# Authoring Tools for Structuring Text-Based Activities

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**Abstract.** In this paper we present research results and discuss recent directions concerning the structural analysis of science texts and cognitive aspects of text elements, such as causal relationships between text elements. We outline the process of structuring text material for the design of dialogue activities for science text comprehension in the educational environment of ReTuDiS (Reflective Tutorial Dialogue System). The system supports text comprehension using reflective dialogue activities, adapted to learners of different levels and its authoring tool, ReTuDiS*Auth,* supports users in authoring dialogue activities.

**Keywords:** Text structure, authoring tools, dialogue activities, cognitive categories and causal relationships.

## 1 Introduction

In approaching text comprehension, researchers examine issues that focus on assisting comprehension through the design of the text form [8]. Assuming that readers build mental representations of information contained in the text during the comprehension process, primary role should be attributed to the understanding of cognitive categories such as state, event and action and their causal and temporal relationships [2].

The design of the structure of text-based activities is important in order to enhance learning in an educational system. In order to make the information in such activities available to target users (students, teachers, researchers, authors, educators) new efforts have emerged to bring together novel methodologies and technologies. Authoring such activities demands an authoring system which involves knowledge acquisition, design process and managing a large amount of complex information [18]. Authoring tools offer the appropriate structure and guide authors to import and elaborate educational material (text, questions, dialogues etc.) [1].

Researchers have been investigated Intelligent Tutoring Systems (ITS) authoring tools almost since the beginning of ITS research and authoring systems have been built [16] [20]. An authoring tool is a generalized framework along with a user interface that allows non programmers to formalize their knowledge [16] [19] [24]. Part of authoring an ITS is the systematic decomposition of the subject matter into a set of related text elements. Each authoring system provides tools or cues which assist the author in this process of breaking down and elaborating the content to the necessary level of detail according to an instructional model. There are intelligent adaptive hypermedia systems like CALAT [18] and GETMAS [24] that their functions overlap those from

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both the above categories. There are also expert systems, like Dempndtr8 [3], IRIS-tutor [2] which include rule-based cognitive models of problem solving expertise and observe learner behaviour in order to build a learner model.

In this paper we present the process of structuring text material for the design of dialogue activities for text comprehension in the environment of ReTuDiSAuth, which is the authoring tool of ReTuDiS system [22] [10]. In the second section, we outline theories behind text comprehension concerning cognitive relationships. In the third section, we comment about authoring tools and authoring process. In the fourth section, we present the main components of ReTuDiS and ReTuDiSAuth and focus on describing knowledge acquisition methods and authoring techniques offered to the authors in order to build dialogue activities for text comprehension. In the fifth section, we describe text structuring in the environment of ReTuDiSAuth. In the sixth section, we present evaluation results. Finally, we conclude and give our future perspectives.

## 2 Text Comprehension

Many studies on text comprehension have focused their interest on the sentence structure presented by the text [5] [15]. Sentence structure of a text could be organized on the basis of hierarchy in order to allow the importance of sentences in the text to be revealed [23]. The cognitive psychological approach in text comprehension suggests that the internal variables of the reader hold a primary role in text comprehension, such as his personal goals, interests and pre-existing knowledge. However, cognitive science does not ignore the influence of the text form, in which factors such as text cohesion and logical coherence of facts presented have been proved to be significant elements that facilitate its comprehension [7].

In order to examine the representation constructed by learners during the comprehension process of a text, primary role should be attributed to the understanding of the cognitive categories *state*, *event* and *action* [4]. The term *state* is static and describes a situation in which no change occurs in the course of time. The term *event* refers to an effect, which causes changes but is not provoked by human intervention. The *event* can be coincidental or provoked by human intervention, e.g. by a machine. An *action* causes changes but is originating by a man. This consideration deals with text comprehension as the attribution of meanings to causal connections between occurrences in the text. Learners compose a representation of the text, which contains the cognitive categories: event, state and action. For the interpretation of learners' cognitive processes their discourse is analysed, in order to trace the recognition (or not) of the three cognitive categories.

Furthermore, text analysis in relation to the cognitive categories does not suffice [4]. The organization and structure of cognitive representation should be examined on micro and macro-levels. Mental representations capture elements of the surface text, of the referential meaning of the text, and of the interpretation of the referential meaning, thus constructing a micro-world of characters, objects, spatial settings, actions, events, feelings etc. [15].

The person who reads a text gradually constructs the microstructure of the text representation, i.e. the states, event and compound actions of the world described in

the text as well as the time and causal relationships that interlock those structures. In order a person, to be able to explain the operation of a technical system on a micro-level scale, has to construct a representation of the "natural flow of things", where every new event should be causally explained by the conditions of events which have already occurred [4]. The creation of a text that allows a precise description of a technical system and facilitates readers in constructing its microstructure representation must involve: (a) the description of the units that constitute the system based on the causal relationship which unites them and (b) the description of event sequence taking place in these units in respect of the cause affecting them as well as of the changes they bring to the state of the system.

On macro-level, the development of the macrostructure by readers is achieved through the reconstruction of the microstructure and the establishment of a hierarchical structure with goals and sub-goals. The creation of a text which facilitates readers in constructing its macrostructure representation for a system must involve the teleological hierarchical structure of goals and sub-goals of the various operations as well as their implications.

For example, in a technical text describing a local network, the network constitute a system of units (server, workstations and peripherals) connected according to a topology [10]. Messages are sent and received between the local network devices causing events. There are causal and temporal relationships between events [13]. At the end of a sequence of events the system changes its state returning from one state to another.

## 3 Authoring Tools

ITS authoring is both a design process and a process of knowledge articulation. While authoring tools are becoming more common and proving to be increasingly effective they are difficult and expensive to build. Authoring tools use methods to achieve the following goals [1] [18]: a) decrease the effort of authoring (time and cost), b) allow others to take part in the design process c) help the author articulate or organize his domain knowledge d) support good design principles concerning the pedagogy and the interface and e) allow quick evaluation cycles.

Authoring tools achieve the above goals using a number of methods. Authoring systems use methods to simplify and automate authoring and knowledge acquisition. Part of authoring an ITS is the systematic decomposition of the subject matter into a set of related elements, for example a hierarchy. Each authoring system provides tools or cues which assist the author in this process of breaking down and elaborating the content to the necessary level of detail according to an instructional model.

Authoring tools allow non-programmers to build tutors by incorporating a particular model or framework to scaffold the task [18]. Learner modelling process requires making certain choices, and it is in these choices that the learning process is located [14]. We do not learn much from looking at a model, we learn from models by building them and using them [17] [12]. Learning from building models involves finding out what elements fit together in order to represent the world of the model. The design of dialogue activities for adaptive learning supported by appropriate authoring tools attracts the interest of many researchers and educators in inventing

new methodologies for effective teaching and learning. The authoring process activates authors to decompose the subject matter into a set of related elements to discover what elements fit together in order to represent a concept, for example a hierarchy. The authoring process, as a process of choosing, organizing, structuring and linking educational material becomes a process of learning.

Authoring tools for text comprehension have to discover and offer mechanisms which help authors design activities for the diagnosis of learners' difficulties in comprehending texts. They offer the appropriate structure and guidance in order the author to be able to import and elaborate educational material (text, questions, dialogues etc.). There has been a growing concern about scientific text comprehension [5]. Efficient teaching and learning requires that educators should be familiar with the difficulties which learners are likely to face.

## 4 ReTuDiS and ReTuDiS*Auth*

### 4.1 ReTuDiS System

ReTuDiS is a diagnosis and open learner modelling tutorial dialogue system for text comprehension. The system infers learners' cognitive profile in order to construct and revise the learner model with the learners' participation [21]. ReTuDiS consists of two parts: the Diagnosis part and the Dialogue part.

The diagnosis part of ReTuDiS approaches learner's text comprehension supporting the theory of Baudet & Denhière that learner's representation of the text contains the cognitive categories: event, state and action [4]. The system engages learners in an activity which includes reading comprehension of text and answering question-pairs by selecting between given alternative answers. Learners' answers are used for diagnosing learners' text comprehension. Learners have to study all the text to comprehend it, to compare each factor with the others and then select answers from the given alternative answers, in order to express their position on certain issues and support it by a justification. The diagnosis part infers learners' cognitive profile and his learner model.

The underlying theory beyond the dialogue part of ReTuDiS is the Theory of Inquiry Teaching [6]. ReTuDiS approaches dialogue activities based on theories of dialogue management, strategies, tactics and plans which promote reflection in learning. The dialogue part is based on the learners' cognitive profile, inferred by the diagnosis part, the learners' answers to question-pairs and the selected dialogue strategy offered by the system. The dialogue part of ReTuDiS engages the learner in personalized reflective dialogues in order to revise the learner model with the participation of the learner [22]. The dialogue generator activates the appropriate for the learner sequence of dialogue-parts, and using the dialogue plan, dynamically constructs the individualized learning dialogue.

### 4.2 ReTuDiSAuth

ReTuDiS*Auth*, the authoring tool of system ReTuDiS, offers an environment that lays out the appropriate parameters an author needs to define. The authoring tool supports users registered as teachers or administrators. Teachers have the authority to create

new activities or edit existing ones. Administrators of the system have the authority to manage the base of the users of the ReTuDiS and the educational material. The environment offers the *tools* and the *shell* (Figure 1). The tools, which add interactivity to the system and support authors to import educational material, are the following:

*Text fields.* These fields are designed to help authors enhance their own educational material into the system for example, titles of activities, texts, questions.
*Pop-up menus.* The menus are designed to help authors select from predefined by the teacher or by the system values or defaults such as: categories of activities, characterizations of answers, teaching strategies.
*The knowledge base.* This data base includes the whole educational material.
*Association buttons.* They are buttons designed to help authors establish causal relationships between text elements such as factors of a text and make associations such as between educational material and learners' profiles, teaching strategies and learners' profiles, learners' profiles and dialogue plans.
*Guidance tips.* They are information tips designed to support the author by giving back the appropriate feedback to his actions that is confirmation or not of the completion of each step.
*Administrative tools.* These tools are for managing the lists of users, the roles of the users (teachers or students), the categories of activities, the activities, reports on carried out activities (log files for each student).

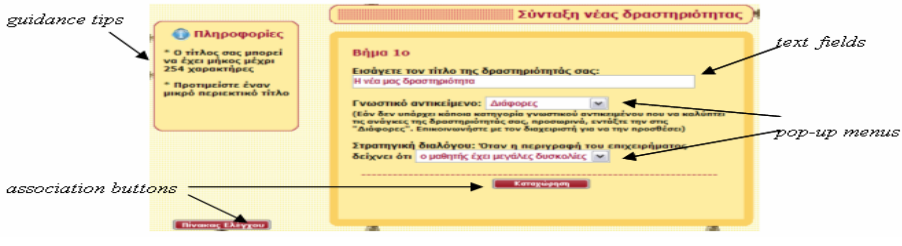


**Fig. 1.** The ReTuDiSAuth: Tools for structuring and elaborating a dialogue activity

The shell delivers the educational material according to the instructions generated by the author using the tools in combination with its predetermined defaults. A semantic network is created by the author using the association buttons. The nodes of the network represent the elements of the material and the branches represent possible paths followed by the learner while participating in instructional activities. While delivering the educational material to a learner in a specified manner the shell constructs his learner model. The values of the learner model change over the activity course as the learner participates in dialogues.

## 5 Text Structuring with RETUDIS*Auth*

The structuring process needs the description of the domain knowledge according to the system's specifications. ReTuDiS*Auth* involves the author in the following

processes concerning text structure, questions with alternative answers and dialogue structure:

### 5.1 Text structure

**Structuring the text by separating it in paragraphs called factors.** The author focuses on assisting comprehension through the design of the text form [22]. He forms the text in paragraphs, called factors, each of which represents a cognitive category *state, event* or *action.*

**Titling paragraphs**. The author gives a phrase as a title for every factor. The title helps in organizing the structure of the activity.

**Specifying the cognitive categories**. The author specifies the cognitive categories involved and the number of them. For example, in case of historical text are used three cognitive categories: state, event and action [21] [11].

### 5.2 Questions and Alternative Answers

**Forming questions with alternative answers**. For every titled factor the author submits a question-pair to the system and its related alternative answers. The first question in the question-pair is related to this factor and the learner's alternative answer concerning this question is declared to the system as *position*. The second question is related to the learner's justification concerning a position and is declared to the system as *justification*. Position and justification represent the causal relationships in the text.

**Forming classifications**. The author classifies the alternative answers concerning position and justification as *scientific*, *towards- scientific* or *non- scientific*. For every question-pair the combination of the learner's *position* and the corresponding *justification* constitutes the learner's *argument*. Arguments are classified as *complete,* when both position and justification are *scientific*. Otherwise the argument is *non-complete*. The author defines the different degrees of *argument completeness*. Possible values of argument completeness are: c*omplete, almost complete, intermediate, nearly incomplete* and *incomplete.*

### 5.3 Dialogue Structure

**Forming dialogues**. The author creates a library consisting of *specific* dialogue-parts for all combinations of possible answers and associates them with the corresponding answers. Each *specific* dialogue-part is designed to remedy a particular learning difficulty. The specific dialogue-parts are dependent on the specific text. The *specific* dialogue-parts of different types are associated with predefined and embedded in the system dialogue tactics

**Forming dialogue tactics**. Dialogue tactics, inspired by the general teaching strategies of Collins [6] [8], are hints or Socratic-style dialogues. Tactics correspond to different levels of dialogue concerning the specific subject matter and involve learners in activities which promote reflection. The author defines the dialogue tactics which have the following forms: (a) picks positive or negative examples, (b) picks

counterexamples, (c) generates hypothesis, (d) makes learner to form hypothesis, (e) makes learner to test hypothesis, (f) entraps the learner, (g) traces consequences to a contradiction or faulty knowledge of a learner and (h) promotes questioning authority.

**Selecting dialogue strategy.** The choice of the dialogue strategy is decided in the beginning. Example of a strategy embedded in the system is the following [11]: "The system sorts learners' argument classifications in a list according to decreasing degree of argument completeness. The tutorial dialogue begins with a discussion about the factor for which the learner seems to face less learning difficulties. The system generates the sequence of dialogue-parts for this factor. Then the system prepares the next dialogue-part, based on the results of the previous dialogue-part".

**Selecting dialogue tactics**. Predefined dialogue tactics are accessed throughout a pop-up menu. The author selects a predefined dialogue tactic and formulates the dialogue-part.

**Planning dialogue**. For the selected teaching strategy and depending on the learner profile the system constructs the initial dialogue plan for the learner. The system uses: (a) the *general* dialogue-parts, which include typical dialogue-parts, concerning participation of the learner in dialogue, encouragement, motivation, agreement or not with the system, guidance etc. and (b) the *specific* dialogue-parts that were previously entered by the author according to the appropriate dialogue goals and tactics. During entering the author has made the appropriate associations between contradicting answers (contradictions between learner's position and his justification concerning causal relationships in the text) and dialogue-parts for all possible combination of answers. So as, the system becomes able to initiate the dialogue and generate dynamically the appropriate dialogue in response to the learners' feedback during the dialogue process.

**Defining learners' profiles.** Learners can be described as belonging to one of a set of author-defined learner profiles taking into account the number of learner's arguments with high degree of argument completeness.

## 6 Evaluation

Formative evaluation, concerning the use of ReTuDiSAuth for text structuring, was conducted with the participation of 26 postgraduate students and 6 experts in informatics and history domains at the University of Athens. Evaluation aimed at further revisions, modifications and improvements of the system [18]. The participants were given explanations about the aims of the authoring tool.

Students were asked to participate in the evaluation process and perform representative tasks: (a) to prepare source material of their choice (b) to use the system for the construction of dialogue activities. Each student proposed a two pages text, three question- pairs with alternative answers involving causal relationships and specific dialogues-parts (Figure 2).

Experts used the material proposed by the students in order to identify and comment issues concerning specific problems or deficiencies users face in formulating learning goals, questions and tutoring dialogues and the educational benefits of the process.

**Local Network Operation**

…..A bus topology is designed with each node connected directly to a high-data speed bus. Nodes communicate across the network by passing packets of data through the bus (they read and write data -in the form of packets). Packets placed on the bus, transfer messages to nodes. A message includes the receiver's address, which specifies the network address of the target node. A node watches the bus continuously and reads the target address of each packet. After that, the node compares the address with its own, and if they are the same, then reads the message of the packet, otherwise ignores it. When a node is ready to broadcast a message, waits until the bus is free and then begins passing it to the bus. If a node uses the bus it watches it and can be aware of any other node using the bus at the same time. In that case both nodes stop using the bus waiting until one of them accidentally attempts to us it. When a limited number of packets are simultaneously transmitted throughout the bus, them this competence strategy is successful. The bus topology network can work even in case of disconnection of a node…..

**Question-pair 3**

3a) In a bus topology network, what happens in case there is an interruption (a cut off) of the bus. Select one of the following answers.

1. the network crashes (non scientific)
2. the network continuous to work properly (towards scientific)
3. the network is divided into two independent networks each one working properly (scientific)

3b) Justify your answer by selecting one of the following answers.

1. because all nodes are connected with the bus and they cannot communicate if there is a cut off (non scientific)
2. because all nodes have spare connections between each other that can operate without the bus (towards scientific)
3. because a bus network needs only a central bus to connect the nodes to (scientific)

**Fig. 2.** Text fragment and questions with alternative answers given by a student

Both students and experts were given a questionnaire and commented about usability, learnability and efficiency:

- the depth to which the system can infer a learner's knowledge, respond accordingly and teach
- if the system can support dialogue activities on different knowledge domains
- how easy non-programmers can learn to use the system
- how quickly a trained user can build dialogue activities
- the amount of resources needed to produce dialogue activities

Moreover, experts were asked to comment about:

- how much the underlying instructional model of the system constrains the author
- the sources of teaching and domain expertise
- the level of expertise /background of the target authors.

In general, most of the experts faced minor difficulties in using the interface. Experts spent more time to overcome difficulties in structuring the text and matching text paragraphs with cognitive categories. Experts commended about the quantity and the quality of questions made by the students. They identified as beneficial the method used for training students, which may be potential teachers, for the improvement of their authoring skills for text- based dialogue activities.

## 7 Conclusions

In this work we presented research results of the educational benefits after the use of ReTuDiS*Auth* as an authoring tool for structuring educational text material. Students experimented in the environment and designed text-based dialogue activities that promote learners' reflection. Evaluation got hold of representative users: graduate students and experts. Results of the current study indicate that authoring makes students improve their authoring skills and become familiar with text structuring. Experts found the system appropriate for the education of postgraduate students in reflective dialogue environments.

In our future plans we foresee improvement of the system concerning direct specification of causal connections between text elements during text structuring. Moreover, we plan further research into the evaluation of the system in classroom conditions and compare results in different knowledge domains.

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