doi: 10.14355/jitae.2013.0204.02

Monitoring the Text Comprehension of Students for Profiling in ReTuDiS

Maria Samarakou[1], Grammatiki Tsaganou[2], Andreas Papadakis[3], John Gelegenis[1], Emmanouil D. Fylladitakis[1], Maria Grigoriadou[2]

[1]Technological Educational Institute of Athens, Energy Technology Department, GR-12210, Athens, Greece
[2]University of Athens, Department of Informatics and Telecommunications, GR-15784, Athens, Greece
[3]School of Pedagogical and Technological Education (ASPETE), Department of Electronic Engineering Educators, GR-14121, Athens, Greece,

[1]marsam@teiath.gr; [2]gram@di.uoa.gr; [3]apapadakis@aspete.gr; [1]Jgelegenis@teiath.gr; [1]edf3@teiath.gr; [2]gregor@di.uoa.gr

Abstract

This work describes the system specifications and requirements for monitoring a student's behavior while participating in text comprehension activities within the Reflective Tutorial Dialogue System (ReTuDiS). Based on text comprehension theories, the system provides students with prior knowledge tests for thematic topics concerning technical texts in terms of a course. The purpose of the tests is to infer the initial cognitive profile of a student, decide on the appropriate personalized feedback and support in the form of text activities. This study explores how assessing the prior knowledge of a student will help the system estimate the educational needs and offer the appropriate text activity for personalized feedback and support.

Keywords

Student Monitoring; Student Profiling; Text Comprehension; Personalized Learning

Introduction

In an online learning environment, the lack of face-to-face interaction with an educator and the freedom to learn at one's own pace can make the student slothful and unmotivated, leading to loss of interest for the course. This calls for regular monitoring of student's behavior and feedback to the student. When technology-based behavior capturing systems are employed, the acquired data can provide a portion of information similarly valuable to that which a live educator may discern and can permit the evaluation of a student's performance (Macfadyen & Dawson, 2010). In higher education, formative evaluation and student feedback are still a process largely controlled and operated by educators. Feedback is perceived as a transmission process, even though some influential researchers have challenged this viewpoint (Sadler, 1998; Boud, 2000). Educators 'transmit' feedback messages to the students in order to point errors in their work and students use this information to perform changes (Nicola & MacFarlane-Dick, 2006). This view raises a number of problems when applied to formative evaluation and feedback. When formative evaluation remains mainly in the hands of the educators, then it is difficult to ascertain how students could realize how to develop the self-regulation skills needed to prepare them for thinking scientifically (Boud, 2000). When educators transmit feedback information to students, these messages are expected to be easily decoded and translated into action (Dewitz, Jones & Leahy, 2009). On the other hand, there is strong evidence that such feedback messages may be complex and difficult to decipher, which suggests that students may require support in order to comprehend them. When students are involved in the feedback process, they play an active role in adjusting their own performance in relation to the learning goals and teaching strategies used to reach these goals (Wiggins, 2012). As soon as the students formulate their own understanding from feedback messages derived from the educators, avocation with the task requires the use of their prior knowledge and motivational factors (Bull & Nghien, 2002).

Monitoring is the process of measuring progress and continuous assessment within a process with the purpose of teaching (França et al., 2012). Monitoring the sequence, duration and timing of student interactions with the educational materials of the course and learning assets in real-time allows the development of a learning behavioral profile for each individual. Learner modeling supports the creation of systems that are adaptive to each learner's interests, preferences and background knowledge in order to provide personalized instruction to a particular learner (Niu, Mccalla & Vassileva, 2004; Dimitrova et al., 2007). However, most of them have only primitive student-monitoring features and their capability of customizing the tutorial to suit each individual student is also limited. A critical initial task regarding the design of a monitoring system is to identify the information needed to ensure effective operations and meet external reporting requirements. Educators have to decide on how to gather and analyze the information, as well as draw a plan for the monitoring system.

Since monitoring systems for modeling the student provide valuable information about his performance, learning systems which include this feature, become more profitable. The goal of this work is to set up the monitoring requirements of student behavior while participating in text comprehension activities within ReTuDiS. Moreover, another goal is to test the accuracy of student profiles which the system assesses relying on monitoring results. This work contributes to the field of student monitoring for profiling. Specific problems student faces about text comprehension can be identified by ReTuDiS. It is important for the learning system to be able to provide the student with personalized study material as feedback taking into account his specific needs.

This work presents the description of the requirements for monitoring students in ReTuDiS. In the introduction section systems for student monitoring and profiling are being presented. The following sections include a short presentation of educational monitoring systems, the student text comprehension monitoring process in ReTuDiS and the learning goals. Specific issues about the monitoring requirements and results of the first trial with discussion are presented. Conclusions are summarized at the end of the paper.

Student Monitoring Systems

Today, a large number of schools, colleges and universities are implementing methods involving the monitoring of the student, the development of a student profile for each student and delivering personalized instruction based on the individual profile (Deno, 2005). There are a number of course management packages such as WebCT that has inbuilt student monitoring and tracking features (Niu et al., 2004). WebCT systems give limited information about the student, usually more quantitative features and less really information about learning or the strengths and weaknesses of the student about learning concepts. ITSs, as computer-based instructional systems, discreetly apply a built-in inference mechanism for monitoring which allows the identification of students at risk (McMaster & Wagner, 2007; Lamb & Rice, 2008; Hughes & Dexter, 2011). ITSs use stereotype approaches and student is assigned to a certain student group: novice, beginner, intermediate or advanced. Inference mechanisms often face conflicts and there is no decision.

Platforms like Moodle are being used by GISMO-a graphical interactive monitoring tool, for the visualization of student activities in online courses and by MonSys-Monitoring System for Students and Tutors of Postgraduate Courses (Mazza & Milani, 2004; França et al., 2012). Monitoring is also used to conduct a curriculum analysis of text comprehension in core reading programs (Dewitz et al., 2009). Beyond LMSs, there is the Learner Interaction Monitoring System (LiMS), which is a web-based application that can communicate with a web-based course delivery platform (Sorenson & Macfadyen, 2010). INTUITEL is a general purpose framework which enhances LMS and focuses more on devices and tools for learning than on the learning process itself. Most of such systems have been developed similarly to ITSs, where the learning largely depends on the interaction with the system. They are more course management software products and have primitive monitoring features and limited capability.

Chaatra is a Student Monitoring and Learner Modeling System which tracks the student performance in a course, by identifying the correct answers to questions and mapping question answers to tested concepts to create "question concept-map". (Rehani & Sasikumar, 2002). The instructor contacts a quiz by creating a list of concepts to test. Chaatra identifies which topics and concepts the student is weak on and decides which smaller concepts at different level must be dealt with. The similarity of our work with systems as Chaatra, is that they use monitoring in order to assess student's learning profile and provide personalized feedback.

The difference of ReTuDiS from Chaatra is a different point of view to learning from texts and questions. It provides students with texts and activities (not just a quiz in a topic) elaborated by experts to the field according to the text comprehension theory of Denhiere & Baudet (1992). Moreover, questions are distinguished in types and the questions of each type test specific concepts or causal and temporal relationships between entities described in the text.

ReTuDiS uses four different categories of questions with alternative answers (not plane multiple choice) selected by the experienced instructor or expert such as to correspond to answers given by different level students. Such answers reflect inactive concepts, misconceptions or contradicting arguments.

The innovation of ReTuDiS in this work relative to previous articles (Tsaganou & Grigoriadou, 2009) is the organization of the student monitoring process and the revision of the profiling and modeling process. What is important to the field is that in ReTuDiS the monitoring of student's answers is not a measuring process of just a number of correct or non-correct answers. Monitoring enables the system to have access to fairly detailed information concerning the activities of the participating student and to identify each student's personalized educational needs. The student deals with text activities which help him to activate inactive concepts, to overcome his misconceptions, to think about his contradicting arguments. Moreover, the student receives specific feedback in the form of advice or guidance which triggers reflection and is motivated to continue.

Monitoring the Text Comprehension of Students

In contemporary education, educators need tools to help them identify the educational needs of individual students, in order to adjust their instructional strategies to better meet their needs (Kay & Mccalla, 2012). Monitoring student progress is a practice which allows educators to continuously assess the effectiveness of their teaching and make advanced educational decisions by using the student performance data. To implement student monitoring, the educator defines the current level of acquaintance which the student possesses on skills that should be achieved during a course, identifies the goals and learning outcomes which the student needs to reach and determines the rate of progress which the student must maintain in order to meet the course requirements. The educator then compiles a plan and begins assessing the progress of the student using measures easy to implement (Safer & Fleischman, 2005). Research conducted has demonstrated that when monitoring student progress, students absorb more information and their comprehension of that information improves, thus the teaching process improves overall as well. When educators use student monitoring systematically to record their students' progress on reading and text comprehension, they are better able to identify the students in need of further assistance. The policy of monitoring a student's performance suggests greater priority to monitoring the goals of quality control in student's education (Kilpatrick, Turner & Holland, 1994). Steps involved in the design of an effective monitoring system are the following: a) establishment of the monitoring system objectives, b) link activities and resources to objectives, c) translate objectives into performance indicators, d) collect data based on these indicators, e) report on the monitoring results, f) plan a critical feedback process for improving learning and g) devise communicating the results to the students (Kusek & Rist, 2000).

Students, when are reading a text on a topic, activate their prior knowledge and use this knowledge to overcome their misconceptions in order to comprehend the text. The combination of the newly received information with prior knowledge helps the students contemplate and comprehend the deeper meaning of the text. Monitoring interconnects the students' ability to adjust new information from the text into what they already know. Students relate what they read to personal experiences, to information previously received from other texts and to information received by the world in order to enhance their understanding of text.

The purpose of the initial assessment, during which students answer questions about the text, is to infer the student's profile in order to proceed with new instructional activities (França et al., 2012). Assessment may offer a number of educational rewards; it can help with the clarification of meanings, as well as motivates the students to contemplate about the text. Moreover, assessment can focus attention on specific parts of the text, locate a specific answer and reflect on ideas inspired by the text.

When providing feedback, the focus should be on maintaining a positive, motivational relationship with the student. Before the student starts reading, the focus is to activate the students' prior knowledge. To achieve this, the educator can motivate students to read, establish one or more specific and explicit purposes for reading and provide vocabulary instruction if necessary (Caillies & Denhière, 2012). During the reading the focus is to provide students with activities that satisfy their personal educational needs and allow them to improve their text comprehension. After the reading the aim is to provide students with an opportunity to assess their own comprehension of the text, as well as to reflect and elaborate on ideas from the text. The student should be able to infer meanings from what was read, improving text comprehension and the solution of problems. The student can justify or defend his views by applying criteria such as importance, accuracy, credibility, usefulness, appropriateness and personal enjoyment to information obtained from the text. Inferring expands understanding by helping the student discover what is implied in the text but not explicitly stated by the author.

Text Comprehension in ReTuDiS

In text comprehension studies, researchers focus on assisting comprehension by improving text coherence (McNamara & Kintsch, 1998; Graesser & Tipping, 1999), by improving the design of the text form and text activities (Denhière & Baudet, 1992) or by exploiting a student's prior knowledge on a topic and giving feedback to improve a student's skills (Caillies & Denhière, 2012).

ReTuDiS is a web-based diagnosis and dialogue learner modeling system for text comprehension, which deduces a student's cognitive profile in order to construct and or revise the student model with the participation of the student (Tsaganou & Grigoriadou, 2009). In the diagnostic part the system, based on Text Comprehension Theory (Denhière & Baudet, 1992), engages students in a diagnostic activity which includes the answering of questions. The purpose of this activity is to deduce the student's initial profile. Students compose a cognitive representation of the text, which contains the cognitive categories: entity, state, event and action, a hierarchy of part to whole relations between entities, as well as causal relations. Furthermore, the organization and structure of cognitive representation involve three text types: relational text, transformational text and teleological text. The organization and structure of cognitive representation is also examined on micro and macro-levels. On a micro-level scale, in order for a person to be able to explain the operation of a technical system described in a text, he or she has to construct a representation where every new event should be causally explained by the conditions of events which have already occurred. On macro-level, the development of the macro-structure by readers is achieved through the reconstruction of the micro-structure and the establishment of a hierarchical structure with the goals and sub-goals found in the text. The underlying theory behind the dialogue part of ReTuDiS is the Theory of Inquiry Teaching (Collins, 1987). ReTuDiS provides dialogue activities based on theories of dialogue management, strategies, tactics and plans, which promote reflection in learning. Reflection is viewed as productive and as conducive to learning. The dialogue part is based on the cognitive profile of the student, which has been provided by the diagnostic part, the student's answers to text activities and the selected dialogue strategy offered by the system. The dialogue part of ReTuDiS engages the student in personalized dialogues to promote student reflection in order to revise the student model with active participation on behalf of the student.

School and university text-books usually include texts not structured according to any theory of text comprehension. Research held with participation of 60 students studying Didactics of Informatics in the Department of Informatics and Telecommunications, University of Athens, during the academic year 2006-2007, requested students to select texts and write questions for text comprehension (Tsaganou & Grigoriadou, 2009). The research results indicated that selected texts embody mainly descriptions of micro-structure, whereas descriptions of macro-structure were very poor or fragmentary. On the other hand, questions submitted by the students included descriptions of macro-structure. As structuring a text is a demanding process, the text should be organized and structured in order to include descriptions on micro and macro-level representation of the knowledge domain. For this process authors should lie heavily on the construction of the appropriate questions regarding the text. In the framework of designing, organizing and setting up the appropriate educational settings for supporting learning through text comprehension, ReTuDiS includes an authoring tool (Tsaganou & Grigoriadou, 2009). The tool was used for compiling the structure of texts and text activities for adaptive learning and incorporating them in the system (Tsaganou & Grigoriadou, 2011).

Text Structure

The underlying educational model concerning the structuring of a text mainly depends on the theory of Denhiere & Baudet (1992) for text comprehension. In the environment of ReTuDiS, texts, which come mainly from technical text-books, are considered to mainly contain descriptions of technical systems. The identified cognitive categories in the text are: entities, events, states, actions, as well as causal, temporal and part to whole relations. The three versions of text are structured with respect to the Relational, Transformational and Teleological system.

The Relational text (Re-text) refers to: (a) a description of units that constitute the system described by the text, (b) a description of part to whole relations connecting system units and (c) a description of static states of the units on micro-level.

The Transformational text (Tr-text) includes: (a) a description of events and event sequences taking place in the units of the system described by the text and provoke changes to the state of the system, (b) a description of causal and temporal relations among events and the changes they bring to the state of the system.

The Teleological text (Te-text) includes: descriptions throughout a "tree" of goals and sub-goals and how the technical system described by the text changes from an initial to a final state due to events in order to achieve the goals and sub-goals on macro-level.

Text Activities

The underlying model behind authoring text activities, such as questions, dialogues and the dialogue management for inquiry-based learning, is the Theory of Inquiry Teaching (Collins, 1987). Questions provide the focus and direction for the instruction through a reflective tutorial dialogue. The design of the reflective dialogue helps students to enhance their reasoning and construct more coherent arguments, thus leading them towards better scientific thinking. Each of the above versions of text corresponds to one or more text activities of the following categories:

A) Formulating question-pairs with alternative answers: the author formulates the appropriate questions with alternative answers from a text by using possible student answers (based on his educational experience or on bibliography). The first question in the question-pair is related to the causal importance of a specific factor in the text and a student's answer concerning this question is called position. The second question is related to a student's reasoning concerning the selected position and is called justification.

B) Categorizing entities: to structure this text activity, the author identifies entities described in the text, which have part to whole relations among them and makes the appropriate connections among entities so as to declare their part to whole relations.

C) Classifying events or operations: to structure this text activity, the author inserts in the appropriate fields one by one the events belonging to a sequence so as one or more of them appear in a wrong causal and temporal order.

D) Completion of event or operations missing in a sequence: to structure this text activity, the author abstracts one or more of the events in a sequence of events, which sequence constitutes an operation.

ReTuDiS' Specifications for Monitoring and Profiling

Student monitoring and profiling a student's text comprehension, as processes with the view of learning, are applied in ReTuDiS. The educational environment is designed in order to realize the monitoring of a student's movements, the student's answers to questions and the student's model.

The Subsystem of Monitoring Student Movements

The subsystem of monitoring student's movements in the educational environment monitors student's movements during activities. Students have agreed to be monitored but they do not have control over this process. The type of inputs available for monitoring students depends upon the educational settings. Monitoring is designed to include all of the input submitted by the student, such as: double-clicks, right clicks, left clicks and drag & drops. Student movements include the selection of answers to questions of different types and seeking assistance using the on-line help. The system monitors the number of hits per page, pages visited and order of steps taken by the student. As a result the monitoring system keeps a complete history of the time each student spends on each topic content page, as well as the time intervals between activities. The system monitors how many times a question has been visited and how many times the answer has been changed. Moreover, the system monitors the student's logical mistakes/errors or unnecessary steps. Finally, the system also monitors the activities student chooses to partake, the number of times he makes a mistake of the same or different type, as well as any other information connected to student behavior during interfacing with the environment.

The Subsystem of Monitoring a Student's Answers

This subsystem observes and monitors a student's answers to questions while the students participate in: a) the prior knowledge test and b) text activities.

For each of its topics ReTuDiS provides a prior knowledge diagnostic test in order to identify and recognize a student's prior knowledge concerning the topic. Prior knowledge test consist of a number of general or specific questions with alternative answers about the topic. Alternative answers are not plane multiple choice answers. They have been selected by the experienced instructor or expert such as to reflect inactive concepts, misconceptions or contradicting arguments. Each question about the topic is characterized as Re-type, Tr-type or Te-type. By monitoring the student's answers to questions regarding a specific topic, the system takes note of the student's educational needs. Moreover, monitoring facilitates analysis, editing and codification of a student's arguments process, which contribute in the formulation of student's initial cognitive profile.

For each topic ReTuDiS provides three versions of text: Re-text, Tr-text, and Te-text with questions accompanied by alternative answers. The three versions of text and the questions aim to help the student build, during the comprehension process, cognitive representations of the information contained in the technical system described by the text. According to the different educational needs of each student, the system provides the appropriate text activity which stands as personalized feedback. Each student receives specific feedback in the form of text with questions and alternative answers and is motivated to participate in the process.

The expected practical outcomes of this process are: a) the system traces student's educational needs b) the student is motivated to participate, c) the student is expected to activate his inactive concepts, overcome his misconceptions, reflect on his contradicting arguments and d) the student is expected to change his answers with the perspective the improvement of his initial cognitive profile. For example, in case a student succeeds in Re-type and fails in Tr-type questions, this means that he may recognize concepts but they are inactive. Occupying himself with Tr-text activity (see below) is expected to gradually activate inactive concepts, such as events for message transmission between nodes, by putting them in a sequence, constructing a hierarchy, finding part to whole relations between concepts. Advice or guidance motivates student to continue, triggers reflection and leads him to more scientific thinking.

The subsystem for monitoring a student's answers to questions within the educational environment is designed so as to satisfy specifications in order to record: a) the student's name (for registered students), b) the thematic topic code c) the thematic prior knowledge test code, d) the total number of questions included in the prior knowledge test, e) the total number of alternative answers to each question of the test, f) the kind of questions: multiple choice, position & justification, question-pairs with alternative answers, categorizing entities, classifying events or operations, completion of event or operations missing in a sequence, g) the type of each question: Re-type, Tr-type or Te-type, h) the number of questions for each type and i) the level of difficulty of each question.

The Subsystem of Monitoring Student Models

The student diagnostic subsystem in ReTuDiS deduces the cognitive profile of a student. A student's model represents his cognitive profile for text comprehension over a thematic topic. The initial profile represents a student's prior knowledge concerning a thematic topic. To specify a student's special features, the diagnostic subsystem exploits the results recorded in the prior knowledge test which embody appropriate questions with alternative answers about a particular thematic topic. Student's special features to be identified involve his misconceptions, conflicts, inactive concepts, knowledge gap or contradictions in his arguments. Moreover, other features such as his learning style, and his motivation for participation in activities can be identified and monitored, which option may be utilized for offering the most appropriate text activities for the individual needs of each student. The text activity which is given to the student as personalized feedback acts as a motivational factor for further involvement in text comprehension activity. Such motivation may drive students to the process of internally reflecting to their thoughts. Moreover, feedback can be given in the form of help, advice, suggestion and guidance, or even in the form of solved problems-examples, which can engage student in the reflective process. The system assesses the student's final cognitive profile after his participation in the activity. The process of student profiling takes into account the initial cognitive profile and the final cognitive profile, as well as the changes which happen with student's active participation through reflective thinking. The practical outcomes of this process include the following: a) the student participates in the revision of his profile, b) the student is expected to change his answers and improve his initial cognitive profile and c) the system assesses student's final cognitive profile and constructs the student model.

Specifications for composing a student's model are: a) description of the rules applied for deducing a student's initial cognitive profile, b) artificial intelligence techniques used for the diagnostic process such as case based reasoning, fuzzy logic or neural networks, c) description of the layout of the student features such as descriptive characterization (high, medium or low level profile) or numeral (33%, 66% or 100% performance), d) decision making techniques for supplying each student with the appropriate text activity after the diagnostic process (Re-text, Tt-text or Te-text) and e) description of the structure and the content of the cognitive profile and the student model.

Research

The research is aiming to perform tests of the system from a technical and educational point of view. The research was conducted with participation of 30 postgraduate students studying Informatics in the Department of Informatics and Telecommunications, University of Athens and two experts in the field. The knowledge domain was that of telecommunication networks, a thematic topic included in ReTuDiS.

Prior Knowledge Test Process

The prior knowledge test was a 15 question test with alternative answers which included 5 questions for each type: Re-type, Tr-type and Te-type.

The system monitors, for example, student A who succeeds in answering all or most of Re-type questions (more than 20%) in the prior knowledge test and fails in answering all or most of Tr-type and Te-type questions. This information is then being used for the construction of the initial profile of this student. Student A is characterized as a Re-student and the system decides that the Tr-text is the appropriate personalized feedback for the student to begin with, with the Te-text following after that. Other possible profiles may be: Tr-student, Te-student, Re/Tr–student, Re/Te-student, Tr/Te-student, or Re/Tr/Te-student. Table 1 displays prior knowledge test results of the research.

TABLE 1 PRIOR KNOWLEDGE TEST RESULTS - STUDENT PROFILES

Student profiles	More than 20% right answers to questions in Prior knowledge test	Number of students out of 30
Re-students	Re-type	25
Tr-students	Tr-type	10
Te-students	Te-type	5
Re/Tr-students	Re-type or Tr-type	10
Re/Te-students	Re-type or Te-type	2
Tr/Te-students	Tr-type or Te-type	14
Re/Tr/Te-students	Re-type & Tr-type & Te-type	1

Student Modeling Process

Based on the prior knowledge test results, the system decides which of the three versions of text (Re-text, Tr-text or Te-text) to provide. Each text comprises of 10 questions of the corresponding type. The sample text which follows comes from a section of Brookshear's (2012) university informatics text-book titled "Local Network Operation". The text version is Tr-text and the sample question is a Tr-type question for classifying events or operations.

Example of Tr-Text: *…A bus topology is designed with each node connected directly to a high-data speed bus. All devices are connected to a central cable, called the bus or backbone. 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. Otherwise a collision happens. The bus topology network can work even in case of disconnection of a node…*

Sample Tr-type question. *Put in the right order the following events for message transmission between nodes in a local area network: a) packet collision, b) packet transmission, c) collision detection, d) bus occupation, e) re-transmission f) initial transmission attempt.*

TABLE 2 PRIOR KNOWLEDGE TEST RESULTS FOR THE 25 RE-STUDENTS AND PROPOSED FEEDBACK

Re-students (20% or less wrong answers to Re-type questions)	Identified Number of students	Proposed feedback
20% or less wrong answers to Tr-type questions and 20% or less wrong answers to Te-type questions	1	Student decides between Tr-text and Te-text
20% or less wrong answers to Tr-type questions and more than 20% wrong answers to Te-type questions	10	Tr-text
more than 20% wrong answers to Tr-type questions and 20% or less wrong answers to Te-type questions	6	Te-text
more than 20% wrong answers to Tr-type questions and more than 20% wrong answers to Te-type questions	14	Tr-text and then Te-text

Table 2 displays the feedback proposed by the system to students which have been designated as Re-students from the prior knowledge test. The results display that a large number (11 out of 25) of the Re-students have educational needs involving both Tr-type and Te-type questions.

The student is given the text activity and after carrying it out the system again deducts a profile. Table 3 shows results after reading text and answering the questions.

TABLE 3 READING TEXT RESULTS FOR RE-STUDENTS

Feedback to Re-students	Number of students before reading text	Number of students after reading text
Need for Tr-text & for Te-text	1	0
Need for Tr-text	10	3
Need for Te-text	8	5
Need for Tr-text and for Te-text	14	9

Discussion

The research was aiming to test the effectiveness of the presented monitoring system. From a technical point of view, the purpose of the research is to test: a) if the monitoring process is made according to the rules, b) if there are any monitoring mistakes and c) if the system delivers the appropriate feedback. Moreover, testing the behavior of the system while multiple users have been working simultaneously revealed some technical glitches which have been dealt with. From an educational point of view, the purpose of this research is: a) to test the accuracy of student profiles which the system assesses relying on monitoring results and b) to ascertain the proportion of student profiles; for example, how many students have been classified by the system as Re-students in comparison with those classified as Tr-students and or Te- students, in order to deduce which profiles to focus on and whether there is a need to redesign profiling rules.

To satisfy the purposes of the research and ensure the truthfulness of the profiles, the participated experts classified manually the profiles. The manual results were compared with that of the system and no substantial differences were found. A matter of discussion was if the description of the rules applied for deducting the student's initial cognitive profile have been precise enough. Points of discussion aroused regarding the correlation of the number of questions in the prior knowledge test and the percentage of more than 20% right answers to questions. Our team agreed with the experts that unreliable results will be extracted in case of very small or very large number of questions. For example, student who succeeds in answering all or most of Re-type questions (more than 20%) in the prior knowledge is classified as Re-student. In case of 3 or 4 Re-type questions the percentage 20% seems to falsify the results. The same happens in case of more than 8 Re-type questions. To ensure the truthfulness of the estimation we agreed in the formulation of another rule: "A prior knowledge test, which consists of minimum 15 questions (5 of each type) and maximum of 21 (7 of each type) questions, is requisite for initial profile estimation". Another point of discussion focused on whether the decision making techniques used for profiling have been appropriate, for example, the percentage 20% of right answers in the prior knowledge test. This limit essentially corresponds to one wrong answer, as student may lose accidentally one question. There was agreement between the experts and our team to keep this limit and avoid to apply very strict measures in inferring initial profiles.

The research results, as expected, displayed that Re-students outnumber Tr-Students and Te-students. Despite the fact that the Re-students succeeded in Re-type questions, there are inactive portions which are keeping students from grasping concepts during text comprehension. For a large number of Re-students, the prior knowledge test displayed that they face similar difficulties with either Tr-type or Te-type questions. Discussion has been made regarding the fact that we have an opportunity to personalize instruction not only in terms of content, but also in terms of student learning style. Re-text, Tr-text and Te-text within the ReTuDiS system reflect not only different educational needs but different learning styles. Objective of the system in discussion is to test the percentage of the students participating in the process who have changed their profiles in relation to their initial profile. Moreover, the description of the structure and the content of the cognitive profile and the student model which we have to communicate to the students.

ReTuDiS, as a student monitoring system, can observe the sequence of a student's actions and provide a wealth of information to the educator that can be used to improve instruction and learning within the lines of a course. The educator may adjust his teaching techniques and customize the instruction to match the needs of the student by delivering personalized educational material based on concepts learnt, active concepts and inactive concepts for that student. The educator can inspect the level of participation of individual students and their progress in qualitative form.

In order to make improvements in ReTuDiS learning environment, we have decided the set of monitorable indicators and the types of data which require monitoring. Moreover, we have managed and organized information gathered from monitoring. All available sources of information have been used for a more accurate estimation of the student profile. We explored several queries, which have been discussed, and have found their answers and others are going to be the object of future research.

Conclusions

This work contributes to the improvement of ReTuDiS system through the incorporation of monitoring specifications for personalization and profiling the text comprehension of students. Developing the monitoring framework serves a variety of purposes. Students are motivated to participate. Students with different learning needs are anonymously identified by the system and given access to appropriate educational texts with questions adapted to their cognitive profile. Data about the student's prior knowledge, as well as their strengths and weaknesses in a topic, are recorded. Thus, the framework can serve as a diagnostic tool. Student monitoring, as a process from the view of learning, results in producing effective, vital and specific feedback. Feedback provided by the system is expected to promote critical thinking and help students improve their text comprehension skills.

Setting-up a monitoring system within ReTuDiS strengthens its learning environment and makes it convenient to support regular education students in general classrooms with participation of educators. Moreover, a significant advantage of ReTuDiS system is the ability to customize the instruction based on a student's needs in online courses. This can be achieved by regularly monitoring the student, developing a learner profile for each student and delivering instruction based on the individual profile.

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.

REFERENCES

Boud, D. "Sustainable Assessment: Rethinking Assessment for the Learning Society". Studies in Continuing Education, 22(2), 151-167, 2000. DOI:10.1080/713695728

Brookshear, J., Glenn. "Computer Science: an Overview" (pp. 139-186). Pearson International Edition, 11th Ed., 2012. ISBN-10: 0132569035

Bull, Suzan & Nghien, Theson. "Helping Learners to Understand Themselves with a Learner Model Open to Students, Peers and Educators". In Proceedings of Workshop on Individual and Group modeling Methods that Help Learners Understand Themselves, International Conference on ITSs edited by Brna P., & Dimitrova V., 5-13, Spain, 2002.

Caillies, Stephanie., & Denhière, Guy. "The Interaction between Textual Structures and Prior Knowledge: Hypotheses, Data and Simulations". European Journal of Psychology of Education 16(1), 17-31, 2012. DOI:10.1007/BF03172992

Collins, Allan. "A Sample Dialogue based on a Theory of Inquiry Teaching". In Instructional Theories in Action edited by Reigeluth Ch., 181-199, Lawrence Erlbaum Associates Inc., Hillsdale, 1987.

Denhière, Guy, & Baudet, Serge. "Lecture Comprehension de Texte et Science Cognitive". Presses Universitaires de France, Paris, 1992.

Deno, S. L. "Developments in Curriculum-based Measurement". The Journal of Special Education, 37(3), 184–192, 2003. DOI:10.1177/00224669030370030801

Dewitz, Peter, Jones, Jennifer, & Leahy, Susan. "Comprehension Strategy Instruction in Core Reading Programs". Reading Research Quarterly, 44(2), 102-126, 2009. DOI: 10.1598/RRQ.44.2.1

Dimitrova, Vania, Mccalla, Gordon, & Bull, Suzan. "Open Learner Models: Future Research Directions". International Journal of Artificial Intelligence in Education, 17(3), Special Issue (Part 2), 217-226, 2007.

França, M., Romulo, Figueiredo de Oliveira, Anna, Dahmer, Alessandra, & Barreto, Lina. "MonSys - Monitoring System for Students and Tutors of Postgraduate Courses of UNASUS / UFMA in Distance mode using Moodle". In Proceedings of 1st Moodle Research Conference, 140-

147, Greece, 2012. ISBN: 978-960-98516-2-6

Graesser, Arthur, & Tipping, P. "Understanding Texts". In Bechtel, W., & Graham, G. edited by A Companion to Cognitive Science. Blackwell, Malden, 1999.

Hughes, Charles, & Dexter, Douglas. "Response to Intervention Summary". Theory into Practice, 50(1), 4-11. The Ohio State University, 2011. DOI: 10.1080/00405841.2011.534909

Kay, Judy, & Mccalla, Gordon. "Coming of Age: Celebrating a Quarter Century of User Modeling and Personalization: Guest Editors' Introduction". User Modeling and User-Adapted Interaction, 22(1-2), 1-7, 2012. DOI 10.1007/s11257-011-9113-9

Kilpatrick, Allie, C., Turner, J., B., & Holland, P., Thomas. "Quality Control in Field Education: Monitoring Students' Performance". Journal of Teaching in Social Work, 9(1-2), 107-120, 1994. DOI:10.1300/J067v09n01_01

Kusek, J., Zall, & Rist, C., Ray. "Making M&E matter—get the Foundation Right". Evaluation Insights, 2(2), 2000.

Lamb, Stephen, & Rice, Suzan. "Effective Intervention Strategies for Students at Risk of Early Leaving". Centre for Post-compulsory Education and Lifelong Learning. The University of Melbourne, 2008.

Macfadyen, P., Leah, & Dawson, Shane. 'Mining LMS Data to Develop an "Early Warning System" for Educators: A Proof of Concept". Computers & Education,54(2),588-599, 2010. http://dx.doi.org/10.1016/j.compedu.2009.09.008

Mazza, Riccardo, & Milani, Christian. "GISMO: A Graphical Interactive Student Monitoring Tool for Course Management Systems". In Proceedings of IFIP TC3 Technology Enhanced Learning Workshop (Tel'04), World Computer Congress, Toulouse, France, 2004.

McMaster, L., Kristen, & Wagner, Dana. "Monitoring Response to General Education Instruction". In Handbook of response to intervention: The science and practice of assessment and intervention edited by Jimerson, S. R., Burns, M. K., & VanDerHeyden, A. M., 223–233, New York: Springer, 2007. DOI:10.1007/978-0-387-49053-3_16

McNamara, S., Doane, & Kintsch, Walter. "Learning from Texts: Effects of Prior Knowledge and Text Coherence". Discourse Processes, 22(3), 247-288, 1998. DOI:10.1080/01638539609544975

Nicol, J. David, & MacFarlane-Dick, Debra. "Formative Assessment and Self-regulated Learning: a Model and Seven Principles of Good Feedback Practice". Studies in Higher Education, 31(2), 199–218, 2006. DOI: 10.1080/03075070600572090

Niu, Xiaolin, Mccalla, G., & Vassileva, Julita. "Purpose based Learner Modeling". Computational Intelligence, 20(4), 548-561, 2004. DOI: 10.1111/j.0824-7935.2004.00253.x

Rehani, Bh., & Sasikumar, M. "Chaatra - a Student Monitoring and Learner Modelling System". In Proceedings of Vidyakash -International Conference on Online Learning, 2002. Retrieved January 4, 2013, from: http://www.cdacmumbai.in/design/corporate_site/override/pdf-doc/chaatra.pdf

Sadler, D., Royce. "Formative Assessment: Revisiting the Territory". Assessment in Education, 5(1), 77-84, 1998. DOI:10.1080/0969595980050104

Safer, N., & Fleischman, St. "How Student Progress Monitoring Improves Instruction". Educational Leadership, 62(5), 81-83, 2005. ISSN-0013-1784

Sorenson, Petter., & Macfadyen, Leah. "Learner Interaction Monitoring System (LiMS): Capturing the Behaviour". In Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education edited by Sanchez J. & Zhang K., 2725. Chesapeake, VA: AACE, 2010.

Tsaganou, Grammatiki, & Grigoriadou, Maria. "Design of Text Comprehension Activities with RETUDISAuth". In Advances in Human-Computer Interaction, edited by Pinder, Sh. (pp. 161-172). I-Tech Education and Publishing, Vienna, Croatia, p. 161-172, e-ISSN: 1687-5907, 2009

Tsaganou, Grammatiki, & Grigoriadou, Maria. "Authoring with ReTuDiSAuth Adaptive Dialogues for Text Comprehension". In Proceedings of Procedia - Social and Behavioral Sciences, 15, (pp. 2813-2817), 2011. DOI: 10.1016/j.sbspro.2011.04.194

Wiggins, Grant. "Seven Keys to Effective Feedback". Educational Leadership, 70(1), 10-16, 2012.

Yorke, Mantz. "Formative Assessment in Higher Education: Moves towards Theory and the Enhancement of Pedagogic Practice". Higher Education. 45(4), 477–501, 2003. DOI:10.1023/A:1023967026413

Authors Information

Maria Samarakou received her B.A. in Physics from University of Athens (1977) and her Ph.D. in the area of system optimization from University of Athens (1986).

She is Professor at the Dpt. of Energy Technology, Technology Educational Institution of Athens (TEIAth), since 1987, and responsible for the Applied Informatics Laboratory. Her research work has contributed to the design of educational environments, intelligent tutoring systems, artificial intelligence, energy management, web-based education and computer science education.

Professor Samarakou is a member of the Association for the Advancement of Computing in Education (AACE), as well as Physicians Greek Union (EEF), and of Informatics Scientists Greek Union (EPEE).

Grammatiki Tsaganou received her B.A. (1984) in Physics, M.Sc. in Informatics (1987) and her Ph.D. in the area of dialogue-based tutorial systems for text comprehension from University of Athens (2003).

She has been teaching Informatics in Vocational School, Secondary Education, since 1993. She also teaches educational technology as lecturer at the University of Athens, Dpt. of Informatics and Telecommunications. Her research work has contributed to the design of web-based adaptive learning environments (design based on current learning theories, personalization at individual and group level and use of internet tools), open learner modeling, text comprehension and computer science education. She is interested in technology supported learning, especially for personalized learning.

Dr. Tsaganou is a member of the executive review board of the Educational Technology & Society journal, as well as Greek Scientists Union of Technology of Information & Communication in Education (ETPE).

Andreas Papadakis received his B.A. (1997) in Electrical and Computing Engineering and his Ph.D. in the area of electrical and computing engineering, National Technical University of Athens (2002).

He has been Assistant professor at the Dpt. of Electronic Engineering Educators, School of Pedagogical and Technological Education (ASPETE), since 2008. His teaching interests include: digital radio and TV systems, signals and systems and digital signal processing. His research work has contributed to networked video delivery and quality evaluation, future internet architecture, service provision in intelligent communication environments and knowledge management and semantic web.

John Gelegenis received his B.A. in Chemical Engineering (1984) and his Ph.D. in the area of geothermal energy deposits, National Technical University of Athens (1988).

He has been Associate professor at the Dpt. of Energy Technology, Technology Educational Institution of Athens (TEIAth), since 2008. He uses software tools for teaching engineering courses in teaching in higher education. His research work has contributed to simulations of energy systems, educational environments and web based evaluation techniques especially applied in the area of Energy management and renewable energy resources. He has worked in the Centre for Renewable Energy Sources and Saving (CRES), and in projects supporting Public Power Corporation S.A. (PPC), GR.

Prof. Gelegenis has served as National Representative for the United Nations Program: "Energy Productivity 2000" and as specialist in energy subjects in the Ministry of Environment, Energy and Climate Change, GR.

Emmanouil D. Fylladitakis received his B.A. in Energy Engineering from Technological Educational Institute of Athens (2010) and his M.Sc. in Energy from Heriot-Watt University, United Kingdom (2012).

He is a research fellow in the Energy Technology Department, Technological Educational Institute of Athens and is working on a Ph.D. in Electrical and Computer Engineering, Brunel University, London, United Kingdom. He specialized on engineering e-learning applications. He is interested in open interactive learning systems for laboratory-based academic courses on energy technology, student diagnosis, assistance and evaluation systems based on artificial intelligence.

Researcher Fylladitakis has received the awards: First in class-Department of Energy Technology (2010) and Prize for outstanding merit-Heriot-Watt University (2012).

Maria Grigoriadou received her B.A. degree in physics from the University of Athens (1968) and her DEA (1972) and Ph.D. (1975) from the University of Paris VII.

She is Emeritus Professor in education and language technology and head of the Education and Language Technology Group, Department of Informatics and Telecommunications, University of Athens. Her current research interests include the areas of adaptive learning environments, Web-based education, ITS, educational software, natural language processing tools, and computer science education.

She has participated in 15 projects, and has four invited talks to her credit; as well as 47 publications in international journals, 12 in international book chapters, 200 in proceedings of international conferences and more than 1200 citations to her research work.

Emeritus Professor Grigoriadou was the recipient of eight awards and is a member of IEEE, AACE, IADIS, EDEN, Kaleidoscope and LeMoRe.