 18), during the 3rd stage of development. They will be referred to as Tester 1 and Tester 2. Verbal protocol analysis (thinking out loud), observation, and analysis of screen recordings were used during the evaluation of the software and interviews were conducted to further assess user needs from instructors' and students' perspectives. Students were not required to provide a verbal protocol, as it would add significantly to the cognitive load of the activity.

¹² This project evolved from the first prototype of C-SAW that was developed during a preliminary investigation on representing argumentative writing through XML, done as part of a masters studies program. See <http://tecfaeed.unige.ch/staf18/modules/ePBL/uploads/proj7/paper4.xml>

REPORTING – Reporting at the end of each phase permitted the recording of testing results for use in the identification of successes and problems within the design and testing processes. This analysis in turn determined the focal points and the changes that were implemented within the prototype and tested during the subsequent development phase.

All three phases concerned themselves with answering the research questions of this project, though some phases focused more on some questions than others.

PHASE 1 – DESIGN ANALYSIS

Phase 1 was largely aimed at developing the design of the prototype with the direct input of practitioners, ascertaining their comfort and attitudes towards instructional technologies, and putting to question the design of the framework, functionality and usability aspects developed in a preliminary investigation on representing argumentative writing through XML.¹³

The design stage is one of the most important segments of a user-centred software development process. It is during this stage that technical requirements are set; technical feasibility is discussed; user and task analyses are run to determine existing work processes and user types; new features are prioritized and agreed upon or disposed of; initial designs are mocked up; initial paper and pencil prototypes are user tested; integration of the new features into the existing product are discussed. Doing this step before coding is essential. (Axup, 2002)

Existing theoretical and practical frameworks for representing argumentation were reviewed, with particular attention given to models of argumentation (Aristotle, Toulmin, Warnick) and XML schema-based representations (AML, ARL, Mini-ArgML) developed for computer-supported argumentation tools. This was the basis for the prototypical representation of the executive structure of C-SAW.

Literature on the use of scaffolding (Bereiter & Scardamalia, 1987a) and of linguistic markers and connectives (Akiguet & Piolat, 1996) provided the initial input for the markers and cues used within the interface to help writers develop and expand their arguments.

Adhering to the principles of user-centred design, the first phase of testing was with a practitioner—an English writing teacher at Hull School in Zurich, a private secondary school leading to O- and A-Level (British Matura) certification.

We tested a mostly static prototype on screen (actual functionality was only visually represented) that represented most of the features of C-SAW as it is now. Seeing as C-SAW is intended as a computer-based tool to complement lesson plans involving argumentative writing, one aim of the first interview was to gather information on user needs, user perceptions and user acceptance from the instructor's perspective. Also important were the recording of feedback from the practitioner on the argumentation model used and the overall structure of the representation.

As in all three test phases, a list of tasks (Appendix F) was presented to the user to help reveal problems in the interface design of C-SAW (Poirier, 2005). In Phase 1, verbal

¹³ ibid

protocol (think aloud) was used to gather feedback on the user's perceptions and difficulties as she accomplished the required tasks. The test ended with an interview (Appendix G) to further assess user-perceptions and needs.

Following testing, the developer and practitioner also discussed on what could be done within an interface to enhance motivational and self-regulatory aspects of the design.

PHASE 2 – SYSTEM DESIGN, FUNCTIONALITY AND USABILITY

Phase 2 began with addressing the needs revealed in Phase 1 testing. Modifications were made to improve user-interface problems and ameliorate the transparency of the underlying framework and executive structure.

A further literature review was made to determine ways to facilitate the use of connectives (Crewe, 1990) and findings were applied to the development of the next prototype.

Literature on self-regulatory mechanisms (Karoly, 1993) and research on their use in computer-supported argumentation (Jermann, Soller, & Muehlenbrock, 2001) were consulted in the initial design of a visualization device that reflects writers' progress in the form of a graphic map.

Phase 2 testing looked at the effect of modifications to the interface and overall structure, the help with connectives provided within the system, and the introduction of the visualization. Phase 2 testing was again with practitioner Sonia Fitzi. This time she was presented with a functioning prototype and a task list (Appendix F) followed by an informal discussion about the latest version of C-SAW that included recommendations made during Phase 1 testing. No instruction or user guide was provided prior to tasks. Tasks covered a wide range of activities that can be accomplished within C-SAW in order to test the usability of the design and solicit the practitioner's opinion on the efficacy of the devices included to facilitate idea-generation, reasoning, structuring and linearization during writing.

Verbal protocol, a screen recording and observation were used to uncover problems with functionality and usability. To test the design of the *graphic map* tool developed to give visual feedback on the substantive status of a user's essay, three graphic representations of essays in various stages of completion were presented to the user, who was asked what she thought to be reflected in each.

An informal discussion took place after the task segment, regarding the difficulties observed during the verbal protocol. This centred mostly on the use and misuse of connectives, their appropriateness and the potential to customize the language and terminology used within the interface. The proposal to include a visualization of writers' progress in the form of a graphic map was also discussed so as to further develop the design and representational function of the graphic.

PHASE 3 – TESTING WITH STUDENTS

This initial test with students aimed to reveal preliminary information on the writing processes of novices of argumentative writing using a computer-supported environment as well as usability related issues.

Phase 3 was conducted with volunteer students (17 and 18 years old) from Hull School. English was a second language for both testers. The students had received previous instruction on argumentative writing and its components in preparation for English proficiency examinations. They were selected by their teacher, the domain expert for the development of C-SAW, because of their different level of competence in and different approach to writing.¹⁴ One student was considered to be a low-self monitor with average writing skills (Tester1); the other a high-self monitor with poor writing skills (Tester 2). This sample of users appears to contradict findings that align novice writers with low-self monitoring (Bereiter & Scardamalia, 1987b), however, their writing level assessment may be based on an evaluation of their skills in writing in English rather than their writing skills in general. It has been suggested that writers' writing styles and cognitive strategies while writing in a second language may not be consistent with writing styles and cognitive strategies in their native language and they tend to engage in less free-flow text production when writing in a second language (Thorson, 2000).

The prototype version with which students worked was fully functional except for the re-ordering (*move down*) and *add argument* functions, which were only represented with a static icon. The graphic map was not yet implemented and not featured in the interface, but was tested with an adapted paper prototype as in Phase 2.

Testing with students consisted of 4 activities over a 1 and a half hour session:

1. **WRITING OF AN ARGUMENTATIVE ESSAY:** The students were asked to select a topic from a list presented, so that they would feel comfortable and motivated by the topic they would write about. They were instructed to write an argumentative text using C-SAW.

To partially compensate for time limitations, the students were given a list of tasks to attempt during the exercise so as to gather information on a range of metacognitive aid and usability aspects of the interface. (Appendix F) An analysis of verbal protocol to gather information on user perceptions and difficulties encountered, with respect to the facilitation devices within C-SAW, was considered, but in the end rejected because its benefits were not believed to outweigh the effects of additional cognitive load it would have on the writing activity of novices.¹⁵ Instead users' actions were recorded and analysed using screen recording software. To partially make up for what could not be recorded, an observer took notes during the writing task and followed up on problem areas during the post-task interview. Students were allowed to ask questions if they were stuck but were informed that their questions might not be answered, as it was important to see how they would try to solve the problem.

They were also given an extra sheet of paper to use during the testing, which they were instructed to use if they wished, as the way in which this was used during the writing process could potentially reveal preferences for a type of idea-generation, organization or planning support not included in C-SAW.

¹⁴ Originally 3 students were selected (with low, medium and high levels of writing skills) but the student with a high skill level chose last minute not to participate.

¹⁵ Flower and Hayes used protocol analysis to compare the cognitive processes of novice and expert writers but did not refer to the idea that this may present a larger cognitive load for novices than expert writers, thereby effecting their cognitive processes and the quality of their argumentative texts (Flower & Hayes, 1981)

2. **POST-TEST:** The post-test was designed to gather information on the internalization process of the structure of argumentative writing as facilitated by C-SAW. Students were required to mark up a prepared argumentative text to indicate the various components of the underlying schema. It was administered to determine if students were able to recognize the components of a given argumentative text. Scardamalia and Paris (1985) and Desmet et al. (2005) used identification of discourse components to test learners' familiarity and subsequent assimilation of the structures of argumentative text. The components of an argumentative text as presented within the C-SAW interface were each assigned a colour. The students were asked to highlight different components in different colours to assign an argumentative function to the different parts of the text.
3. **INTERVIEW ON WRITING AND POST-TEST ACTIVITIES:** Interviews with the students were conducted following the writing activity to gather information on their current writing practices and their experience with C-SAW. The purpose was to gather information on user needs and user acceptance potential of the tool for future development phases. Problems observed during testing and post-testing were also discussed with the students.
4. **INTERVIEW ON THE VISUALIZATION:** As the visualization component of C-SAW was not functional at the time of testing, the students were presented with a printout of 4 different graphic representations of 4 possible states of development of an argumentative essay. One was empty, others were partially filled and one was representative of a sample essay. (Appendix E) They were interviewed on their interpretation and their perceived usefulness of the graphics presented.

The results of phase 3 testing were implemented in the current version of C-SAW and are incorporated in the Results section. Appendix H lists evaluation results.

7. Development

The design and development of C-SAW went through three iterative phases modifying the framework, interface and components, and devices as a result of literature reviews of theory and practice on argumentative writing and the use of computer-supported tools for argumentation, and interviews and testing with practitioners and students.

7.1. THE FRAMEWORK

One goal of C-SAW is to offer varying representations of the underlying framework as represented within an XML based schema, while keeping the elements of the schema simple enough to be accessible to young writers. AML is all encompassing, but too large and complex to be easily translated into terms and an XML template structure that could be introduced to young writers. Mini-ArgML, on the other hand, focuses only on the components of a stand-alone argument and is not geared to representing a finalized written text. C-SAW needed a schema to represent the ontology of an entire argumentative essay.

In response both schemas were consulted, in addition to writing instructional resources (Harvard Writing Center) and literature on argument components (Aristotle, Toulmin, Warnick's excellent textbook on critical thinking); the importance of encouraging idea-generation throughout the writing of an essay (Galbraith); the importance of scaffolding (Vygotsky, Wood, Bereiter & Scardamalia); and the impact of language markers used in supporting cognitive and metacognitive processes in writing (the input of teachers interviewed, Dolz, Bell). Through user testing and literature reviews, further elements and attributes were added to reflect and facilitate the cognitive processes of writing. The result was ArgEssML (Argumentative Essay Markup Language) using the RELAX NG schema language. (Appendix A and Appendix B)

7.2. C-SAW INTERFACE OVERVIEW

The user-interface of C-SAW, i.e. the screen with which the writer must interact, is an explicit representation of ArgEssML and can be manipulated to give different textual and graphical representations of the argumentative text as writers compose.

The text is divided into four areas that are definitive of an argumentative essay: *heading* (author and title information), *introduction*, *arguments area* (consisting of individual arguments) and *conclusion*. (Appendix C: Fig. 12-5) The areas contain labelled components (editable text fields) reflective of the ontology inherent in ArgEssML. Changes in ordering, deleting and adding arguments is done within the *display mode*. The *editing mode* gives access to input fields for text generation. Writers can switch back and forth between text-generation and structuring activities at will, throughout the writing task. Each area is individually editable (editing mode) to allow writers to concentrate on the individual task, but notes can be taken at any point and changes can be saved or deleted, returning the writer to the overall view (display mode). *Procedural* and *substantive* facilitation is provided for problematic input fields in the form of labels (*markers*) and more detailed help (*cues*) that can be solicited at will. For relevant fields, suggested lists of possible connective words and phrases are also available. Various viewing options allow

writers to see visual representations of the progress of their composition and read their text with or without textual markers in separate windows and export or print their text. (Appendix C: Fig. 12-8)

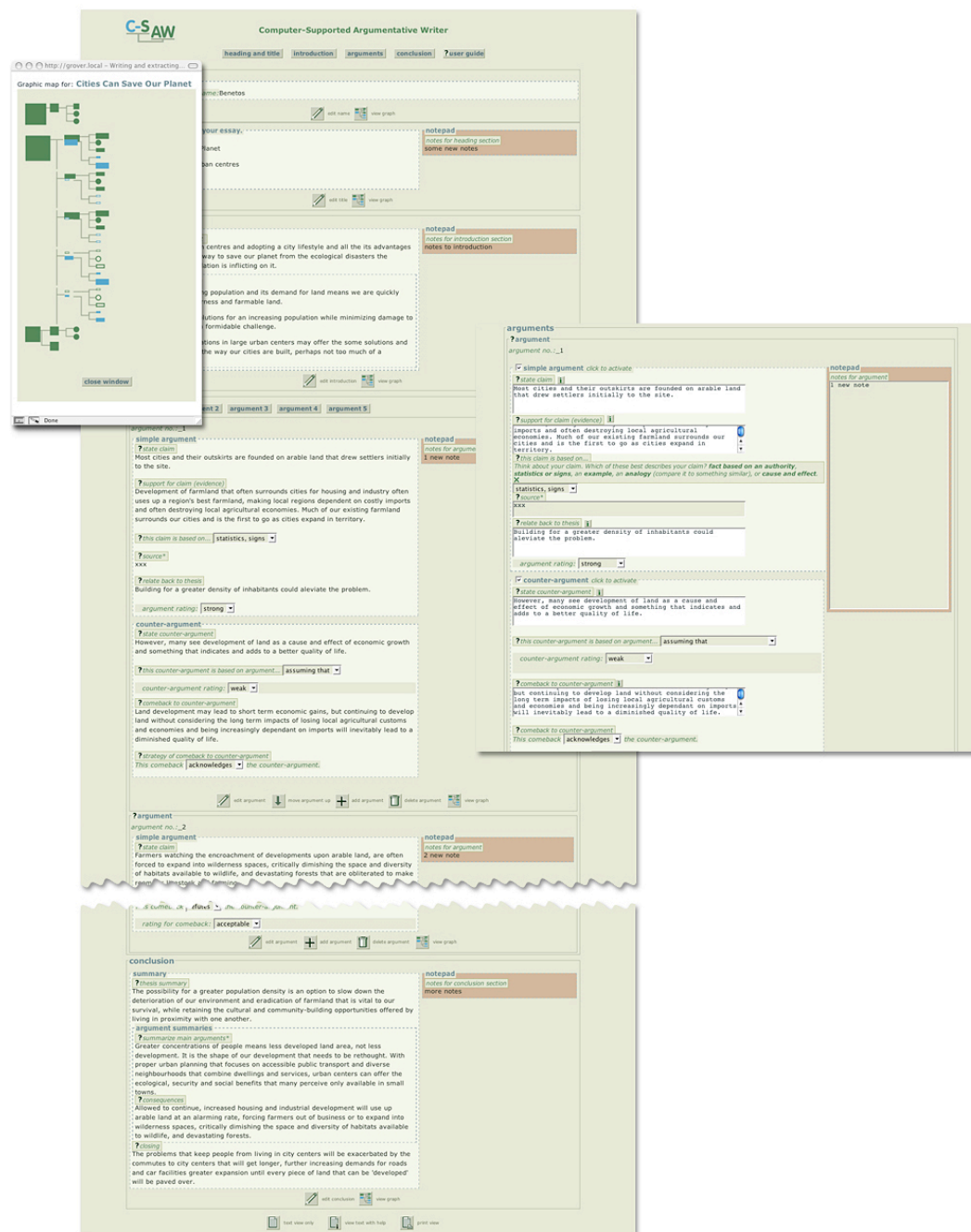


Fig. 7-1 Screen capture of the C-SAW interface. Behind: display mode, top right: edit mode, and top left: the graphic map.

7.3. C-SAW COMPONENTS AND DEVICES

The following outlines the different components of the C-SAW interface and their elements, in addition to the various facilitation devices within each, with a description of their cognitive or metacognitive function within the composition of argumentative texts.

7.3.1. Notepads

Notepads, available for input of free-flow text or note-taking, may serve both *low* and *high-self monitors*, but probably serve the latter better. The capacity to engage in free-flow text that enhances text generation and hence idea-generation, at all stages and processes of writing, may encourage high-self monitors to take more notes and store ideas generated during text elaboration, thus reducing the tendency to censor their ideas. These notes, turned into artefacts of episodic memory, can then be used in subsequent argument development. Conversely, low-self monitors are free to compose their text directly in text fields, while adhering to the executive structure.

7.3.2. Introduction area

The introduction area facilitates the definition of a rhetorical goal. The markers and cues provided are intended to draw the writer's attention to the importance of defining the purpose and the worthiness of the topic and standpoint to be elaborated. This can easily be reviewed and revised as the writers' knowledge and representation of the topic expands or changes during the activity. (Appendix C: Fig. 12-3)

7.3.3. Conclusion area

Similarly to the introduction, the conclusion area allows adherence to argumentative essay executive structures while the cues encourage the writers to re-assess their rhetorical goal and perhaps modify their position accordingly (Appendix C: Fig. 12-5). The process may invoke forward search processes as the text produced in summary inspires further re-assessment and revision that can have repercussions on the entirety of the text. Additionally, backward searches can come into play as writers use constructed arguments to guide knowledge-transformation through the consideration of *consequences*, forming unanticipated conclusions, and modifying the main rhetorical goal. It should be noted that this is a process that may be iterated with every new or modified argument on the sub-level as the writer is cued to reflect upon the significance and relation each argument to the rhetorical goal (Flower & Hayes, 1980).

7.3.4. Argumentation model

The design of the individual arguments is based on careful consideration and simplification of components of Toulmin's model as listed earlier in Section 3.1.1.

To allow for a variety of argument constructions and formats based on cultural conventions, there are three types of arguments that can be constructed using C-SAW:

Simple argument: claim and evidence, related back to the main thesis.

Counter-argument: counter-argument to the main thesis with a rebuttal turning the counter-argument on itself and using it to back the main thesis

Complex argument: presenting a simple argument, a counter-argument to the simple argument and a rebuttal that anticipates the counter-argument.

One important aim of the C-SAW interface is to include elements and their markers to reduce the cognitive load for writers not familiar with the executive structure of argumentative writing (substantive facilitation). A perhaps more critical aim, is to facilitate the cognitive process (procedural facilitation) involved in reasoning through the use of cues that can be solicited when needed. These cues demand that the writers make crucial aspects of their reasoning explicit to the reader (*evidence, relating*) and to themselves (*basis* and *source*). The elements within an argument are linearized¹⁶ to reflect a common yet flexible written argumentation pattern, and are presented as input fields to be completed.

CLAIM (*state claim*) allows writers to make their propositions.

EVIDENCE AND REASONING is divided into *support for claim, basis for claim, source* and *relating claim back to the main point*. Only *support for claim* and *relate back to thesis* are text input fields that result in text that will be part of the essay. The former act as *data, warrant* and *qualifier* to support the claim; the latter as cognitive aids to encourage writers to assess their claim alone and with respect to the global rhetorical goal.

ANTICIPATION OF A COUNTER-POSITION or *counter-argument*, as it is referred to in C-SAW, can be used in two ways. It can be used to present a counter-position to the main thesis followed by a rebuttal thus creating an argument or it can be used to present a counter-position to the preceding claim. The counter-argument must be defined from a list of suggestions that are a simplification of reasoning and logical fallacies commonly used in argumentation (Householder). Defining the basis of the counter-argument may facilitate the formulation of a valid rebuttal.

RESPONSE OR REBUTTAL answers the counter-argument. With the help of the available cue, writers are encouraged to reflect upon the strategy they use within the rebuttal. The *refute, acknowledge* or *concede* choices that are explained in the cue reflect the range of possible ways to deal with a counter-argument (Aristotle, 350 BC, Warnick, 1987).

7.3.5. Domain specific cognitive aid

The cognitive aid that is provided within C-SAW is specific to argumentative essay writing. It uses the terminology of the domain of argumentation and refers to the function of content within this context, but steers clear of giving any guidance as to actual content.

REASONING

The cue presented under *evidence* suggests types of evidence that may be presented. To further encourage the building of rhetorically sound arguments, *basis for claim* asks writers

¹⁶ See *Issues and feature requests* section in this document

to identify the type of reasoning used, based on Warnick's categories¹⁷ and *source* asks writers to prove the reliability of their evidence by citing a source (this is optional). Both elements do not appear as part of the final text product and serve only as cognitive aids to encourage writers to reflect on the nature of the claim and the reasoning behind it.

Similarly, *state counter-argument* and *comeback* contain text input fields, while *basis for counter-argument* and *strategy* act as cognitive aids in the construction of a cohesive argument. (Appendix C) The simplification of logical fallacies is a derivation from suggested strategies for counter-argumentation (Householder) and is purposely limited, as novices of argumentation may have great difficulty distinguishing types among an extensive list of argumentative fallacies. The *comeback* strategy used must also be defined.

CONNECTIVES

In keeping with research by Akiguet & Piolat (1996) and Crewe (1990), the possibility to solicit a list of context specific connectives was added to the interface (Appendix C). The list of connective words and phrases for each element was derived from a list provided by the writing centre at Texas A&M International University and cross-referenced with several online resources (Phonetics & Linguistics at University College London, University of Wisconsin Writing Handbook). Crewe's principles of reducing lists of terms to subsets, expanding them to phrases and showing how they enhance overall logical progression were used to refine the lists (Crewe, 1990).

7.3.6. Models of linearization of argumentative essays

The linear organization of a written argumentative text can take on various forms dependent cultural on conventions (Kachru, 1997):

For example, the organization can follow: (a) introduction, arguments 'for', arguments 'against', conclusion; (b) introduction, arguments 'against', arguments 'for', conclusion; or (c) introduction, an argument 'for' and its counter-argument, another argument 'for' and its counter-argument, etc., conclusion.

Stating the claim, giving *evidence* and *relating* back to the thesis form an argument 'for' the thesis; referred to as a *simple argument* in C-SAW. Stating a counter-position and responding to it (*state counter-argument* and *comeback*) form an argument 'against' or 'response-type' argument; referred to as a *counter-argument* in C-SAW. These two argument types can be used individually or combined to represent a variety of argument organization strategies (Appendix C: Fig. 12-5).

7.3.7. Self-regulatory facilitators

The facilitation of self-regulatory mechanisms can lead to more elaborate argument development and a more cohesive overall structure by enabling writers to gain control over which writing process they should engage in and when (Rijlaarsdam et al., 1994). C-SAW offers three devices that may lead to an improvement of self-regulation.

¹⁷ Warnick, in her textbook "Critical Thinking and Communication" distinguishes four basis for reasoning: analogy, generalization (*example*), cause (*logic*), sign (*statistic*), authority (*fact*).

Jermann et al. (2004), describing collaboration management tool design options, distinguish between three types of regulation tools: *mirroring tools*: reflect information on an interaction with no evaluation; *metacognitive tools*: propose possible courses of action with a comparison to a reference model; and *guiding systems*: comparison of the current state with the desired state is assessed by the system internally and guidance is provided accordingly. Allowing that in C-SAW the interaction is between the user and the system rather than between one user and another (through the system), the self-regulatory tools within C-SAW fall under the first two categories.

RATING

Each text input element within an argument (*simple* and *counter-arguments*), can be evaluated by the writer through C-SAW's interface that allows the writer to give a rating to the idea they have generated, thereby invoking the benefits correlated to self-evaluation (Bereiter & Scardamalia, Karoly, Schunk, Flower & Hayes). The ratings are kept simple: *weak*, *adequate*, or *strong*. These ratings are then used in the generation of the visualization of the essay and its status within the *graphic map*.

GRAPHIC MAP

The graphic map represents the structural components of the essay and their current status in a hierarchical tree graphic produced from data stored in the XML data file that is edited as writers work on their essays (Appendix E). It is intended to give writers immediate visual feedback on demand, aiding in self-monitoring and task completion.

The graphic map is produced from:

1. The data model in the XML data file
 - a. a new argument node (and its sub-nodes) is created for every argument added.
 - b. nodes are full or empty depending on whether or not all mandatory elements have been filled out (based on Boolean values testing for the existence of content).
 - c. nodes are colour-coded to show stance (*pro* or *counter*)
 - d. node shapes indicate whether or not it is mandatory to complete a particular node
2. The values transmitted by the actions of the writer
 - a. rating scores given by writers to each argument that are factored into the score
 - b. Boolean values from testing for the existence of content in optional elements (giving bonus points for extra effort)
 - c. number of arguments presented in the essay.

At the start the essential components—the introduction, 3 arguments, and the conclusion—are represented as empty. Components and their elements are filled in as the writer adds text to them in the main editing window. Moving the mouse over a node gives its marker label.

VIEWS

The variety of viewing options allow for multiple visual representations of the written text during the writing process in the hope that it will facilitate structuring and internalization of the executive structure of argumentative writing (Baker et al., 2003, Erkens et al., 2002a,b). There are four different views possible within C-SAW:

Editing and Display mode views: the main window in which text composition occurs.

This view includes all the markers and cues and help with connectives that can be solicited.

Text with help: A pop-up window provides a view of the text produced but ‘marked-up’.

Cues can be solicited as the text is reviewed.

Text only: A view of the text produced with no markers or cues.

Print view: A view of the text produced with no markers or cues but formatted for printing. The file may be saved in text format through the browser’s file menu.

It is hoped that through the cognitive aid tools and the visual representations available to writers using C-SAW, they will be encouraged to engage in metacognitive processes to create arguments and counter-arguments that are based on diverse types of reasoning, learn to control these processes and through repeated guided use, eventually internalize the reasoning mechanisms and components of argumentation to be able to write argumentative texts without external guidance (without C-SAW).

7.4. TECHNOLOGY USED

C-SAW is a browser-based application that behaves like an authoring tool. At its core is the PHP based server-side application that runs on any Apache server installation running PHP5. This interprets and modifies the XML data file that is edited through the web-based interface of C-SAW. C-SAW currently works only through the Firefox 1.5 and higher web browser with the SVG plug-in installed.

To edit the XML data file, PHP functions are used to modify the DOM (Document Object Model) of the XML file.

JavaScript is used to control interactions that require the opening of various views in pop-up windows and the display of solicited cues.

The visualization (*graphic map*) of the argumentative text is generated using PHP to call up SVG functions that read the DOM and XML data as it is modified through the main window and then generate the graphic representation. PHP files, with different HTML coding for the visual rendering of the text data, are used to generate the different textual representations.

8. Results

This research investigated three major areas that needed to be considered in the design and development of a computer-supported authoring tool to help novices of argumentative writing improve their writing skills and their knowledge of the schema inherent to argumentative writing.

The first area of investigation concerned the design and development of arguments and their components, looking at difficulties with idea-generation, reasoning and structuring at the local and global level. Devices to improve the quantity, quality (scope and depth), organization, and structure of written arguments were introduced and tested.

The second area of investigation looked at the possible ways that internalization of the schema underlying the argumentative genre could be enhanced within the system's design. A framework was designed and facilitation devices that aimed to enhance the internalization of the schema underlying the proposed structure for argumentative writing were introduced and tested.

The third, investigated approaches and types of feedback that could be used to enhance self-regulation aimed at improving the global quality of the text. Devices that enable the visualization of self-evaluation and progress were introduced to facilitate self-regulation during the writing activity and improve global structure and linearization of the written text.

8.1. DESIGN PROCESSES AND METHODS

As with any information or knowledge representation system, it is only useful if the result succeeds in facilitating the desired goals, users understand what they can and must do within the environment, targeted users are capable of manipulating the interface to accomplish desired tasks and users find the environment pleasing to work with (Poirier, 2005). To feel comfortable within a computerized environment, the user should be able to understand the language and sign system (icons, links, what is permitted, what is not), reasonably predict the outcome of actions (functionality), and receive adequate feedback on actions taken (e.g.: forms submitted or fields omitted).

Argumentative writing is a complex writing process and the capacity to write argumentative texts is key if students are to be able to engage in curriculum that incorporate the goals of writing-to-learn based curricula. The instruction and learning of argumentative writing is difficult and dependent on many factors (age of students, type of argumentation expected, learning goals, students' learning styles, current practices in the field, cultural conventions, etc.). Any research on the design of a tool to facilitate the production of argumentative writing and the internalization of its inherent processes and structure, would have to consider all these aspects as well as the dynamics between them, while trying to build upon a body of theoretical knowledge. A combination of methods derived from *design-based research* (Collins, 2004, Reeves, 2000), *user-centred design* theory and practice (Poirier, 2005, Axup, 2002), and *systems design* (Dillon & Morris, 1996), as described by van den Akker below best align themselves with the goals of this project.

Interaction with practitioners is needed to gradually clarify both the problem at stake and the characteristics of its potential solution. An iterative process of

'successive approximation' or 'evolutionary prototyping' of the 'ideal' intervention is desirable. Direct application of theory is not sufficient to solve those complicated problems. One might state that a more 'constructivist' development approach is preferable: researchers and practitioners cooperatively construct workable interventions and articulate principles that underpin the effects of those interventions. (van den Akker, 1999, p. 4)

A *needs analysis — theoretical framework — design — test — report* loop was iterated in three phases with targeted users.

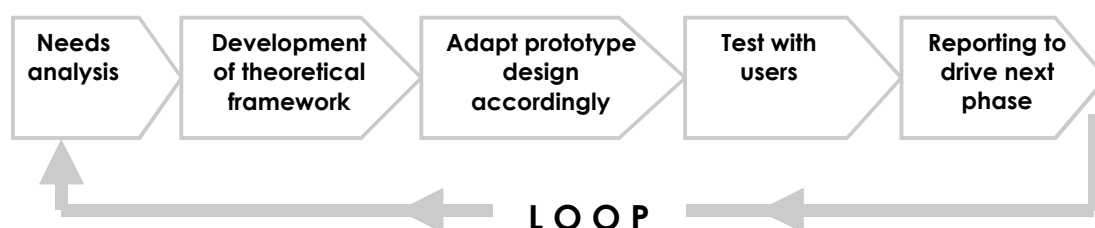


Fig. 8-1 Design-based research process used in the development of C-SAW derived from literature on *design-based research*, *user-centred design* and *systems design*.

8.2. FACILITATION OF THE GENERATION OF IDEAS AND ARGUMENTS

The idea-generation process is crucial to the deepening and expansion of knowledge and the development of arguments, and can occur at any stage of the writing process (Flower & Hayes, 1981). One of the potential negative impacts of cognitive aid that imposes a structure upon writers is that the cognitive load introduced in the attempt to adhere to the structure may inhibit idea-generating processes (Galbraith, 2005, Bereiter & Scardamalia, 1987a). Different writing styles (low vs. high self-monitoring) also play a key role in what form ideas are initially translated. Acknowledging the importance of supporting idea-generation and the differences in writing styles throughout the writing process and recognizing that the capacity to engage in free-flow text or note-taking as needed, a *notepad* is included within every major component area of the interface (the introduction, each argument, and the conclusion). It was thought that the free-flow and note-taking options combined with the permanence of the text produced, would encourage idea-generation thereby aiding in the improvement of the text as a whole.

The practitioner engaged during development phases concurred on the importance of facilitating idea-generation within the computerized environment to complement more collaborative idea-generating activities within lesson plans. This is in accordance with C-SAW's goal to be a support within existing lesson plans that would focus on the structuring and linearization processes without hindering idea-generation.

Preliminary testing with students indicates that although space for idea-generation is important, it is not vital to have a designated space strictly for this purpose. Although Tester 1 attested to using paper to generate her notes, neither she nor Tester 2 used the scrap paper provided, nor did they use the notepad within C-SAW to generate their ideas. Closer scrutiny of the testers' writing process showed that free-flow text generation and note-taking was going on, just not in the spaces allocated for this process. Both

recorded their ideas directly in the text fields. Tester 2 expressed that she particularly liked being able to easily record her ideas and have them at her disposal.

Each tester worked differently while writing: Tester 1 wrote full text directly into the text fields and made fewer revisions than Tester 2 (consistent with low-self monitoring). Tester 1 solicited help more often than Tester 2. More consistent with the writing styles of high self-monitors, Tester 2 used the first text field in each area to engage in a combination of free-flow text and note-taking forms of idea-generation before expanding her text. Neither engaged in any global planning activities prior to writing.

Idea-generation, for these two testers did not appear to be hampered by the constraints of the tool. Both the low and high-self monitor generated equal amounts of ideas. Tester 1 produced almost double the text, but both produced similar amounts of ideas during the time allotted.

8.3. ENHANCING REASONING AND THE QUALITY OF WRITTEN ARGUMENTS

To help novices of argumentation improve the quality of their written arguments, it was necessary to identify their difficulties. Literature reviews and interviews with practitioners revealed that novices of argumentation have great difficulty in constructing valid arguments. Their arguments lack scope (Baker et al., 2003) and reasoning (Dolz, 1996) and are not expanded to anticipate opposing points of view or come to conclusions arising from their argumentations (Brassart, 1996). The practitioner during development blamed much of her students' poor argumentation skills on deficient reasoning and a lack of critical thinking approaches.

C-SAW includes scaffolding devices that apply recommendations set out by Bereiter & Scardamalia's (1987a) substantive and procedural facilitation guidelines providing contextual guidance through marker and cues to lessen the cognitive load.

The practitioner interviewed stated that having students develop their arguments in stages of increasing complexity could facilitate the argumentation process. Particularly appreciated by the practitioner was the option to build different types of arguments and the prominence, though not imposition, of the counter-argument as an essential component of a complex argument, as it would allow writers to practice with different types of arguments. The itemization of the components of an argument within C-SAW was believed to allow writers to focus on one element at a time, while making the model of argumentation being used explicit to writers, who could use the cues to evaluate their ideas with respect to the claim and the rhetorical goal as a whole.

Screen recording revealed much about the process of writing for each student tester. Both students often referred to the markers and cues. However, it is difficult to tell whether testers used the cues to guide their writing or simply read the cues as a perfunctory response to the task. Tester 1 solicited cues before beginning to fill out an element, and left them mostly open while composing but engaged mostly in free-flow text production, limiting reviewing to grammar rather than content. Tester 2 solicited help less often than Tester 1, though often more than once while filling out a component, and usually closed the cue before resuming writing. Recording of eye movements could answer if and when writers read the markers and cues.

Tester 2 appeared to be engaged an attempt to resolve the ethical conflicts her ideas presented. She did not appear to have a strong opinion to begin with and seemed to be developing her position as she wrote. Solicitation of the cues in the middle of the text production might indicate that the tester was using the cue to guide her writing or to evaluate her ideas. It seems she may have been using C-SAW to engage in a dialogue and evaluate the validity of her ideas as they were generated. The fact that she produced less text points to a censoring process or selection of appropriate ideas taking place that corresponds to a knowledge-transforming process, but she nonetheless produced an equal amount of ideas as Tester 1 (though in note form).

The testers, while admitting that the cues made them think more about the arguments they were building and made writing more demanding, believed this would in turn help them write better texts. Tester 1 remarked that she had a difficult time attacking her own ideas and did not enjoy feeling she had to do it, but felt that through C-SAW she could learn how to include counter-arguments without destroying her claims.

8.4. IMPROVING THE OVERALL STRUCTURE AND LINEARIZATION

Novice writers have difficulty juggling content generation, attending to the executive structure of argumentation and adhering to the global rhetorical goal of their text. Within C-SAW structuring is facilitated on the global level as well as the sub-levels. To determine how the design of a computer-supported authoring tool could help novices to improve the overall structure and linearization of their argumentative texts, task lists were designed to include structuring and linearization activities and testers' actions were recorded and observed during the each phase and modification (Appendix F).

The structure within arguments is facilitated through the prescribed ordering of components. This particular model was chosen as a good starting point to familiarize novices with the components of argumentation and the order in which they should appear so as to construct a cohesive argument. Further help in structuring arguments is provided by guiding writers to relate their arguments to the global rhetorical goal. Although the practitioner thought the model to be both comprehensive and easy to follow, testers seemed to have difficulty adhering to the structure within an argument. Testers included counter-arguments or evidence within their claims. Surprisingly, the counter-arguments, whose formation is noted as being particularly difficult for novices, were better constructed than the arguments "for".

To be effective in aiding writers with the global structure and linearization process, the text should be easy to view as a whole, it should be easy to reference and edit different parts and elements, and easy re-order. The text should be easy to manipulate. Practitioners and testers expected at least the features offered by a simple text editor. User testing allowed for the discovery of problems and proposal of solutions to the execution, organization and linearization processes.

Although the testers at no point complained about this, screen recordings and observation showed significant disorientation and much scrolling as users moved between *edit* and *display* modes. Anchored links to the different parts of the document were included at the top of the interface window. A numbering system for arguments was implemented and anchored links to individual arguments were introduced within the *arguments* area.

There were initial problems while editing areas, where the users did not know how to escape *editing mode* without making any changes. *Cancel* and *Delete* options have been added to the interface to allow users to escape from an action without committing changes. These modifications have not yet been tested.

It is difficult to draw strong conclusions on the potential efficacy of the structuring and linearization devices within C-SAW from the limited user testing conducted as part of this research. Tester 1 engaged in the writing task for 40 minutes; Tester 2 for 45 minutes. During this time both worked on the introduction and first argument areas only. Testers, however, appreciated having the executive structure pre-defined. With the 'skeleton' provided they claimed they could focus on the content.

8.5. FACILITATING THE USE OF CONNECTIVES

The proper use of connectives is crucial to the structuring of individual arguments, the overall organization of arguments and the development of conclusions (Akiguet & Piolat, 1996). The use of connectives by novices of argumentative writing was reviewed in literature and was monitored and discussed during testing to determine the potential effects of context-related suggested lists of connectives on testers' texts.

The presentation of help with connective words and phrases went through several stages of evolution and editing, from a general list to more context specific suggestions pertaining specifically to the argument component being edited. Lists of connectives, while relevant to the related component, were still not optimal in content. The practitioner pointed out that it was important for her to be able to edit the lists to limit them to words and phrases that have been introduced in class so as to ensure their proper use. Limiting choices and expanding terms to exemplary phrases is likely to limit the tendency by novices (and especially ESL students) to misuse and overuse connectives and copy connecting phrases verbatim (Crewe, 1990).

It became apparent during testing with students that the icon linking to the suggested connectives for each element was not well placed. One student did not notice the icons linking to the suggested connectives. The icon was moved next to the marker in each case, so as to be more prominent and accessible.

Both student testers' texts were poor in the use of connectives, mostly limiting use to *if*, *but* and *or*, and using Germanisms (*when* for *if*). Tester 2 referred to the lists of words often and made changes to her text afterwards, and did not copy the suggestions verbatim. Both students expressed appreciation for the suggested lists of connectives and thought they would help them link their ideas, though they admitted they were not familiar with many of the terms. This revealed that students recognize their difficulty in linking ideas and indicates that suggested connectives to help them formulate and structure their arguments could be beneficial to the quality of written arguments and the structure of the global text. Literature and the interviewed practitioner, however, insist that the number of options, their relevance to the particular process of the argument and proper instruction on the semantic use of the words and phrases must be considered (Zamel, 1983, Crewe, 1990). With the exception of instruction on the semantic and grammatical use of connectives, these considerations have been included in the design of the device that provides help with connectives.

Perhaps one of the most important developments to come out of the Phase 1 testing was a rethinking of who should control the cognitive aids. Until the feedback analysis, wording of markers and cues as well as the list of connectives suggested was controlled by the developer. It was revealed that it is imperative to eventually implement a user-centred solution that would allow teachers to edit the text of markers, cues and list of connectives. C-SAW includes proposed lists of connectives, but teachers are able to customize these through C-SAW's included JavaScript file.

8.6. SCHEMA INTERNALIZATION

Dolz (1996) showed that preliminary instruction on the components, conventions and structure of argumentative writing had positive effects on the quality of the texts produced for students as young as 10 years old. It is believed that through the markers and cues included within the substantive and procedural facilitation, the design of C-SAW acts as additional instruction and may reinforce the internalization process of the components and conventions of the schema inherent to argumentative writing. A post-test was administered to determine if students, by writing texts using C-SAW, had learned something about the executive structure of argumentative writing.

Post-test results showed a poor capacity to recognize components of an argumentative text. Both students failed to accurately recognize evidence and counter-arguments as such. Questioning students after the post-test revealed that they had difficulty with the language used within the text sample essay (Appendix I) and the terminology within C-SAW. Evidence was often mistaken for counter-arguments; even claims were mistaken for counter-arguments. One student didn't distinguish between the thesis (main point) and claims (arguments 'for'). The problem was exaggerated when the arguments did not follow the claim, evidence, relate, counter-argument, comeback order. In the argument where the evidence was purposely presented before the claim, both students mistook the claim for a counter-argument. This was a *simple-argument* that presented only a case "for", implying that they were perhaps relying on the order of the ideas presented rather than their meaning to make their choice.

The practitioner believed that an interface that represented the executive structure would help novices internalize the underlying schema of argumentation and enable them in the long-run to write better argumentative texts, independent of C-SAW. The student testers agreed. Tester 1 explicitly stated that she would use the software "only in the beginning to learn how to do it properly". Both of the student testers believed they learned something about the structure of argumentative texts through the use of C-SAW. Post-testing, however, showed that neither student was capable correctly identifying the function of the different parts of the text presented.

It is very likely that in this experiment students did not work with C-SAW long enough to internalize an adequate representation of a schema for argumentative writing. When asked to assign a label from C-SAW to the different parts, they were both able to correct some of their errors (the task used terms the students had been using in class). Students were not familiar with the terms used in C-SAW's markers and cues. They had been instructed using different terminology (argument for = claim, argument against = counterargument, etc.), and although the cues through the guidance they offer inherently

further define the markers, the students had some difficulty understanding the language used within the cues. Tester 2 used an online German-English dictionary to translate terms she did not understand. This was compounded by the fact that they both found the level of the language of the sample essay provided for the post-test difficult.

This further highlighted the need to allow practitioners to easily modify the language used within the markers and cues. Currently the markers can be edited in the template XML file, but cues can only be edited within the PHP files. Both options are not very feasible for practitioners. Future prototypes need to implement an interface for practitioners, that allows them to customize the language used throughout the C-SAW interface.

8.7. ENHANCING SELF-REGULATION THROUGH VISUALIZATION

To enhance self-regulation, it was thought that in addition to a device enabling writers to actively rate their contributions to individual components of each argument and area, multiple visual representations of the executive structure, reflecting the desired state and the writers' progress would be beneficial (Erkens et al., 2002a).

As a result of discussions during the first two development phases with the practitioner, on how to make self-evaluation evocative so as to inspire revision and facilitate self-regulation, a visualization device was introduced. It was concluded that the design of the *graphic map* should show at once the minimum requirements expected, reflect writers' contributions and self-evaluations, and give extra credit for completing optional sections, to reward extra effort.

The practitioner and developer thought the graphic map to be an addition that might prove very motivating to students seeing artefacts created through their composing process. Beginning with an introduction, 3 empty arguments and a conclusion represented as the minimum to be completed, it was thought it would help the self-regulating process by allowing them to see what is missing and what can be improved.

The graphic map in the form of a hierarchical tree map was well received all testers. Both students saw it as a good way to track their progress and draw their attention to what needs to be reviewed and revised. The graphic itself was thought to be straightforward and easy to understand if one is even vaguely familiar with the structure of an argumentative essay. The graphic map was easily and correctly interpreted as a visualization of the status of an essay. Its usefulness was accepted by Tester 1, but put into question by Tester 2 who did not think she would refer to it for feedback.

The *graphic map* was developed and included in the final prototype version to make it available for further testing. It represents what is required, what is complete and factors in writers' self-evaluation and 'extra' effort.

8.8. INTEGRATION OF C-SAW

Preliminary interviews with 2 practitioners attempted to assess practitioners' attitudes to using instructional technologies within the classroom and determine any doubts or difficulties these might present in further testing and eventual acceptance and integration

of a computer-supported authoring tool for argumentative writing in their current teaching practice.

Teachers at the Hull School are not currently using any computer-supported tools for either individual or collaborative writing activities, but are open to introducing them as long as they are “user-friendly” (not more difficult than a typical word processing software like MSWord). The interviewees believed that teachers would be willing to use a tool that would facilitate writing (a skill that presents great difficulty for the largely ESL students of Hull School) and keep them at task for about an hour.¹⁸ Access to computers is not a problem within the school and students have adequate keyboarding skills.

In order for it to be readily accepted by teachers, practitioners agreed that the computerized tool should:

- be easy to implement
- require no technical knowledge beyond basic computer user skills (navigating to website, basic text editing functions, etc)

C–SAW requires no proprietary software and only the installation of the Firefox 1.5 or later web browser and can be run from any computer or server running an Apache web server with PHP5 installed (a very common server and common configuration). As such, it is considered easy to implement.

Working with C–SAW requires only basic computer user skills.

8.8.1. User acceptance potential

User acceptance of information technologies (that can determine whether or not a computerized tool will be used for its intended purpose) can be predicted by the analysis of *perceived usefulness* and *perceived ease of use* (Davis, 1989). Results of testing can be interpreted to predict a potentially high perceived usefulness for C–SAW among teachers and students. Both students and teachers involved in testing phases believed that the use of C–SAW would enhance their performance: teachers saw C–SAW as an aid to help students improve their argumentation capacities and argumentative writing skills; students believed C–SAW would help them think through their argumentation and write better texts.

User testing also revealed a high perceived ease of use from a systems design perspective, i.e. the tool as a technological device was easy to use, the interface was intuitive, and tasks could be easily accomplished within the environment. However, the procedural tasks the environment supports are made explicit, thereby demanding the user engage in a greater variety of cognitive processes (text production, idea-generation, adherence to an executive structure, critical self-assessment, ordering of ideas). Users, through admission, appeared to recognize this as necessary in working towards the process goals and learning goals and that these, through repetition and practice, would become easier to achieve.

¹⁸ Practitioners stated that students they rarely stay at task longer than an hour.

9. Discussion

9.1. FEATURE REQUESTS

The three research phases conducted revealed some features that should be included and tested further within future prototypes:

All *markers*, *cues*, and lists of *connectives* should be editable in future versions (currently editable through XML, PHP or JavaScript files) through a separate interface that allows practitioners to configure the language to their students' needs and capacities.

The ability to add *transitional ideas* between arguments to make text more fluid can be better facilitated (Burchfeld, 1996). Transition elements could allow for optional free text, so as to not excessively constrain writing to the prescribed structure and unintentionally limit idea-generation. Future versions should consider the inclusion of a transitional element at the start of each argument. As this optional element may be open to misuse by writers lacking self-monitoring capacities, the activation of this feature could be regulated by instructors, who could choose to introduce the additional level of complexity once the basic structure has been internalized.

The argument model design and the possibility for further options must be revisited and studied further. The order of the elements within an argument should be open to 're-ordering' for more sophisticated argument structures where evidence or warrant may come first and lead the reader to the claim. This can also be a feature that is open to regulation by teachers, so as to ensure that the additional level of complexity is introduced only once the basic structure has been internalized.

A versioning system that allows the writer to save drafts that can be recuperated at will should be envisioned in future versions.

9.2. APPRAISAL OF PRELIMINARY TESTING

The goals of this research and development project were to explore the potential of a computer supported argumentative writing software to improve the writing of novices. Some limitations partly inherent in design-based research that incorporates methodologies of ethnographic and qualitative research in a complex situation (Collins, 2004), and some partly dependent on the short-comings of the testing as executed in this research, raise some questions and concerns about the results obtained that should be further investigated.

- With the small sample of testers, the observation that Tester 2 exhibited some characteristics of low self-monitors and was not an extreme example of high self-monitoring, coupled with the possibility that her high self-monitoring tendencies may have been amplified by writing in a second language, means that extra caution has to be taken when attributing her behaviour to her writing style.
- While high user acceptance was predicted by testing, user acceptance is an assessment of "people's subjective appraisal of performance and effort and do not necessarily reflect objective reality." (Davis, 1989, p. 335) The relationship between

user acceptance and the quality of final texts produced with the use C-SAW and without would need to be investigated to see whether C-SAW leads writers to have an accurate appraisal of the qualities they attributed to it.

- Screen recordings reveal a lot on users' activities but don't reveal where a user is looking during pauses. Although an observer took notes during the testing, it was difficult to ascertain what the writer was doing during pauses in the writing process and the frequency with which markers and cues were being read. Recordings of eye movements may reveal more.

Testing was not integrated within a lesson plan where students would have arrived with some ideas and would be ready to structure ideas and linearize their texts. Testers were not available for the time required to write a complete essay. As a result testers spent the larger portion of the writing task generating ideas and arguments. Their texts are partial attempts and incomplete. Only preliminary conclusions on the effects of the tool on the quality of text could be drawn from the user testing. It is also difficult to draw conclusions based on the overall structure and quality of the text produced by testers. Further testing with a larger representative sample over the course of several days and the inclusion of the activity using C-SAW within an actual lesson plan would provide a more precise observation and understanding of the ways in which a computer-supported authoring tool is and could be used.

9.3. FURTHER QUESTIONS AND RESEARCH

One advantage of using C-SAW to study argumentative writing processes is that it produces XML data files that are open to many forms of qualitative and quantitative analysis. Some suggestions on possible research that could be conducted using C-SAW are outlined.

1. Changing the order of argument models to test which is more natural to novices: (a) *claim > data > conclusion* or (b) *data > conclusion > claim*
2. Many questions have been raised especially as to the specific role of each type of cognitive and metacognitive aid provided within the system. The markers and cues can be easily isolated and manipulated to study the effects of aids in particular cognitive processes and types of facilitation (substantive, procedural).
3. The effects of the different types of visualizations can be further studied. Some questions include: What do the different types of visualizations specifically reveal to writers about their texts? Do they serve multiple purposes or different ones for different writing styles and different processes?
4. One tester thought the graphic map could be used to navigate to the different text parts within the main edit/display window. Could the visualization tool be used as a menu as well as a representation to construct the text—adding, editing and accessing markers and cues, and text produced through it, rather than the current text-based visual representation? What effects (benefits or disadvantages) would this graphic structuring and linearizing tool have on the writing process of novices?

5. Students believed C-SAW could help them think through their argumentation and write better texts, suggesting that the use of C-SAW may enhance self-efficacy. Testing this variable with and without the use of C-SAW may yield interesting insight on the role of computer support on self-efficacy.
6. The effect of solicited vs. unsolicited help was studied by Salomon, Zellermayer, Globerson and Givon (1991) and they found unsolicited help had positive effects on text quality. This prototype offers minimal unsolicited help through unsolicited *markers* and detailed help through the solicited *cues*. C-SAW can allow for a variation on the types of solicited and unsolicited help offered and facilitate further studies in this area.

10. Conclusion

A well-designed computer-supported authoring tool could offer the structural support and guidance, and a writing medium to help in the writing process by alleviating the cognitive load for novices of argumentative writing. The computer-mediated environment should provide a way to note, structure, linearize, track and reflect upon ideas and formulated arguments. It should help increase the quantity of arguments generated. The quality of arguments should be enhanced in scope (variety of arguments including epistemological (Baker, Quignard, Lund, Séjourné, 2003) and functional (Dolz, 1996) perspectives), and depth (inclusion of counter-positions) to improve the structural quality of the written discursive texts of novices.

The *needs analysis — theoretical framework — design — test — report* design-based research processes adapted for the design and development of the C-SAW prototype allowed for an integration of theory, practice and experimentation in iterative stages that brought the design in line with the development goals of this project as outlined earlier (Section 5) and above.

It is not the purpose of this design experiment to produce a tool that will favour one type of writing process over another, or one style of writing over another. It is believed that free-flow text processes, knowledge-telling and knowledge-transforming processes regardless of whether they lead to knowledge-constitution, are all important to argumentative writing and need to be facilitated in an environment that purports to support argumentative writing. Furthermore, it is recognized that writing styles can vary according to the writer's disposition to the topic or task, therefore the environment needs to support both styles of writing. C-SAW does, however, focus its facilitation on the development and structuring of arguments on the local and global level, as well as the quality and linearization of the argumentative text as a whole (including the introduction of the central thesis, its development and a conclusion based on the evolution of the argumentation).

C-SAW respects the requirements of a computer-supported authoring tool to support argumentative writing. Literature and testing suggest that the design of C-SAW supports a variety of writing styles and writing processes. The structure represented by C-SAW allows planning using note-taking or text-production in a hierarchical outline. This facilitates both low and high self-monitoring writing styles in idea-generation. Both substantive and procedural facilitation are offered through structural supports provided within the different visual representations accessible within C-SAW. Markers and cues included can be customized to the specific needs of the novice writers and targeted to scaffold their reasoning processes and the linguistic demands (use of connectives) involved in the development and linking of ideas and arguments, and the structuring of arguments and the global text.

Testing with students suggests that C-SAW, through the cues to support cognitive activity may be engaging writers in a dialogue with themselves, encouraging them to reflect upon and modify their positions and as such serve to some extent the same expansion of the space of debate that is supported through CSCL. Testing showed that students working with C-SAW were struggling with the demands of constructing valid

arguments and fulfilling all the requirements of the argument model, but felt they were building better arguments. This suggested that they might have been learning the function of an argument's components while using C-SAW. The structural and linearization support also lessen the burden of the executive structure, allowing students to further focus on the content and building up of their argumentation.

The design of the authoring tool can facilitate the structuring and linearization processes by including simple editing and re-organization devices and proposing a standard structure (substantive facilitation) to be executed along with the procedural facilitation to achieve the desired standard. These are offered in C-SAW through the markers and cues of the proposed argumentative essay model to be completed and supported through the different available views of the global text produced. Student and practitioner testers believed that having the requirements visible and facilitation accessible would help them to eventually learn to fulfil the requirements and produce better argumentative texts without C-SAW. Making the executive structure and underlying schema of the argumentative writing task it represents explicit within the various visualization and viewing options of C-SAW can facilitate the internalization of the structures and processes of argumentative writing.

If self-regulation can determine which strategy or process will be selected at which point in the writing episode and if motivation, in turn, may decide whether a writer will expend the time and effort needed to engage in self-regulation, then incorporating both structuring and regulating devices within a visualization that shows students' progress, self-evaluation and what needs to be done to achieve the learning or procedural goals defined by the lesson plan and the type of argumentation required, can be ways to keep a writer to task longer. A visualization device like the C-SAW's graphic map, by mirroring writers' metacognitive activity, can focus their attention on what is required, while reflecting what has been achieved and thereby guide writers' to select appropriate strategies and cognitive processes.

The use of C-SAW within the current practice of argumentative writing instruction will depend on its ease of use and perceived usefulness. On the whole, the prototypes of the computer-supported authoring tool evaluated during the three design phases of this research were enthusiastically received. Student testers and practitioners believed C-SAW to be easy to use. The interviewed practitioner believed that computer-supported writing motivates students more, as they are more willing to use word-processors and text-editors than to handwrite. The practitioner also believed the use of a computer-supported authoring tool that facilitates reasoning, structuring and organization may improve the argumentative composition skills of novice writers and keep them at task longer, but it would need to be easily customized to correspond to the reasoning and linguistic capacities of the writers involved. Perhaps more importantly, students that tested the C-SAW prototype admitted that argumentative writing was very difficult for them and believed C-SAW could help them think through their argumentation and write better texts. The faith in instructional technologies to alleviate the problematic learning situation presented by argumentative writing is the call and challenge that inspired this project's goals to create a tool that could embody the approaches and devices that have the potential to meet their expectations, and should be the driving force behind future research.

11. References

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12. Appendix

12.1. APPENDIX A

ArgEssML RELAX NG schema

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        <value type="string">being opposed by other evidence</value>
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Figure 12.1-1 Relax NG schema

12.2. APPENDIX B

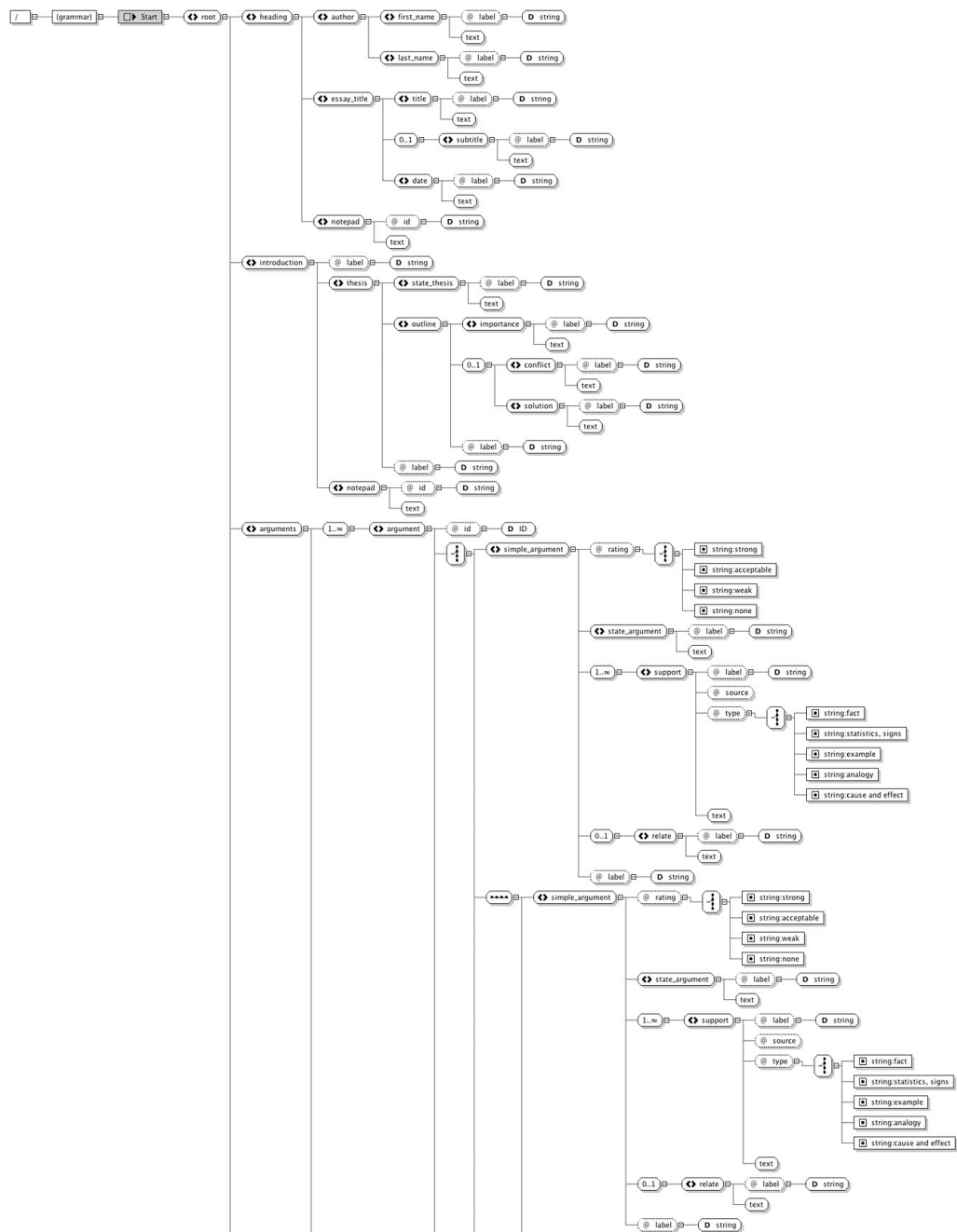


Fig. 12-1 Relax NG schema for ArgEssML expanded full model view (part 1)

12.3. APPENDIX C

SCREEN CAPTURES OF THE C-SAW INTERFACE

The screenshot shows the C-SAW interface with a light green background. At the top, the logo 'C-SAW' is on the left, and 'Computer-Supported Argumentative Writer' is in the center. Below the logo is a navigation bar with buttons: 'heading and title', 'introduction', 'arguments', 'conclusion', and '? user guide'. The 'heading and title' section is active, showing a dashed box for 'author' with 'first name: Kalli' and 'last name: Benetos'. Below this is a 'title and subtitle of your essay' section with a dashed box containing 'title: Cities Can Save Our Planet', 'subtitle: The case for large urban centres', and 'date (Month dd, yyyy): July 6, 2005'. To the right of the title section is a 'notepad' area with the text 'notes for heading section' and 'some new notes'. The 'introduction' section is also visible, showing a dashed box for 'thesis' with 'state your main point: Moving to large urban centres and adopting a city lifestyle and all the its advantages and may be the only way to save our planet from the ecological disasters the ever-increasing population is inflicting on it.' and an 'outline' section with 'importance of issue: The world's increasing population and its demand for land means we are quickly running out of wilderness and farmable land.', 'conflict: Providing housing solutions for an increasing population while minimizing damage to the environment is a formidable challenge.', and 'solution: Concentrating populations in large urban centers may offer the some solutions and with a rethinking of the way our cities are built, perhaps not too much of a compromise.'.

C-SAW Computer-Supported Argumentative Writer

heading and title introduction arguments conclusion ? user guide

heading

author

first name: Kalli last name: Benetos

edit name view graph

title and subtitle of your essay.

? title
Cities Can Save Our Planet
? subtitle*
The case for large urban centres
date (Month dd, yyyy)
July 6, 2005

edit title view graph

notepad

notes for heading section
some new notes

introduction

thesis

? state your main point
Moving to large urban centres and adopting a city lifestyle and all the its advantages and may be the only way to save our planet from the ecological disasters the ever-increasing population is inflicting on it.

outline

? importance of issue
The world's increasing population and its demand for land means we are quickly running out of wilderness and farmable land.
? conflict*
Providing housing solutions for an increasing population while minimizing damage to the environment is a formidable challenge.
? solution*
Concentrating populations in large urban centers may offer the some solutions and with a rethinking of the way our cities are built, perhaps not too much of a compromise.

edit introduction view graph

Fig. 12-3 Screen capture of Heading and Introduction areas in display mode.

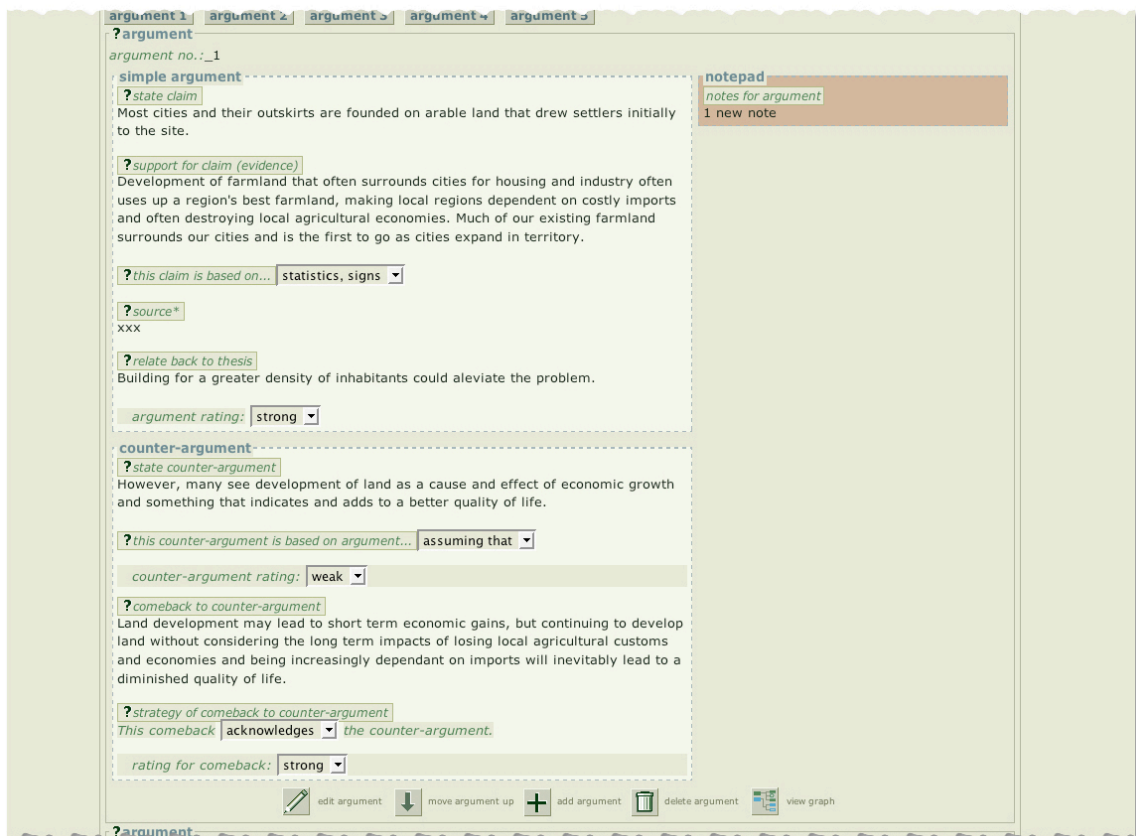


Fig. 12-4 Screen capture of Arguments area in display mode.



Fig. 12-5 Screen capture of Conclusion area in display mode.

arguments

? argument

argument no.: 2

simple argument click to activate

? state claim i

? support for claim (evidence) i

? this claim is based on... fact

? source*

? relate back to thesis i

argument rating: none

counter-argument click to activate

? state counter-argument i

? this counter-argument is based on argument... assuming that

counter-argument rating: none

? comeback to counter-argument i

? comeback to counter-argument

This comeback acknowledges the counter-argument.

rating for comeback: none

notepad

notes for argument

save argument

cancel changes

delete argument

Fig. 12-6 Screen capture of an argument in edit mode.

66

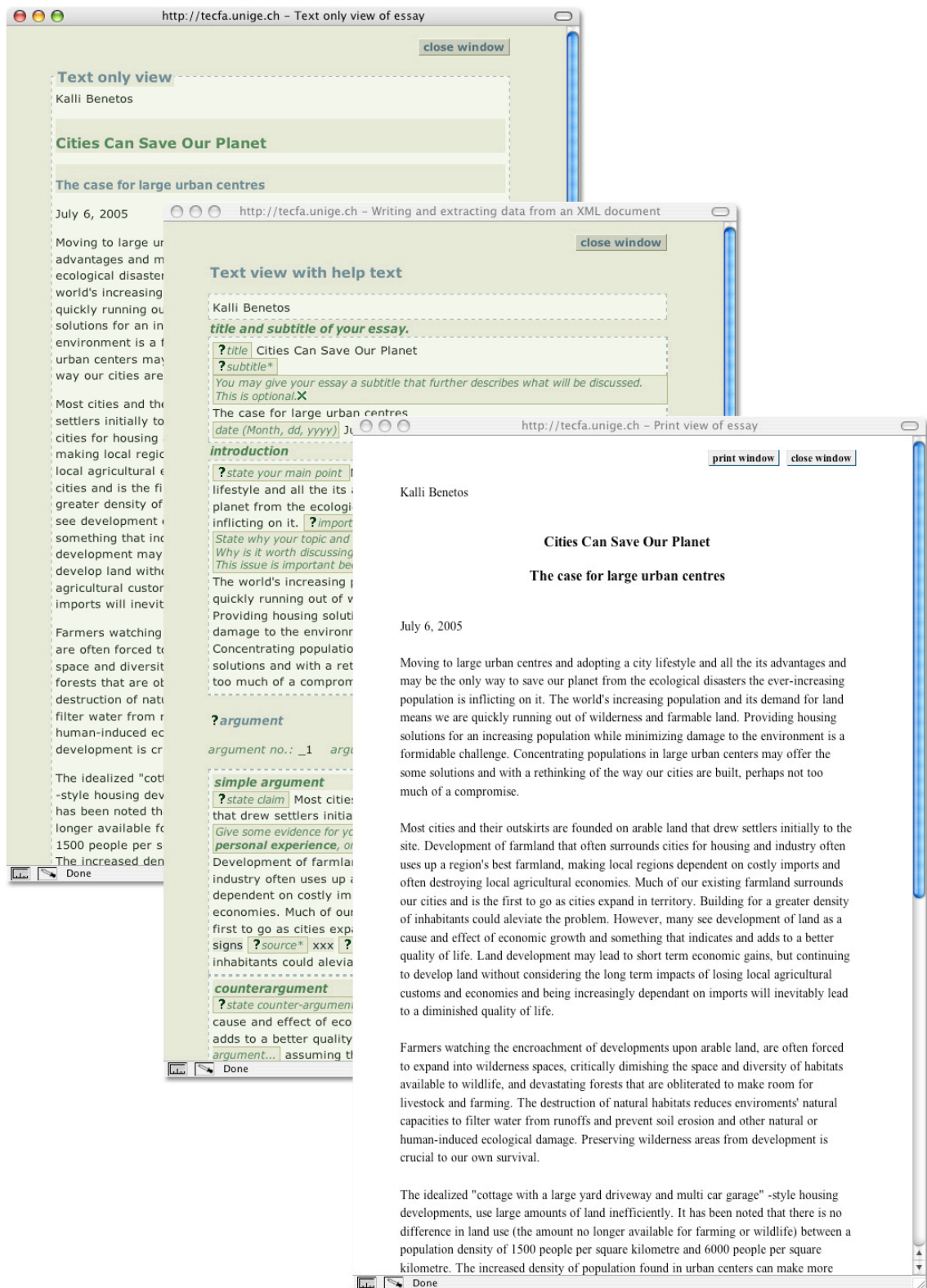


Fig. 12-7 Screen capture of view options left to right: text only, text with help, and print view windows.

12.4. APPENDIX D

arguments

?argument

argument no.: _1

✓ simple argument click to activate

?state claim i

State your claim. This the point you are trying to make in this argument.X

?support for claim (evidence) i

Give some evidence for your claim. Back it up with some known **facts, statistics, a personal experience** or give an **example** to illustrate your point.X

?this claim is based on...

Think about your claim. Which of these best describes your claim? **fact based on an authority, statistics or signs, an example, an analogy** (compare it to something similar), or **cause and effect**. X

fact ▼

?source*

?relate back to thesis i

Explain why this argument is important or relevant to your main point.X

argument rating: none ▼

✓ counter-argument click to activate

?state counter-argument i

Give a possible counter-argument either to the argument you have just given or to the main point.X

?this counter-argument is based on argument...

The counter-argument uses which of the following methods to attack your argument or your main point? Does it claim that your argument is **not logical** or is **untrue** or that it **assumes** something that is not the case? The counter-argument may say that your argument **may mean** something unintended or it may present **other evidence** that opposes your argument or main point. This is for your own information. It will not appear in your essay.X

assuming that ▼

counter-argument rating: none ▼

?comeback to counter-argument i

Reply to this counter-argument. Consider its good points and bad. Give a reason why it should be either **refuted** (not considered), **acknowledged** (accepted as a good point but then dismissed) or **conceded to** (accepted as a good point - try not to have too many of these).X

?comeback to counter-argument

This comeback **acknowledges** ▼ the counter-argument.

Consider your comeback. Does it **refute** (not consider the counter-argument good), **acknowledge** (accepts the counter-argument as a good point but then dismisses it) or **concede to** (accepts the counterargument as a good point - try not to have too many of these). This is for your own information. It will not appear in your essay. X

rating for comeback: none ▼

save argument

cancel changes

delete argument

notepad

notes for argument

Fig. 12-8 All cues in open state for the argument area. (Cues are solicited individually.)

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12.5. APPENDIX E

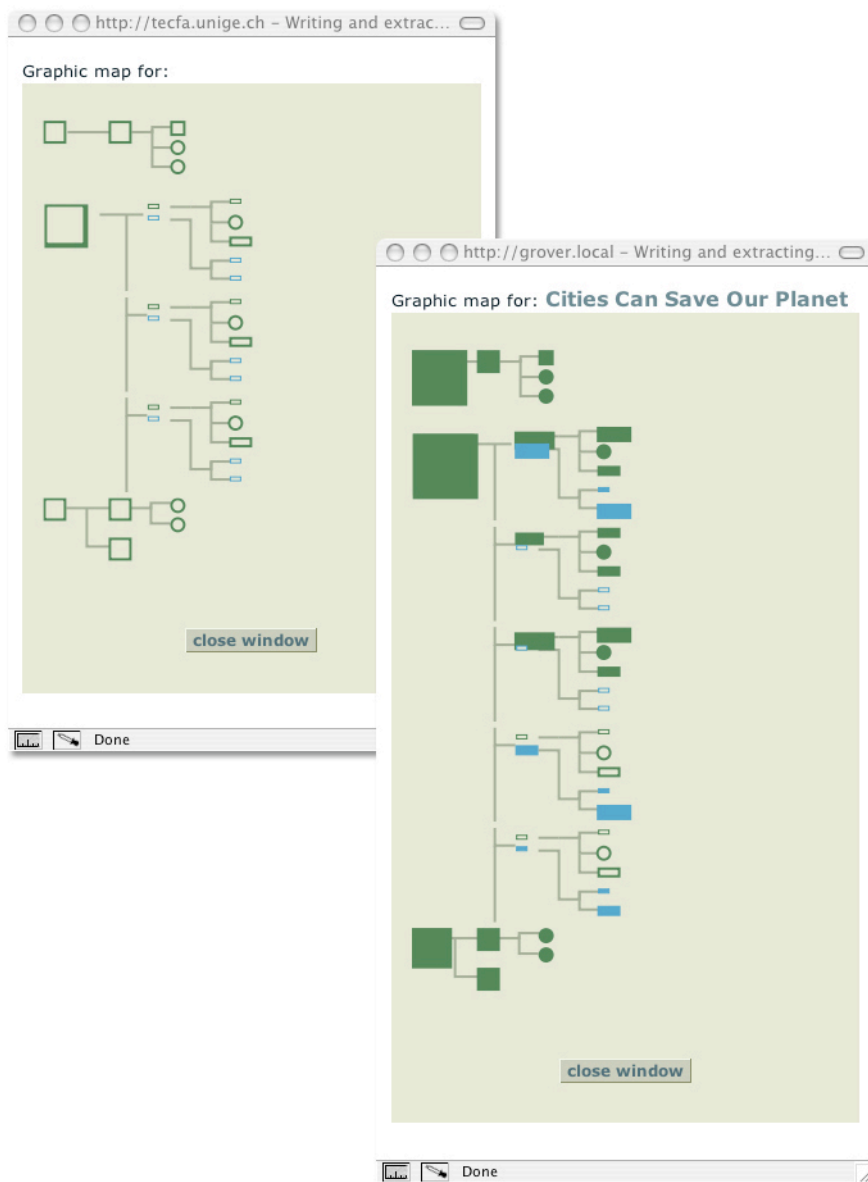


Fig. 12-9 Graphic map examples, left: graphic map for an empty essay; right: graphic map for a sample essay.

12.6. APPENDIX F

12.6.1. List of evaluation tasks

PHASE 1 & 2

- make and save changes to an area.
- find help on the screen for a specific task.
- note some ideas for later use
- view your text as a whole.
- print your text.
- add an argument.
- delete an argument.
- change the order of your arguments.
- rate the strength of an argument
- rate the strength of a comeback

PHASE 3

Below is the task sheet presented to students testing C-SAW.

EVALUATION OF C-SAW

July 10, 2006

BEFORE STARTING, please read through this carefully and ask if you are not sure about any part of the instructions.

TASK 1

Make sure the browser window in front of you has this web page open.

<http://tecfa.unige.ch/staf/staf-k/benetos/thesis/tester1/editAll.php>

Read through the list of topics below and select one to write about using C-SAW (the software available on your screen). You will have about 40 minutes to write your essay.

- While writing your essay try to:
- save changes you have made to an area.
- find help on the screen for a specific task.
- find on the screen suggestions for words that you can use to connect your ideas.*
- note some ideas for later use *
- view your text as a whole.
- print your text.
- add an argument.
- delete an argument.
- view the graphic map of your essay*
- change the order of your arguments.

- rate the strength of an argument
- rate the strength of a counter-argument
- rate the strength of a comeback*

Essay topics:

Should motor traffic be restricted?

Should we do more to deal with the problem of domestic violence, or is the problem exaggerated?

We are becoming more and more dependent on computers. Is this dependence on computers a good thing or should we be more suspicious of their benefits?

Should animals be used for scientific research?

Considering that cigarettes are believed to be as addictive as heroin, should cigarettes be treated like other addictive illegal drugs?

Should restrictions be placed on the use of mobile phones in public areas like restaurants and theaters?

Should the death penalty be mandatory for people that kill other people? Is it cruel murder or a just punishment? Can it be a deterrent to crime?

Some studies show that girls do better academically in girl-only schools. Boys do better in mixed boy/girl schools. Should boys and girls go to separate schools?

Human beings do not need to eat meat in order to maintain good health because they can get all their food needs from meatless products and meatless substances. Argue for or against this opinion.

Some countries have banned commercials for children's products before 8:00 p.m. Should advertising aimed at children and teenagers be allowed?

TASK 2

Read through the short essay entitled "Cities Can Save Our Planet".

Use the pens to highlight the text as follows:

blue = the main point

green = arguments for

pink = counter-arguments (arguments against)

orange = support/evidence

yellow = comeback to counter-arguments

TASK3

We will take a few minutes at the end to discuss your experience using the software.

12.7. APPENDIX G

12.7.1. Post-task questions

PHASE 1

What tasks did you find the most difficult?

None. Finding which argument I am looking at.

What areas of C–SAW do you think would be helpful to students as they write?

The notepads. The filling-in structure, it simplifies the task. The help with making an argument is very good. They have a lot of trouble with being logical.

What presents the most trouble for your students when writing argumentative texts? In your experience as a teacher, do you think this is representative of most students learning to write argumentative texts?

They have great difficulty with logic; connecting ideas logically, realizing that ideas are not related. They interject ideas that do not relate to the main point. They have a poor understanding of how to use connectives, but the problem goes beyond that. They do not know how to think critically.

Describe briefly the current lesson plan you use to teach argumentative writing.

Examples are presented. I review the problems they are likely to encounter, grammar, structure, making arguments “for” and “against”. We have debates or activities to help them get ideas down that they can work with. I have thorough lesson plan that I follow.

Regarding the structure of argumentative writing, what is presented differently within C–SAW, compared to the structure you teach?

The language used is different. I talk about discursive writing, instead of argumentation. I try to simplify the language to their level, point instead of claim, and arguments “for” and “against”. However, presenting both terms might be good. It could help them learn the terminology and advance their comprehension of the parts that make up an argument. I’m not sure. It would be nice to be able to change the wording in the help text (cues) to suit the students’ level.

The order is good. It lets them (students) make different types of layouts. Maybe they would need more in-class instruction about this, but this should be done before the sit down to write anyway.

What tools are you currently using to teach argumentation?

None. Paper, pen and discussion.

What benefits do you think a tool such as this could bring to argumentative writing?

This could also help them recognize discourse components and work with them. I think that might keep them writing longer. Anything that can keep them at the activity for about an hour is good, they won’t spend longer at a writing task.

What worries would you have using C–SAW within a classroom setting?

I believe teachers would be willing to use any tool that would facilitate writing, as long as it is not too difficult to set up. This seems simple enough.

Describe student's computer skills and more specifically their keyboarding skills.

Computer-(supported) writing motivates students more. They are more willing to use word-processing, etc. than to handwrite. Keyboarding is not a problem.¹⁹

PHASE 2

No formal interview.

PHASE 3

STUDENT INTERVIEW QUESTIONS

How do you usually go about writing an essay? Take notes first? Start writing right away? both?

Tester1: Brainstorms, takes notes, makes lists of arguments “for” and “against”

Tester 2: Sketches out main points on paper.

Tell me about the difficulties you encounter when you have to write an essay.

Tester1: has trouble building strong arguments

Tester 2: has difficulty finding ideas

What do you usually use to write? Word processor? Paper?

Tester1: uses paper and pen

Tester 2: uses computer for writing, so she can look up words, use thesaurus

What did you think about using a software to help you write before you started?

Tester1: didn't know what to expect, expected more of a word processor.

Tester 2: looked forward to it as she likes working with the computer.

Did your opinion change? during? after? In what way?

Tester1: It was good to have structure there to be able to focus on arguments and wording.

Tester 2: No change.

What elements of this software did you particularly like?

Tester1: The help was useful. Made her focus on making good arguments.

Tester 2: It was helpful to have structure and build essay up. She could get her ideas down easily making the writing easier afterwards. It was very helpful to have the explanations to guide her thinking.

What elements of this software did you not like?

Tester1: Filling in the counter-argument. She was not familiar with having to include a counter-argument. Didn't like having to attack her position. The software (C-SAW) showed her how to do it without destroying her argument.

Tester 2: The language was difficult to understand.

¹⁹ Observations of students writing with C-SAW during Phase 3 testing, however, showed students typing to be far from fluid.

What parts did or didn't do something you expected?

Tester1: Expected add argument icon to lead to an *editing mode* not new argument. (Was not yet functional)

Tester 2: She wasn't sure at first if the text written was saved or not. But later saw that she had to submit text so that it could be saved.

What functions did you find missing?

Tester1: Nothing was noted as missing.

Tester 2: A spell-check

What functions would you like to see?

Tester1: To be able to print text (didn't see viewing options at the bottom).

Tester 2: A spell check.

If available, would you willingly use this software to write your essays?

Tester 1: Would use the tool in the beginning to learn the structure. If she uses the tool enough, she will learn the parts.

Tester 2: Yes.

If you had to describe this software and what it does to a friend, what would you say?

Tester1: It is like a skeleton that you have to fill up but you have to think.

Tester 2: It helps you write essays.

INTERVIEW ON VISUALIZATION

This is an empty essay. This is the one you marked up. What can you tell me about what theses boxes and circles mean?

Tester1: Identified the parts corresponding to the components in C-SAW

Tester 2: Found it initially confusing but thought that one should be able to figure it out if they know the structure of the essay.

Could you try quickly to fill this in according to the essay you wrote?

Tester1: easily stated what was needed to match the graphic to her essay.

Tester 2: easily filled out the main parts.

In what way do you think this diagram would be helpful?

Tester1: Would allow her to see what needs to be done or improved.

Tester 2: Would allow her to see what is done and what isn't.

In what way do you think it would confuse you?

Tester1: Thought it would be easy to understand after working with C-SAW

Tester 2: None, if you know the structure.

What kind of information would you like to see on this diagram?

Tester1: See the names of the nodes upon clicking. (paper prototype was presented, this is available in final prototype)

Tester 2: Didn't have any ideas.

What could this diagram allow you to do?

Tester1: allow one to navigate to edit mode in the main window by clicking on the nodes.

Tester 2: did not think she would use the visualization much, but wasn't sure.

12.8. APPENDIX H

Details of usability testing analysis

PHASE 1

The table below outlines the problems revealed during Phase 1 testing, and the recommendations and actions taken as a result.

Category	Description	Problem	Impact*	Solution	Effort**	Action taken
Navigation	move, scroll link to the part of the document users wish to access	document is long and much scrolling is needed	1 - with enough scrolling all areas of the page may be accessed	add anchored links to major sections in document	A	anchored links were included at top level to main areas of document,
General structure	functionality that facilitates the overall structuring of the text (substantive facilitation)	difficult to see number of arguments created, keep track of what has been completed (min. 3 arguments)	3 – the user may leave arguments incomplete, not realize what is needed	Use number tracking for arguments, representation of status	B – but solution was implemented	arguments are numbered, anchored links within the arguments area reflects the number of arguments existing, visualization of the status of a text will be given in the form of a graphic map
help	Facilitating text available on screen (procedural facilitation)	terminology used was not that used by the teacher within her lesson	could result in students' incomprehension, Increase cognitive load for students familiarizing themselves with the language of argumentation	allow teachers to edit the markers and cues	B - This would require a separate interface to allow systematic editing of all markers and cues	currently text markers are editable through the XML template file, Cues can only be edited within the PHP file for the main window. Customizability is awkward but possible.
Language aids	help with linking ideas provided through a general list of connective terms	too general, students have difficulty with connectives (which, when and how to use them)	2- connectives are key to structuring ideas and writing cohesive texts	create short lists that are specific to each element (context)	A	icons linked to pop-up windows containing context specific connectives were added
Self-regulation	Help with metacognitive activities through self-evaluation	Self-valuation of itself does not help comparison with a standard	May not motivate students to strive for a higher self-evaluation	Make self-evaluation comparable to a standard,	B- but will be prototyped	A visualization device that indicates state of completion and implies a minimum standard was added to the prototype

Table 12-1: ***Impact ratings (impact on usability):** 1 = task can be accomplished but not efficiently; 2 = users must make an extraneous effort to accomplish task; 3 = may hinder the user from completing task. ****Effort ratings (effort to implement solution):** A = feasible within the scope of this prototype phase; B = more than 5 hours of development time (i.e. will not be done within the scope of this prototype phase); C = too time consuming, costly or outside the scope of this project (i.e.: will not be implemented)

PHASE 2

The table below outlines the problems revealed during Phase 2 testing, and the recommendations and actions taken as a result.

Category	Description	Problem	Impact*	Solution	Effort**	Action taken
Navigation	move, scroll, link to the part of the document users wish to access	document is long and much scrolling is needed	1 - with enough scrolling all areas of the page may be accessed	add anchored links to each argument	A	further anchored links were added to argument level with individual arguments numbered, changes in adding and deleting arguments are reflected immediately in links
	move, scroll, link to the desired part of the document	Difficulty seeing if text was submitted	1 - lost edit once and learned how to 'submit' text.	Provide some instruction on the use of the C-SAW interface	A	An easily referenced basic user guide was added to C-SAW de
General structure	functionality that facilitates the overall structuring of the text (substantive facilitation)	Within the conclusion, use of individual summaries for each argument was thought to be prone to misuse by novice writers who would repeat themselves or be confused by it.	3 - the user may leave argument s incomplete, not realize what is needed	Reduce the individual summaries to an overarching "Argument summaries"	A	Reduced the individual summaries to an overarching "Argument summaries" that is optional.
Language aids	Facilitating text available on screen (procedural facilitation)	More examples of phrases using connectives could be given	2 - could result in students' improper use of connectives leading to poor cohesiveness in text.	allow teachers to edit the markers and cues	B - This would require a separate interface that would allow editing of all markers and cues	currently lists of connectives are editable through the javascript file included in the C-SAW PHP file. Customizability is awkward but possible.
Visualization	Upon clicking an icon a pop-up window reveals a graphic map that represents the status of the current essay	The visualization should correspond to self-evaluation as well as 'done' or 'incomplete' status of components	1 - no feedback as to the perceived quality of the content is available	Ratings included as self-evaluative aids will be reflected in the generation of the graphic map	A - visualization was still in initial design phase	Ratings as well as completion of optional components were used to change the size of related nodes within the graphic map

Table 12-2: ***Impact ratings (impact on usability):** 1 = task can be accomplished but not efficiently; 2 = users must make an extraneous effort to accomplish task; 3 = may hinder the user from completing task. ****Effort ratings (effort to implement solution):** A = feasible within the scope of this prototype phase; B = more than 5 hours of development time (i.e. will not be done within the scope of this prototype phase); C = too time consuming, costly or outside the scope of this project (i.e.: will not be implemented)

PHASE 3

The table below outlines the problems revealed during Phase 3 testing, and the recommendations and actions taken as a result.

Category	Description	Problem	Impact*	Solution	Effort**	Action taken
Navigation	move, scroll, link to the part of the document users wish to access	Cannot escape the edit mode	2 – user may be forced to commit an undesired change in order to access another area to edit.	Add escape options	A	<i>Cancel and Delete</i> options were added to the argument <i>edit modes</i> , <i>cancel</i> option was added to all other <i>edit modes</i> .
	move, scroll, link to the part of the document users wish to access	Users didn't notice the connectives help icon.	2- user will not make use of available facilitation	Place icon in a more obvious location	A	Icon linking to content specific lists of connectives was moved next to label, making it more prominent
General structure	functionality that facilitates the overall structuring of the text (substantive facilitation)	User unsure of the way the simple/counter-argument options worked	2- user may make false assumptions on when and how to use the argument construction options	Leave the cue for <i>argument</i> always visible	C	Markers are available unsolicited. Cues must be solicited. Further versions can have this regulated by teachers.
Help	Facilitating text available on screen (procedural facilitation)	Users had difficulty with terminology, different terms had been used in their instruction prior to testing	2 – users will have to learn terminology that may increase the cognitive load of the activity	Allow teachers to customize markers and cues.	B - This would require a separate interface that would allow systematic editing of all markers and cues	currently text markers are editable through the XML template file, Cues can only be edited within the PHP file for the main window. Customizability is awkward but possible.
Self-evaluation	Allows self-assessment on quality of arguments composed	Rating within counter-argument was not properly associated with the comeback	3 – user could falsely evaluate <i>counter-argument</i> instead of <i>comeback</i>	Place the rating after the text input field for <i>comeback</i>	A	<i>Rating for comeback</i> was placed after the input field for <i>comeback</i>

Table 12-3***Impact ratings (impact on usability):** **1** = task can be accomplished but not efficiently; **2** = users must make an extraneous effort to accomplish task; **3** = may hinder the user from completing task. ****Effort ratings (effort to implement solution):** **A** = feasible within the scope of this prototype phase; **B** = more than 5 hours of development time (i.e. will not be done within the scope of this prototype phase); **C** = too time consuming, costly or outside the scope of this project (i.e.: will not be implemented)

12.9. APPENDIX I

Sample essay used in development and testing

Cities Can Save Our Planet

The case for large urban centres

Moving to large urban centres and adopting a city lifestyle and all its advantages may be the only way to save our planet from the ecological disasters the ever-increasing population is inflicting on it. The world's increasing population and its demand for land means we are quickly running out of wilderness and farmable land. Providing housing solutions for an increasing population while minimizing damage to the environment is a formidable challenge. Concentrating populations in large urban centres may offer some solutions and with a rethinking of the way our cities are built, perhaps not too much of a compromise.

Most cities and their outskirts are founded on arable land that drew settlers initially to the site. Development of farmland that often surrounds cities for housing and industry often uses up a region's best farmland, making local regions dependent on costly imports and often destroying local agricultural economies. Much of our existing farmland surrounds our cities and is the first to go as cities expand in territory. Building for a greater density of inhabitants could alleviate the problem. However, many see development of land as a cause and effect of economic growth and something that indicates and adds to a better quality of life. Land development may lead to short term economic gains, but continuing to develop land without considering the long term impacts of losing local agricultural customs and economies and being increasingly dependant on imports will inevitably lead to a diminished quality of life.

Farmers watching the encroachment of developments upon arable land, are often forced to expand into wilderness spaces, critically diminishing the space and diversity of habitats available to wildlife, and devastating forests that are obliterated to make room for livestock and farming. The destruction of natural habitats reduces environments' natural capacities to filter water from runoffs and prevent soil erosion and other natural or human-induced ecological damage. Preserving wilderness areas from development is crucial to our own survival.

The idealized "cottage with a large yard driveway and multi car garage" -style housing developments use large amounts of land inefficiently. It has been noted that there is no difference in land use (the amount no longer available for farming or wildlife) between a population density of 1500 people per square kilometre and 6000 people per square kilometre. The increased density of population found in urban centres can make more efficient use of developed land.

Many argue that cities are crowded, congested and dirty and they prefer to live outside the city and travel to work each day. Cities allow for a greater concentration of people and the services they require. This is often what brings people living outside city centres to them everyday, requiring more roads, more car-related space consuming facilities and resulting in the same congestion and pollution people complain of. If people lived centrally they would

travel less on a daily basis and be more inclined to use public transport or walk. This would diminish car traffic and its consequences greatly.

One often cited reason for living outside of large urban centres is that cities are dangerous because the large population offers an anonymity that increases crime. In fact, it would appear that areas where there are great spaces between dwellings and other "privacy-ensuring" barriers, foster a greater anonymity than the proximity offered by a densely populated neighbourhood where people walk and meet in neighbourhood grocery stores and other shared amenities. And knowing your neighbours makes a neighbourhood safer.

The possibility for a greater population density is an option to slow down the deterioration of our environment and eradication of farmland that is vital to our survival, while retaining the cultural and community-building opportunities offered by living in proximity with one another. Greater concentrations of people means less developed land area, not less development. It is the shape of our development that needs to be rethought. With proper urban planning that focuses on accessible public transport and diverse neighbourhoods that combine dwellings and services, urban centres can offer the ecological, security and social benefits that many perceive only available in small towns. Allowed to continue, increased housing and industrial development will use up arable land at an alarming rate, forcing farmers out of business or to expand into wilderness spaces, critically diminishing the space and diversity of habitats available to wildlife, and devastating forests. The problems that keep people from living in city centres will be exacerbated by the commutes to city centres that will get longer, further increasing demands for roads and car facilities greater expansion until every piece of land that can be 'developed' will be paved over.