

ADAPTATION OF EDUCATIONAL TEXT TO AN OPEN INTERACTIVE LEARNING SYSTEM: A CASE STUDY FOR RETUDIS

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ABSTRACT

Theoretical education is mainly based on university text-books, which usually include texts not structured according to any theory of text comprehension. Structuring a text is a demanding process. Text should be organized and structured in order to include descriptions on micro and macro-level representation of the knowledge domain. Since this is difficult, diagnosis of text comprehension can lie heavily on the construction of the appropriate questions and dialogue structure about a not structured text. This may also affect students' performance on laboratory education. Whereas traditional educational systems infer the reasons for the student's behavior without directly involving the student, current educational systems, supported by interactive learning programs, attempt to involve students in the process of diagnosis. This paper presents the adaptation process of a non-structured text to ReTuDiS, an open interactive learning system which is being experimentally used today as an diagnostic, profiling and support system for undergraduate students.

KEYWORDS

Text adaptation; interactive learning environment; cognitive theory; student profiling; computer-assisted education.

1. INTRODUCTION

ReTuDiS (Reflective Tutorial Dialogue System) is an open interactive learning system for reading comprehension based on the theory of text comprehension Denhière & Baudet (Denhière and Baudet 1992) and dialogue theory (Collins and Beranek 1986).

The theory of Denhière & Baudet on text comprehension (Denhière and Baudet 1992) argues that text comprehension implies the understanding of fundamental cognitive categories. When a reader tries to comprehend a text constructs a representation structure in an attempt to reconstruct the world represented in the text. In this representation the key role lies on cognitive categories, the person, the situation, events, acts, as well as the temporal, causal relations and part-whole relationships connecting these structures representation. The term "person" is being used for entities involved in the structure representation. The term "situation" describes the state of non-existence of a change over time. The term "event" describes an action that causes a change but not from humans. The event may be coincidental or caused by a non-human entity, e.g. from a machine. The term "act" is an action that causes a change but which was due to an interaction and or input of a human. The researchers argue that a reader who wishes to explain the operation of a technical system constructs a representation of the "natural flow of things", where each new event may be causally explained by the circumstances and effects of the events that have already happened.

In a survey conducted Baudet & Denhière themselves (Collins and Beranek 1986), the effect of the structure of a technical text on the comprehension of a technical school by the students was being examined. Three different groups of students were given two properly configured texts that refer to the operation of a car's starter. The two texts are structured differently. The first of these determines the relations and states of different units together and then defines a sequence of events linking these events temporally and causally (microstructure). The second text provides a hierarchical structure of subsystems and uses between these

subsystems links expressing the purpose of these relations (macrostructure). The researchers find that the text which refers to the temporal and causal connection of units helped on the better comprehension of the text.

The theory of Collins (Collins and Beranek 1986) is related to the objectives and dialogue strategies used by instructors when students ask questions, in order to: a) the teaching of a subject and b) the teaching of scientific thinking. The dialogue is used to serve both of these two purposes of teaching. The trainers are not trying to teach concepts, but bring them within the context of the theory of a subject. According to Collins, questions that can feed a dialogue in order to achieve these objectives can follow the following strategies:

1. Selection of positive and negative examples.
2. Case (or Comparative) Selection.
3. Selection of alternative examples.
4. Production hypothetical cases.
5. Generation of forecasts / assumptions by the student.
6. Verification cases.
7. Student entrapment.
8. Detection of consequences to a contradiction.
9. Supervision when submitting questions.

2. RETUDIS LEARNING SYSTEM DESCRIPTION

The learning environment ReTuDiS includes a diagnostic and interactive section.

Diagnostic section: In the educational environment of ReTuDiS the student answers a series of questions assessing general prior knowledge (diagnostic tests) in a specific module in the subject of Informatics, choosing from the list of answers given. The questions are designed to explore, according to text comprehension theory, the comprehension of cognitive categories: people, situations and events, comprehension of causal relations between events and situations and understanding the objectives and sub-objectives of the system for which the particular system was designed for (Tsaganou and Grigoriadou 2008, Self 1993). Based on the responses of the student, ReTuDiS outputs the cognitive profile of the prior knowledge of the student (Caillies et al. 2002, Bull and Nghiem 2002).

Interactive part: Based on the cognitive profile of the learner, the interactive part of the RETUDIS provides personalized activities on one or more of the three built versions of a text, alongside with questions and possible answers, as well as feedback. The three versions of text that includes each module are R (Relational), M (Transformative) and T (Teleological).

R (Relational) text describes a document and questions which focus on simple descriptions of the part-whole relations of the system described in the document, as well as on descriptions of the processes, event and system status. (Due to its short, concise sentences and detailed text, the relational text is usually better for weaker students and beginners).

M (Transformative) text designates a document and questions which are focused on describing the sequence of events and the state to state transitions of the system. (The transformative text assumes some basic educational background but describes the system events in detail, therefore is usually more suitable for average students).

T (Teleological) text is focused on detailed descriptions of the objectives and sub-objectives for which the system has been constructed, or of the events and mechanisms which take place within a system. (The teleological text jumps to the results and conclusions without a thorough analysis of the system's events, usually assuming a strong educational background and therefore is typically preferred by advanced students).

After reading the text and answer the questions the system diagnosis / assessment is presented to the student and he/she is asked to engage in dialogue with the system in order to revise the student discrepancies or incorrect answers. The student is guided through the construction of more coherent arguments in text comprehension.

3. ADAPTATION OF EDUCATIONAL MATERIAL TO RETUDIS

The following example, on the subject of: "Computer Network Technology", describes how to adapt standard theoretical literature texts and technical documents to those required by the system RETUDIS, or other similar educational systems, for the education of informatics students.

3.1 Cognitive Category Types

In a text that describes the function of local network computers, the following categories based on the cognitive theory of comprehension Denhière & Baudet (1992) may be displayed:

Individuals are the units of the network nodes, computers, servers, allocators, coaxial cables, the operator of the site, etc. For some units synonyms are used, such as channel, pathway and pipeline crossings.

States in the local network is the "idle state" of the network, i.e. the time that no information is being transmitted, and the "transmission mode", i.e. the time during which information is being transmitted.

Act refers to the state when a node sends another message to the bus in order to communicate with another node. Pressing the "send" button by the operator to initiate the message from a sender node to another network node recipient is a human act. (Not mentioned in the text - implied act). This operation initiates a sequence of events in the sender node.

Events occurring after the act are in chronological order:

- 1-dividing of the message information in packets
- 2-attach control information in each packet
- 3-attempt to capture the transmission medium (channel) for transmission
- 4-packet transmission
- 5-new attempt to capture the channel after a while, if the first attempt fails
- 6-collision of packets sent by two nodes etc.

Random event, which it can be an unpredictable power outage or any other unforeseen event.

Temporal and causal relationships are relationships between events in a sequence of events. For example, if the attempted capture of the channel is successful (event 3), this results in the transmission of the packet (event 4) (causal, and therefore, also a temporal relationship).

Part-whole relations. To send a message, it is being divided into packets from the sender node using a specific model defined by the node. Each packet belongs exclusively to a message. Part-whole relations are those which form a sequence of events and that their integration is a new event, such as sending the entire message when finished sending the packets that were divided.

Micro-level. At micro-level, the student who reads the text regarding the functions of LAN computers, the microstructure gradually builds a representation of the text, defining the units of the network, in which situations the network operates, which events are causing the amendments to the conditions described by the text. The student also fabricates temporal and causal relationships and the part-whole relations connecting these structures.

Macro-level. The following extract of text describes how the local computer network operates: "The control information attached to a package are necessary because they allow the correct routing of the packet into the network, so as to arrive at the right destination. Finding the shortest path interconnecting any two network nodes is the problem of routing". The purpose for which the control information is being attached to a packet is the secure transmission. Finding the shortest path is designed to optimize the transmission speed. To reach an objective individual events occur in order to achieve a sub-objective. These events cause changes to the state of the network and each change is to achieve a purpose. To fabricate the macrostructure, the reader should be able to reconstruct the microstructure of situations (e.g. why the network changes from transmission to idle mode) and sequence of events (for what purpose each event occurs) and part-whole relations (why a series of individual events has to be completed) to reach the predetermined purpose (all this done with secure and fast communication in mind).

3.2 Text Structure

The structure of a text describing a technical system, such as the operation of a local computer network, must enable the reader to fabricate representations of microstructure and macrostructure of the system (Grigoriadou and Tsaganou 2007). Specifically, the text should provide the following descriptions of the microstructure:

- a) description of the units that compose the system which the text describes (R)
- b) description of the part-whole relations connecting the units in the system together (R)
- c) description of static situations where they can find the units of the system (R)
- d) description of events and complex sequences (consisting of sequences of events) and performed in units of the system (M)
- e) description of causal and temporal relationships between events and changes that cause the static states of the system (M)
- f) description of the part-whole relationships between events, which means the hierarchy between them (M)

Also, the text should provide the following description of the macro-structure of the representation of the subject:

- g) a description of the system through a tree of objectives / sub-objectives for each transition of the system from one steady state to another (T)

3.3 Interactive Activities Structure

The following activities are structured in three categories based on the above theory of comprehension and related technical document which describe the system of the local computer network (Tsaganou & Grigoriadou, 2010, Brookshear, 2005).

1. Relational structure activities. These include descriptive questions of the: a) units which compose the system that the text describes, b) Part-whole relationships that connect the units of the system, c) the situations in which the system may be found. For example: In the text there is a description of the units of the network (e.g. hubs, cables), all individual relationships (e.g. broadcast medium connecting two nodes), a description of situations which may a network be at (e.g. data transmission mode, idle) and a description of occurring events (e.g. packetization data, attach control information, etc.).

2. Transformational structure activities. These include descriptive questions of: a) the functions which are carried out by events in the units of the system, b) the causal and temporal relationships between events and the changes which they cause to the state of the system c) Part-whole relations between events, i.e. the hierarchy between them. For example: In the text there is a description of a basic operation of the network, which is the data transmission and description of the series of events related to this, as well as the states in which the network sequentially switches to, the part-whole relationship between events (transmission ends when a series of events is completed in order to make the reconstruction of the message by the recipient).

3. Teleological structure activities. These include questions which describe the system through a tree of objectives / sub-objectives for each transition of the system from one state to another. For example: In the text there is a description of sub-objectives and objectives which need to be achieved. The aim the secure transmission and for this reason control information is being attached. Another aim is the rapid transmission and that is why packets are being routed. Another goal is to serve the greatest possible number of users with the least possible resource cost, which requires a study of factors affecting network performance.

4. RETUDIS LEARNING ENVIRONMENT: TYPES OF QUESTIONS

For each of the categories described in the previous paragraph, the following types of questions are being suggested:

1. Questions with alternative answers.
2. Question-pairs with alternative answers: The first question of the pair (regarding a position) requests the student to take a position on an issue. The second question of the pair (concerning justification) asks the student to justify his/her position on the issue.

3. Categorizing entities: The student is asked to identify the units described in the text which form part-whole relationships and make the appropriate connections so as to describe the relationship between the units. An example of a question regarding categorizing entities which refer to a text based on a relational description is as follows: "The following terms which are being encountered in the text are given. Group these terms into groups with common characteristics and name each group. The terms of each group should have a part-whole relation to each other".

4. Classifying events in a sequence: The student is asked to categorize events or functions in a sequence as some of them are misplaced causally or temporally in the list given. An example of a question requesting the classification of events which may be implemented to a text based on a teleological description is as follows: "A list is given with the steps of a functions sequence required to reach an objective shuffled. Rewrite the list following the correct events sequence.

5. Completing events in a sequence: The student is required to complete events or situations that are missing in a sequence which represents a function.

5. EXAMPLES OF ACTIVITIES

5.1 Example 1

Activity on categorizing entities which are being mentioned in relational (R) text. Title: "Recognizing the parts of a local network".

The following terms are encountered in the text: twisted pair cables, connectors, computer, coaxial cables, connectors, fiber optic terminations. Groups these terms in these categories: Nodes, Transmission, Adaptive Material. This grouping shows the relations part-whole terms with groups.

5.2 Example 2

Filling activity on events sequence which are being mentioned in transformative (M) text. Title: "LAN operation during packet transmission".

In a network channel which is at an initial state, occurs a sequence of events linked causally and temporally, as well as with part-whole relationships which are leading to the change of the state of the network. The following table shows the sequence of events that occur when sending a message from the transmission node to the receiver node, which is the system's default.

Fill in the missing events (steps 4, 6 and 8) by selecting from the list below:

1. Initial (idle) state: The network is idling before the packet transmission.
2. Act: The user of the transmission node requests the delivery of a package to the receiving node by pressing the "send" button.
3. Event 1: The transmission node divides the package into packets, based on the privileges it has according to the network configuration.
4. Event 2:
5. Event 3: The transmission node checks to see whether the channel is available and no other node transmits a package, in order to avoid collisions.
6. Transmission state:
7. Event 5: Comparison of the delivery address of the transmitted package with the address of the first node.
8. Event 6:
9. Event 7: Comparison of the delivery address of the transmitted package with the address of the next node.
10. Event 8: The delivery address of the package coincides with the address of the receiver node and the package is being copied.
11. Final state (idle): Idle network, after the transmission of the package.

Selection of answers:

1. Forwarding of the packet to the next node.
2. The transmission node attaches the destination address in each packet.
3. The network channel is free for packet transmission to both directions of the channel.

5.3 Example 3

Activity of completing the missing parts of a document which refers to a teleological (T) educational text. Title: "Sending a message in a local network – Objectives and sub-objectives tree".

In this example we have the tree of objectives and sub-objectives when sending a message via the local computer network topology bus. The corresponding events or sequences of events in order to realize these objectives may also be seen.

Suppose that the local network contains three nodes (1, 2 and 3) and the message is sent from node 1 in order to be received by the node 2. The message is broken into 2 packages. Fill the gaps in the table 1 below with events listed in the following list given, considering the sub-objective to which they relate and the causal links between sub-objectives with events and situations.

Table 1. Teleological text activity example

Objectives & Sub-Objectives (Macro-level)		Actions, states, events (Micro-level)
Objective: Send a message between two network nodes	Idle state	Network idle
	Action	User presses the send button
Sub-objective 1: Improvement of transmission speed	Event 1	<i>Blank</i>
	Event 2	Package addressing
Sub-objective 2: Transmission security	Event 3	<i>Blank</i>
	Transmission mode (active network)	Transmission via the free channel
	Event 4	<i>Blank</i>
	Event 5	Copy package A to node 1 if it has the required address attached.
	Or	Or
Sub-objective 3: Control of network traffic	Event 6	Forwarding of package A to node 2 if it does not has the required address attached
	Idle state	Network Idle after package transmission
	Sub-objective 4: Return to the original state	

Selection of answers:

1. Comparison of the addresses attached to the packet A and the receiving node 1.
2. Checking if a node transmits a packet via the bus at the moment. If not, then the packet is sent, otherwise postpone.
3. Dividing the message in packets A and B.

6. CONCLUSION

In this paper the procedure for the adaptation of an educational text to an open interactive learning environment and in line with known text reading comprehension and dialog theories has been presented. Although the examples covered a specific module and questions, the method can be used for the adaptation of virtually any educational text, especially technical documents, to the environment of RETUDIS or, with adaptations, to other similar interactive learning environments as well.

Via the answers given by the students and their cognitive profile formed by the system, it is possible to offer personalized support which bases its recommendations on the performance of the student. This

approach goes beyond the common "one-size-fits-all" approach which dominates education today and can be nullified via advanced learning environments.

The methodology described in this study has been used to adapt the educational texts of the module "Computer Network Technology", which is today taught in the department of informatics and telecommunications of the University of Athens. The module adapted to RETUDIS has been successfully used for a semester with very positive results, allowing the research team to assess the capabilities of the system, troubleshoot potential problems and, ultimately, vastly improve the system. Educational material from several different modules which are taught in four different academic institutions and in two different languages is now being adapted to RETUDIS, as extensive further testing and research is scheduled to take place starting from the following academic year.

It is noteworthy to mention that an open interactive learning environment is that the student participates in the construction of his/her own cognitive model, which opens an unexplored area of research, that of open learner modeling.

ACKNOWLEDGEMENT

This research has been co-funded by the European Union (European Social Fund) and Greek national resources under the framework of the "Archimedes III: Funding of Research Groups in TEI of Athens" project of the "Education & Lifelong Learning" Operational Programme.

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