

Dialogue-Based Personalized Reflective Learning

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Abstract

The Web-Based Reflective Tutorial Dialogue System (W-ReTuDiS) is a system for personalized learning of historical text comprehension on the Web. The system offers a two level open interface: tutor level and learner level. In tutor level, the tutor manages the learner model and makes decisions concerning the appropriate activity and dialogue strategy for the learner according to his learner model, which is based on the diagnostic results. In learner level, the learner participates in the construction of his learner model through dialogue activities, which promote reflective learning. The dialogue generator module, which is activated by the diagnostic results, plans the appropriate sequence of dialogue-parts using the dialogue-parts' library and constructs personalized tutorial dialogue. The system promotes learners' personalized reflection to accomplish the learning goals and helps learners to be aware of their reasoning and leads them towards the scientific thought.

1. Introduction

Traditional computer learning systems infer the reasons for the student's behavior without directly involving the student. Researchers in the area of learner modeling have been exploring the potential of externalizing the model to students [17]. Recently, there is a growing interest in opening the student model to the learner, encouraging him to reflect on his beliefs and on the learning process. Given a learner model, it is expected that a tutoring system is able to tailor the learning experience to the individual learner [7]. Reflective tutorial dialogue between the learner and the system about learner's own beliefs can make a learner model open [10]. Interactive open learner modeling involves human learners in learning

dialogues to improve personalized learning through promoting and facilitating reflection. Open learner models encourage learners to reflect on the domain being studied, on their own strategies for learning, on their own understanding. Towards this direction, the dialogue management, the dialogue strategies and the dialogue tactics, which mainly formulate the dialogue framework, aim at the promotion of personalized reflective learning [6] [11] [17]. Recently, approaches involve learners in Web-based personalized dialogues: Kermit [9], TAGUS [10] provide dynamic learner modelling, STyLE-OLM [17] [10] encourages learners in inspection, SQL-TUTOR [5] is dialogue-based problem-solving tutor, ATLAS-ANDES [6] promotes knowledge construction and ScoT is a scalable, reusable, conversational tutorial dialogue system [11]. Developments promoting personalized learner reflection through discussion [5], dialogue planning [6], Case-Based Reasoning educational dialogue systems [14] [16] and dialogue management systems [6] have been explored.

W-ReTuDiS is a dialogue-based learning system for personalized reflective learning using the Web, which models dialogue grounded on the learner model of historical text comprehension [12] [8]. In section 2, we present the modelling process of learners' historical text comprehension in W-ReTuDiS. In section 3, we describe the structure of the system and its functional characteristics. In sections 4 and 5, we concentrate respectively on learner-system and tutor-system interactivity provided by the interface module. Moreover, we describe the system's personalization and how the dialogue engages the learners to reflect on their own strategies. In section 6, evaluation and results are discussed. In section 7, we conclude and give our future perspectives.

2. Modeling the Learner

2.1 Models of Historical Text Comprehension

Comprehension of text is a special kind of the complex and interactive process of cognition [2]. The reader utilises certain fundamental cognitive categories for establishing and organising the meaning of the text. During comprehension of historical text the reader attributes meanings to causal connections between occurrences [3]. In the level of comprehension as a cognitive task, the learner composes a representation of the historical text, which contains the cognitive categories: *event*, *state* and *action* [1]. For the interpretation of the learner's cognitive processes, we trace in their discourse their arguments, which reveal the recognition or not of the three cognitive categories.

2.2 The Learner Model of W-ReTuDiS

The system involves the learner in an activity, which includes the reading comprehension of a historical text and the answering of question-pairs by selecting from the given alternative answers [12]. The historical text includes a number of factors, which represent the 3 cognitive categories *action*, *state* and *event*. The historical text used by the system, includes 5 different factors, which have been the causes of the outbreak of French Revolution (FR) (one factor represents the cognitive category *event*, one the cognitive category *state* and three the cognitive category *action*). For every factor a question-pair, is submitted to the learner. The first question in the question-pair is related to the learner's answer about the significance of this factor and is called *position*. The second question is related to the learner's justification concerning the position and is called *justification*. The learner has to use the given alternative answers, in order to express his *position* for certain historical issues and support it by selecting a *justification*. The alternative answers concerning position and justification are classified as *valid*, *towards-valid* or *non-valid*. For every question-pair the combination of the learner's *position* and the corresponding *justification* constitute the learner's *argument*. An *argument* is defined as *complete* when both position and justification are valid. Otherwise the argument is *non-complete*. The expert defines the different degrees of *argument completeness*. The argument completeness, which is associated with the recognition or not of an instance of a cognitive category, is used as a vehicle to reveal the degree of the recognition or not of the corresponding cognitive category. Table 1 demonstrates all possible combinations of position-justification pair values and the corresponding argument completeness. The learners' cognitive profiles of Historical Text Comprehension are formulated taking into account the

number of his arguments with high degree of argument completeness. The cognitive profile expresses the degree of recognition of the cognitive categories. Possible values of cognitive profiles are: *very low*, *low*, *nearly low*, *below intermediate*, *above intermediate*, *nearly high*, *high* and *very high*.

position	justification	argument completeness
valid	valid	complete
towards valid	valid	almost complete
non- valid	valid	intermediate
valid	non- valid	nearly incomplete
valid	towards- valid	
towards- valid	towards- valid	
non- valid	towards- valid	incomplete
towards- valid	non- valid	
non- valid	non- valid	

Table 1. Argument completeness values

3. Structure of W-ReTuDiS System

Basic components of the system, which communicate with the knowledge base of the system, are the *interface module*, the *diagnosis module* and the *dialogue generator module*. The *Interface module* provides a two levels communication medium between the users and the system: the learner level and the tutor level. In learner level, the learner participates in reflective learning dialogue activities, which result in the construction and revision of his learner model. In tutor level, the tutor makes decisions concerning the appropriate activity and dialogue strategy for the learner according to his learner model. The *Diagnosis module* first infers the argument completeness for all the learner's arguments. Using the technique of Fuzzy-Case Based Reasoning [15] [13] the system handles case adaptation by exploiting the similarity values between the arguments' completeness and infers the learner's cognitive profile and profile descriptor [12]. The *Dialogue generator module* uses dialogue strategies, dialogue tactics, the dialogue-parts' library and dialogue plans [4] [9] to generate the appropriate reflective learning dialogue for the learner's learning difficulties according to his learner model. The system follows the *dialogue strategy*: the dialogue begins with the factor for which the learner seems to face the less learning difficulties where there is a contradiction, for example between his "non-valid position" and his "valid justification" (see table 1). In reflective activities the following *dialogue tactics* are used: (1) positive and negative exemplars, (2) counterexamples and (3) generation of hypothesis.

<p>1 System: Your answers concerning the...(<i>factor</i>) indicate that you consider it as ... (<i>comparison</i>) for the French Revolution. Your argument is characterized ...(<i>description</i>). Do you want the system to... (<i>explanation</i>)?</p> <p>Learner: I'd like to ...(<i>explanation</i>)</p> <p>2 System: You asked the system to explain. Your answers concerning the ...(<i>factor</i>) consist of your position and your justification. Your position is that the ...(<i>factor</i>) was/were... (<i>comparison</i>) for the French Revolution. This is a ...(<i>description</i>) position. Your justification for that position is that the ...(<i>alternative answer</i>). This is a ...(<i>description</i>) justification.</p> <p>Your position about the ...(<i>factor</i>) is ...(<i>contradiction</i>) your justification. That is why your argument is characterized ...(<i>description</i>). What do you intend to do now?... or ...(<i>intention</i>)</p> <p>Learner: I ...(<i>selection</i>) in my position that the ...(<i>factor</i>). ... (<i>comparison</i>).</p>

Table 2: Fragment of a dialogue plan

Each *dialogue-part* (table 3) is seen as a reusable component for the construction of the dialogue between the learner and the system, which component is designed to remedy a particular learning difficulty. In order to construct an initial overall tutoring dialogue plan (table 2), the system uses information in an annotated record of the learner's performance in a comprehension activity concerning a historical text. The dialogue generator is activated by the diagnostic results, plans the appropriate sequence of dialogue-parts using the initial dialogue plan and constructs the tutorial dialogue.

types of dialogue-parts	dialogue-parts
factors	the living conditions of the 3 rd class,
comparisons	the most important reason, important reason, less important reason
descriptions	valid, towards-valid, non-valid, complete almost complete, intermediate, nearly incomplete, incomplete
explanations	explain, don't explain
intentions	insist, don't insist
selections	happened, not happened, yes indeed, no I don't believe, yes I'd like, no I don't like
contradictions	contradictory to, not contradictory to

Table 3: Dialogue-parts' library

4. Learner-System Interaction

The learner communicates with the system through the *activity worksheet* and the *reflective dialogue*.

4.1 Activity worksheet

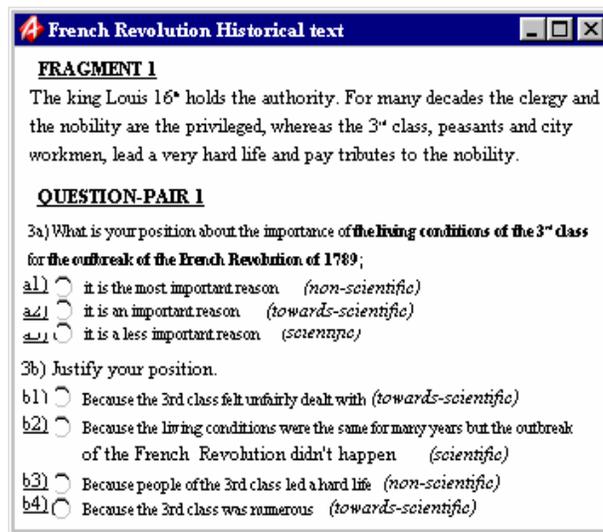


Figure 1: Fragment of the activity worksheet concerning historical text and question-pair 3. (Characterizations of answers are not visible to the learner)

The environment of W-ReTuDiS provides the learner with an easy-to-use interface through which he is given the *activity worksheet*, which consists of the historical text and questions-pairs with alternative answers (figure 1). The learner is encouraged to read the historical text and response to the question-pairs by selecting the valid answers according to his opinion. At the end of this process the system constructs the learner model, which is accessible by the learner:

- formulates characterizations of the learner's answers and the argument (see table 1)
- makes the diagnosis of the learner's cognitive profile
- expresses the profile descriptor

The learner model contains representations of the learner's performance on the *activity worksheet* concerning the historical text and reflects his learning difficulties. The learner can inspect his model and discuss it with the system through the reflective dialogue.

4.2 Reflective dialogue

The actions of the system have to be driven towards the aim of eliminating the contradiction within the learner's arguments and therefore changing the learner's reasoning. The elimination will only be possible when the learner himself removes the contradiction and so he is able to construct a more

coherent argument. In this stage of interaction the system:

- prepares the appropriate dialogue plan (table 2) according to the learner's answers, which are not characterized as valid
- provides the learner, step by step, with reflective activities in the form of questions with alternative answers and participates in the dialogue with the learner.

The learner is involved in interactive dialogue concerning his contradictions within his arguments through a series of reflective activities where the system:

- *encourages the participation in dialogue*: The system makes the learner aware of the general framework of the assessment results, that is whether the learner is correct or not and encourages him to take his first decision for participating in discussion.
- *indicates the contradiction*: The system uses qualitative criteria to indicate where the learner has contradiction between his position and his justification.
- *schedules the dialogue tactics*: The learner's decisions can guide the system to use the appropriate individualized dialogue tactics.
- *motivates discussion and justification*: The system discusses and justifies itself and argues with the learner for his contradictions.
- *encourages participation in diagnosis*: At the end, the system encourages the learner to try again to read the historical text and answer the questions. So, the learner is involved in the diagnosis process and the revision of the learner model.

The following personalized dialogue example illustrates in 4 turns the interaction concerning question-pair 1. The learner has given non-valid position and valid justification, which correspond to answers a1 and b2 of figure 1 and result in an intermediate argument of the category state.

1 **System**: Your answers concerning the LIVING CONDITIONS indicate that you consider it as THE MOST IMPORTANT REASON for the French Revolution. Your argument is characterized INTERMEDIATE. Do you want the system to EXPLAIN or to CONTINUE?

Learner: EXPLAIN

2 **System**: You asked the system to explain. Your answers concerning the LIVING CONDITIONS consist of your position and your justification. Your position is that the LIVING CONDITIONS were THE MOST IMPORTANT REASON for the French Revolution. This is a NON-VALID position. Your justification for that position is that the LIVING CONDITIONS WERE THE SAME FOR MANY YEARS. This is a VALID justification.

Your position about the LIVING CONDITIONS is CONTRADICTORY TO your justification. That is why your

argument is characterized INTERMEDIATE. What do you intent to do now? INSIST or NOT INSIST.

Learner: I INSIST in my position that the LIVING CONDITIONS ARE THE MOST IMPORTANT REASON.

3 **System**: You INSIST in your position. Let consider that the LIVING CONDITIONS as a reason for the French Revolution didn't exist. Do you believe that the outbreak of the French revolution would have happened?

Learner: I believe that the outbreak of the French revolution would have NOT HAPPENED.

System: But the outbreak of the French revolution has happened. So, what is your logic conclusion?

Learner: The LIVING CONDITIONS ARE NOT THE MOST IMPORTANT REASON

4 **System**: You can try to answer again.

W-ReTuDiS uses dialogue tactics to support tutorial interactions. For example, in turn 3, the tactics: *selection of counterexamples* and *generation of hypothesis* are used. The learner considers the "living conditions of the 3rd class before 1789" as the most important reason. The tutor's counterexample can be "whenever the living conditions of people are bad do we have a revolution"? The tutor generates the hypothesis that "if the heavy winter of 1789 did not have happened, would the outbreak of the French Revolution have happened"? in order to make the learner to reason about it.

5. Tutor-System Interaction

The environment of W-ReTuDiS is open to the tutor since it facilitates him to identify learning difficulties that learners face in order to adapt and schedule the appropriate instructional dialogue strategies. The system provides the tutor with management capabilities for the selection of the appropriate activity worksheet and dialogue strategy and the management of the *learner models' base*. The human tutor can access the tutor level interface, which allows him easily select the appropriate activity worksheet and dialogue strategy and determine the dialogue plan to provide the learner. Moreover, he can suspect the current learner model and take information concerning learner's difficulties in the recognition of the cognitive categories, the number, the quality and the degree of recognition of the cognitive categories.

The tutor can manage the *learner models' base*. The learner model includes: personal information for the learner, the learner's answers to the question-pairs, the characterizations of the learner's answers to the question-pairs, the characterizations of the learner's arguments (table 1), the cognitive profile, the profile descriptor and information data about the participation of the learner in the reflective dialogue.

6. Evaluation

Evaluation was conducted as part of the implementation cycle of the system with the participation of human experts and was taken into account for further revisions [9]. The evaluation focused on indicating problems with dialogue coherence, suitability of dialogue tactics and strategies for planning effective diagnostic dialogues. The participants asked to explore a variety of potential situations envisaging the behavior of a learner who would discuss with the system. In general, dialogue planning appeared suitable for organising dialogue that meets the requirements of dialogue-based interactive and reflective learning. The dialogue tactics were considered adequate in respect to maintaining the local focus of the dialogue. Most of the experts characterized the dialogue strategy as successful to help learners face their contradictions. Few problems were identified, e.g. repetitions of system's questions in the dialogue.

7. Conclusions and Future Plans

In this work we presented and evaluated personalized reflective learning historical text comprehension in W-ReTuDiS. The dialogue promotes learners' reflection and helps them to be aware of their reasoning, to construct more coherent arguments and leads them towards the scientific thought. The application perspectives of this dialogue-based interactive and reflective learning environment aim at personalized learning in history. There are educational benefits of the system for the students in changing their reasoning.

In our future plans falls research concerning the application and evaluation of the diagnostic and learning interaction in classroom conditions as well as the application of the system with a new historical text.

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