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The Interaction Analysis with the ADULT environment (A pilot study)

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1. Introduction

ADaptive Understanding Learning Text environment (ADULT) is based on Kintsch's Construction-Integration model for text comprehension (Van Dijk & Kintsch, 1983; Kintsch, 1988; Kintsch, 1994). According to this model, there is a distinction between the text micro- and macrostructure and between the text-base and situation model. It assumes a minimum of two levels of text understanding, text-base and situational understanding and memory of a text does not necessarily imply learning from it as well (Kintsch, 1994). A good text-base understanding relies on a coherent and well-structured representation of the text, whereas a good situation model relies on different processes, primarily on the active use of long term-memory or world knowledge during reading. Links between text-base and world knowledge must be activated in the reader's mental representation of the text. Motivated readers encountering a gap in the text will attempt to fill it, and doing so requires accessing information from their world knowledge, which in turn results in the text information being integrated with long-term memory. This gap-filling process can only be successful if readers possess the necessary background knowledge. Consequently, for a good situational understanding, a single text cannot be optimal for every reader: low-knowledge readers should benefit more from an easier, coherent text, whereas high-knowledge readers should be allowed to infer with harder, less coherent texts. Texts have local and global structure. Microstructure refers to local text properties and macro-structure to the global organization of text. Micro-structure is generally cued by the text via explicit indicators of relations between concepts and ideas (e.g. connectives, argument overlap, and pronominal reference). Micro-structure can also be constructed on the basis of the learner's knowledge when there are details or relations left unstated in the text. A text's macro-structure can be cued directly by the text via topic headers and sentences. McNamara, E. Kintsch, Songer, & W. Kintsch, (1996) examined students' comprehension of four versions of a biology text, orthogonally varying local and global coherence. They found that readers with low- and high-background knowledge benefit from a coherent and a minimally coherent text respectively. Gasparinatou, Tsaganou, & Grigoriadou (2007, 2008c) investigated the role of text coherence and learners' background knowledge in the comprehension of scientific-and specifically Informatics-texts. The results showed that high-knowledge readers benefit from a minimally coherent text, in contrast to low-knowledge readers who learn better from a maximally

coherent text. In this line of research the ADULT environment was designed and developed (Gasparinatou et al, 2008c). Much research has been undertaken on the impact of different styles on learners' preferences and human learning in general (Riding and Rayner, 1998; Entlwistle, 1981; Schmeck, 1988; Kolb, 1984; Keefe, 1979). Style in educational psychology has been recognised as a key construct in the area of individual differences in learning. Different learners approach learning tasks in different ways, or using different styles and through the interaction with a learning environment they develop sets of behaviour that they are comfortable with (Entwistle, 1981). Such viewpoints have led to suggestions of tailoring educational interactions to learners' cognitive or learning style in the context of computer-based and web-based learning environments (Carver et al., 1999; Bajraktarkvic et al., 2003; Chen and Paul, 2003; Papanikolaou et al., 2003; Triantafillou et al., 2003). The flexibility offered by such environments should enhance learning, allowing learners to develop personal navigation patterns and interaction behaviour that reflects their own cognitive characteristics.

The remaining sections of this paper present: (1) An Outline of the ADULT environment, (2) Kolbs' Learning Style Inventory (LSI), (3) An empirical study where students' interactions with ADULT, have been analyzed, within the context of the "Informatics and Education" course, (4) The evaluation of ADULT by these students who are considered pre-service teachers. (5) The paper concludes with suggestions for improving the currently used learning environment in order to achieve more personalized learning.

2. An outline of the ADULT Environment

The Adaptive Understanding and Learning Text environment (ADULT) actively engages students in the learning process. It offers four versions of text with the same content but different coherence at the local and global level. It supports and assesses students' comprehension through text-recall measures, text-based, bridging-inference, problem solving questions and a sorting task. ADULT takes into account readers' background knowledge in order to propose the appropriate text. To achieve this goal, it suggests that the student performs a background knowledge assessment test, with scores characterized as "high", "median" and "low". ADULT motivates high knowledge students to read the minimally coherent text at both local and global levels (lg), median knowledge students to read the text with maximum local coherence and minimum global coherence (Lg) or with minimum local and maximum global coherence (lG) and low knowledge students to read the maximally coherent text (LG). ADULT also allows the student to choose the preferred version of text and records the time spent reading it. The four text versions have the same content but different coherence at local and global level. Text coherence refers to the extent to which a reader is able to understand the relations between ideas in a text. Before reading the text and after completing the assessment activities the system propose that the student performs the same sorting activity in order to examine how readers change their conceptual structures according to the text. This activity involves a set of concepts which are to be categorized into groups. The overall objective is to provide a group of concepts with several rational sorting principles, as well as clearly discernible, text-driven sorting principles.

The following three types of rules were used to maximize local coherence: (1) replacing pronouns with noun phrases when the referent was potentially ambiguous (e.g. In the phrase: *"This gives users the ability to move around within a broad coverage area and still be*

connected to the network", we replace *"This"* by *"A wireless LAN (WLAN)"*. (2) Adding descriptive elaborations linking unfamiliar and familiar concepts (e.g., *"The network topology determines the way in which the nodes are connected",* is elaborated to: *"The network topology determines the way in which the nodes are connected, which means the data paths and consequently the possible ways of interconnecting any two network nodes").* (3) Adding sentence connectives (however, therefore, because, so that) to specify the relation between sentences or ideas. In the global macro coherence versions of the texts (lG and LG), macro propositions were signaled explicitly by various linguistic means (i.e., macro signals): (1) adding topic headers (e.g., Types of wireless LANs) and (2) adding macro propositions serving to link each paragraph to the rest of the text and the overall topic (e.g., *"Afterwards the advantages and the disadvantages of Wireless LAN technology will be discussed"*) (McNamara et al., 1996).

ADULT supports and assesses students' comprehension through text-recall measures, text-based, bridging-inference, problem solving questions and a sorting task. In this study, in the text-recall activity, students were asked to complete the blanks in a text, taken from a text already read. In this way, the system examines students' recall of the text and consequently the text-based model developed after the reading of the text according to Kintsch's model. In text-based questions, the information necessary to answer the question is contained within a single sentence of the minimally coherent lg text (e.g., *"What is a wireless local area network?"*). In bridging-inference questions, the necessary information is contained in the text, but requires linking two or more sentences (e.g., *"In wireless local area networks, what do the first and second modes of transmission have in common?)".* In elaborative-inference questions, linking text information to that from outside knowledge is required in order to answer the question (e.g., *"Which topology (wired or wireless) would you use in order to have a constant transmission rate in a network ?"*). Finally, in problem–solving questions, linking information from separate sentences within the text and applying this information to a novel situation is required *("Assume that you have to construct a wireless local network for a large facility such as an airport. Which transmission mode would you use?").* ADULT examines the text-based model which the reader develops via text-recall, text-based and bridging-inference questions. Elaborative-inference, problem-solving and sorting activities assess if students developed a good situation model, meaning they gained a deep understanding of the text. The learner model in ADULT keeps information about:(1) learners' background knowledge level with respect to the text version/activities worked on, and (2) learners' behavior during interaction with the environment in terms of the learning sequence chosen, time spent on reading the text, time spent on an activity, etc. The learner model is dynamically updated during interaction with the system in order to keep track of the learner's present status. During interaction, learners may access their model and view the information kept concerning their progress and interaction behavior.

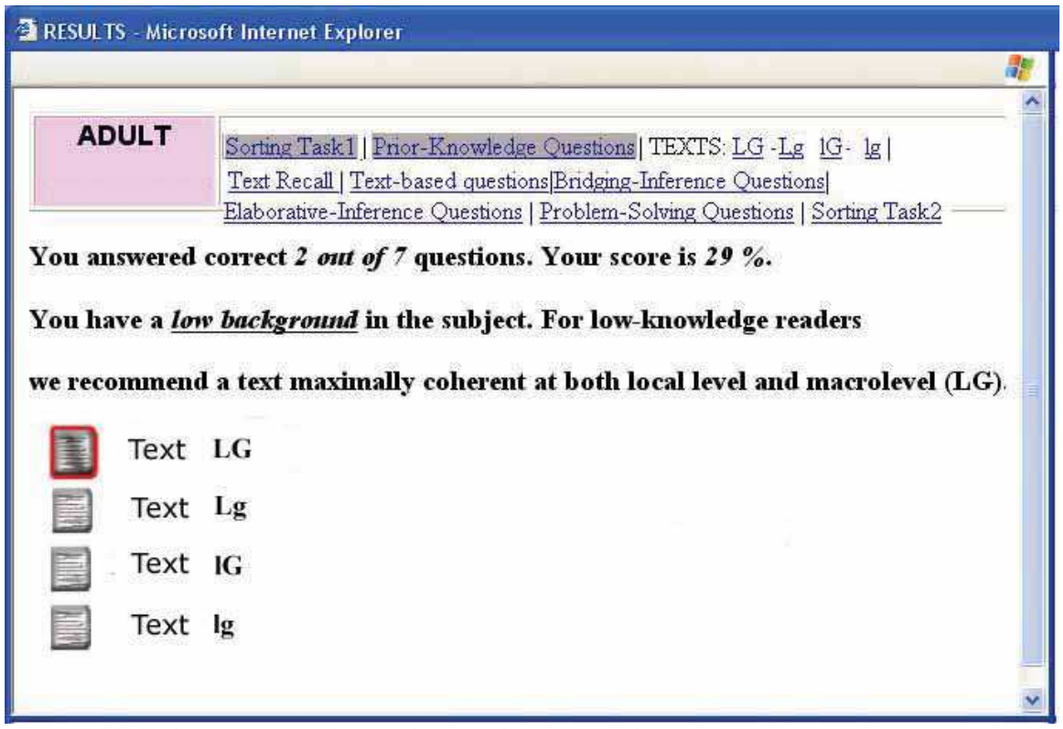

Fig. 1. ADULT characterizes the student and suggests the appropriate text

3. Kolbs' Learning Style Inventory (LSI)

According to Kolb (1984): 'learning is the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping experience and transforming it'. He proposes that experiential learning has six characteristic features: (1) Learning is best conceived as a process, not in terms of outcomes, (2) Learning is a continuous process grounded in experience, (3) Learning requires the resolution of conflicts between *dialectically* opposed modes of adaptation to the world. For Kolb, learning is by its very nature full of tension, because new knowledge is constructed by learners choosing the particular type of abilities they need. Effective learners need four kinds of ability to learn: from concrete experiences (CE); from reflective observations (RO); from abstract conceptualisations (AC); and from active experimentations (AE). These four capacities are structures along two independent axes, with the concrete experiencing of events at one end of the first axis and abstract conceptualisation at the other. The second axis has active experimentation at one end and reflective observation at the other. Conflicts are resolved by choosing one of these adaptive modes, and over time, we develop preferred ways of choosing, (4) Learning is a holistic process of adaptation to the world, (5) Learning involves transactions between the person and the environment, (6) Learning is the process of creating knowledge:'[which] is the result of the transaction between social knowledge and personal knowledge' (1984). Kolb describes the process of experiential learning as a four-stage cycle. This involves the four adaptive learning modes mentioned above – CE, RO, AC and AE – and the transactions and the resolutions among them. The tension in the

abstract-concrete dimension is between relying on conceptual interpretation (what Kolb calls 'comprehension') or on immediate experience (apprehension) in order to grasp hold of experience. The tension in the active-reflective dimension is between relying on internal reflection (intention) or external manipulation (extension) in order to transform experience (Coffield et al., 2004).

It is out of this structure that Kolb defines four different types of knowledge and four corresponding learning styles. The main characteristics of the four styles are summarised below: (1) *Type 1: the converging style* (abstract, active) relies primarily on abstract conceptualisation and active experimentation; is good at problem solving, decision making and the practical application of ideas; does best in situations like conventional intelligence tests; is controlled in the expression of emotion and prefers dealing with technical problems rather than interpersonal issues, (2) *Type 2: the diverging style* (concrete, reflective) emphasises concrete experience and reflective observation; is imaginative and aware of meanings and values; views concrete situations from many perspectives; adapts by observation rather than by action; interested in people and tends to be feeling-oriented, (3) *Type 3: the assimilating style* (abstract, reflective) prefers abstract conceptualisation and reflective observation; likes to reason inductively and to create theoretical models; is more concerned with ideas and abstract concepts than with people; thinks it's more important that ideas be logically sound than practical, (4) *Type 4: the accommodating style* (concrete, active) emphasises concrete experience and active experimentation; likes doing things, carrying out plans and getting involved in new experiences; good at adapting to changing circumstances; solves problems in an intuitive, trial-and-error manner; at ease with people but sometimes seen as impatient and 'pushy' (Coffield et al., 2004).

4. The Empirical Study

4.1 Research Questions

The ADULT environment and the developed educational material in "Wireless Local Area Networks (WLAN)" were used in the 2007-2008 academic year, in the context of the undergraduate course "Informatics and Education". The primary objective was to investigate the interaction of undergraduate Informatics and Telecommunications students with the ADULT learning environment while studying the above thematic unit. Specifically, the main research questions were: (1) Do students follow the suggested learning sequence or their own one, during interaction with the system? (2) Do the background knowledge and the coherence of the text read influence students' performance? (3) Do the learning style influence their learning style? (4) What is their opinion on the effectiveness of ADULT in supporting the learning process in this undergraduate course?

4.2 Participants

The study sample consisted of 40 Informatics and Telecommunications undergraduates of the University of Athens, who were attending the "Informatics and Education" course. Their participation was in the context of an activity having the following objectives: (1) to study the educational material uploaded in ADULT, (2) to perform activities addressing the "Wireless Local Area Networks (WLAN)" domain and (3) to assess the course designed via ADULT. Most students had successfully completed the course titled "Data Transmission and Networks Communications". Therefore, they were considered as "high" knowledge

readers. These participants are also considered to be pre-service teachers, since most of them intend to teach Informatics in the secondary education system, following their graduation.

4.3 Task and Materials

4.3.1 Learning-Style Inventory (LSI © David A. Kolb, Experience-Based Learning Systems, Inc.)

The Learning – Style Inventory describes the way a student learns and how he/she deals with ideas and day-to-day situations in his/her life. It includes 12 sentences with a choice of endings. The student has to rank the endings for each sentence according to how well he/she thinks each one fits with how he/she would go about learning something. He/she has to try to recall some recent situations where he/she had to learn something new, perhaps in his/her job or at school. Then, using the spaces provided, he/she has to rank a "4" for the sentence ending that describes the way he/she learns *best,* down to a "1" for the sentence ending that seems least like the way he/she learns. He/she has to rank all the endings for each sentence unit. Ties are not permitted.

4.3.2 The Educational Material

The educational material was based mainly on a chapter concerning "Local Network Topologies" (Walrand, 2003) and included: (1) four versions of a text, orthogonally varying local and global coherence, (2) a pre-reading sorting activity which included 26 concepts for the students to categorize in five broader categories, (3) a background knowledge questionnaire containing ten questions, (4) a text-recall activity, (5) six text-based questions, (6) four bridging-inference questions, (7) seven elaborative-inference, (8) four problem-solving questions and (9) the post-reading sorting activity, which was the same as the pre-reading sorting activity. All tasks included multiple choice questions. Students were asked to complete and submit the required tasks to the system. All tasks were completed remotely.

4.4 Procedure

The empirical study took place for three weeks and consisted of the following phases: (1) Students were administered the Learning-Style Inventory (LSI © David A. Kolb, Experience-Based Learning Systems, Inc.), (2) presentation of the ADULT environment in the classroom, (3) interaction with ADULT and working out activities, which took place for 2 weeks, and (4) completion of a questionnaire on the effectiveness of ADULT in supporting the learning process in such a course. This phase lasted one week. During these three weeks, students cooperated with one another and the researcher via a forum specifically created for this purpose.

4.5 Data Collection

In order to answer the research questions, we analyzed: (1) Students' answers to the Learning Style Inventory and the algorithm proposed by the Hay Group, (2) ADULT log files created automatically by the system. In particular, students' sequence during interaction with the system and performance in the activities was identified. This way, we obtained an indication of how ADULT supports students to develop an adequate situational model which is in *fact* its main purpose. (3) The assessment questionnaire completed by the students.

4.6 Data Analysis

4.6.1 Achievement measures

Having as an objective to investigate students' exploitation of ADULT facilities and particularly to identify the sequences of actions that students performed in order to study the aforementioned topic, we analyzed ADULT log files.

4.6.2 Questionnaire

The evaluation questionnaire, filled by the students, consisted of Likert-scale type questions asking students to express their opinion on the effectiveness of ADULT in supporting the learning process (10items; indicative item is *"ADULT proposed the most appropriate text according to your background knowledge"*). Students' answers varied from 1 to 5 (1 indicates "I strongly disagree" 5 indicates "I strongly agree"). Additionally the students were given the option to express their opinion about each one of these questions, as well as to make comments and suggestions for the improvement of ADULT.

5. Results

1st Research Question: "Do students follow the suggested learning sequence or their own one during interaction with the system"?

According to the log files: (1) All participants performed the pre-test sorting activity first and the post-test sorting activity last as proposed by the system. (2) Thirty eight out of forty students performed the background knowledge activity (95%). Thirty one of them scored over 0.65 and they were proposed to read the minimally coherent text (lg). (3) Twenty three out of thirty eight read the text version proposed by the system (60.5%). (4) All students performed the assessment questions.

2nd Research Question: "Do the background knowledge and the coherence of the text read influence students' performance"?

Students were divided in two groups: Those reading the text proposed by the system and those reading their preferred text. The results are presented in Tables 1 and 2 respectively. According to the data in Tables 1 and 2 most students had high background knowledge. This was because they had successfully completed the proceeding course titled "Data Transmission and Networks Communications".

Text	N	Backg. knowl.	Pretest sorting activity	N	Text recall	N	Text based	Bridg. infer.	Elab. Infer.	Probl. solving	Post-test sorting activity
lg	17	0.75 (0.16)	0.62 (0.14)	15	0.53 (0.20)	17	0.76 (0.20)	0.81 (0.23)	0.75 (0.23)	0.66 (0.25)	0.77 (0.13)
lG	1	0.50	0.65	1	0.17	1	0.67	0.25	0.57	0.50	0.77
LG	5	0.48 (0.25)	0.53 (0.25)	5	0.34 (0.92)	5	0.77 (0.28)	0.75 (0.31)	0.83 (0.25)	0.70 (0.41)	0.75 (0.22)
Total	23	0.68 (0.21)	0.60 (0.17)	21	0.47 (0.25)	23	0.76 (0.21)	0.77 (0.26)	0.76 (0.23)	0.66 (0.28)	0.76 (0.15)
P-sig[1].		*0.023*	*0.567*		*0.135*		*0.916*	*0.107*	*0.590*	*0.820*	*0.973*

[1] According to one-way ANOVA

Table 1. Students' (reading the proposed text) performance

According to the data in Table 1, students performed quite well in text-based and bridging-inference activities, as well as in elaborative-inference, problem-solving and post-test sorting activities, implying that they developed an adequate text-based and situation model respectively. In all activities, the score differences between students having read a different text version (lg, lG and LG) weren't statistically significant. This was expected according to Kintsch's model of text comprehension, because all students read the appropriate text according to their background knowledge. This was also the goal in designing the ADULT environment: to support readers with appropriate texts according to their background knowledge.

Text	N	Backg. knowl.	Pretest sorting activity	Text recall	Text based	Bridg. infer.	Elab. infer.	Probl. solving	Posttest sorting activity
κανένα	2	0.65 (0.07)	0.29 (0.41)	0.00 (0.00)	0.50 (0.24)	0.63 (0.18)	0.50 (0.30)	0.12 (0.18)	0.55 (0.25)
Lg	1	0.80	0.73	0.17	0.33	0.50	0.57	0.25	0.85
LG	12	0.70 (0.19)	0.65 (0.24)	0.53 (0.22)	0.86 (0.20)	0.88 (0.23)	0.86 (0.22)	0.73 (0.27)	0.75(0.24)
Total	15	0.70 (0.18)	0.61 (0.27)	0.44 (0.28)	0.78 (0.26)	0.82 (0.24)	0.79 (0.25)	0.62 (0.33)	0.73(0.24)
P-sig[1].		*0.812*	*0.208*	*0.014*	*0.050*	*0.157*	*0.111*	*0.020*	*0.533*

[1] According to one-way ANOVA

Table 2. Students' (reading the preferred text) performance

Table 2 reports the performance of students not reading the proposed text, but the one they preferred. Two students didn't read any text before performing the activities, but while performing the activities. Therefore, although having adequate background knowledge, they didn't develop an adequate situation model. One student reading Lg text instead of the proposed lg didn't develop an adequate situational model either. Twelve students reading the maximally coherent text instead of the proposed minimally coherent text developed an equally adequate situation model with the seventeen students (Table 1) reading the minimally coherent text proposed by the system. These students, despite having a high background knowledge, stated that they preferred to read the text with the maximum coherence at local and global level and this capability of the system to facilitate a personalized learning route most likely explains the high performance in the activities. Although these results constitute an indicative answer to the previous research question, we have to repeat the experiment above, with more participants in order to have more reliable results.

3rd Research Question: "Does the learning style influence students' performance?"

According to the students' answers to the Learning-Style Inventory and the algorithm proposed by the Hay Group, twenty students had the converging style, twelve the assimilating style, five the accommodating style and three the diverging one. In Table 3, we can see the number of students in each learning style reading a text version.

Learning style	N	No text	lg	lG	Lg	LG
diverging	3	1	1	0	0	1
assimilating	12	1	5	0	0	6
converging	20	0	10	1	1	8
accommodating	5	0	1	0	0	4
Total	40	2	17	1	1	19

Table 3. Students' learning style

Students' background knowledge performance, before reading the text, taking into account learning style, is presented in Table 4. As it can be seen students' background knowledge is independent of their learning style ($F(3, 34) = 0.283$, $p = 0.837$).

	Score Background knowledge		
Learning Style	N	M	SD
Diverging	3	0.77	0.21
Assimilating	12	0.69	0.18
Converging	20	0.69	0.22
Accommodating	5	0.63	0.13
Total	40	0.69	0.20
	P-sig.[1]	*0.837*	

[1] According to One-Way ANOVA

Table 4. Background knowledge according to learning style

As we can see in Table 5, students having the converging and the accommodating learning style performed better in elaborative-inference and in problem solving questions. This was expected because people having these learning styles, like doing things and are good at problem solving. The students with the assimilating learning style performed better in text-recall, text-based, bridging- inference and posttest sorting activity. This was also expected, because people having the assimilating style prefer the theory more than the action. Diverging students performed better in text-based and also in bridging-inference questions. This was also expected because diverging people like to learn by observation rather than by action (Coffield et al., 2004). Consequently, the results presented in Table 5 are towards the expected direction but they aren't statistically significant. We have to repeat the experiment with more participants, in order to have more reliable results.

Learning Style	N	Text recall	Text based	Bridg. infer.	Elab. infer.	Probl. solving	Pretest sorting activity	Posttest sorting activity
Diverging	3	0.45	0.78	0.67	0.63	0.55	0.51	0.65
Assimilating	12	0.59	0.83	0.83	0.66	0.56	0.66	0.81
Converging	20	0.39	0.73	0.78	0.80	0.69	0.57	0.72
Accommodating	5	0.52	0.80	0.80	0.84	0.61	0.56	0.70
Total	40	0.47	0.77	0.79	0.75	0.63	0.59	0.74
	P-sig[1].	*0.199*	*0.620*	*0.761*	*0.727*	*0.931*	*0.548*	*0.533*

[1] According to One-Way ANOVA

Table 5. Students' performance according to learning style

4th Research Question: "Assessment of the course designed via ADULT"

Item	Description	Valid (%)	Mean (SD)	Median	% distribution of valid responses				
					1	2	3	4	5
1	Proposed text supported learning	100.0	4.13 (0.81)	4.0	0.0	0.0	26.1	34.8	39.1
2	Pre-test sorting activity supported learning	100.0	3.42 (1.10)	3.0	2.5	20.0	30.0	27.5	20.0
3	Post-test sorting activity supported learning	80.0	3.62 (1.04)	4.0	0.0	18.8	21.9	37.5	21.9
4	Text-recall activity supported learning	100.0	3.50 (1.11)	4.0	5.0	15.0	20.0	42.5	17.5
5	Text-based activity supported learning	100.0	4.00 (0.85)	4.0	2.5	2.5	12.5	57.5	25.0
6	Bridging-inference activity supported learning	100.0	4.20 (0.85)	4.0	0.0	5.0	12.5	40.0	42.5
7	Elaborative-inference activity supported learning	97.5	3.95 (0.97)	4.0	0.0	10.3	17.9	38.5	33.3
8	Problem-solving activity supported learning	100.0	3.87 (1.13)	4.0	0.0	20.0	10.0	32.5	37.5
9	Activities were adequate	97.5	4.00 (0.95)	4.0	0.0	10.3	12.8	43.6	33.3
10	Personalized learning sequence	92.5	4.84 (0.37)	5.0	0.0	0.0	0.0	16.2	83.8

Table 6. Students' opinions about the ADULT Environment

Information pertinent to the responses is provided in Table 6, which displays the item descriptive statistics. Valid response rates are very high for all items. Mean scores, for each item, typically exceeded 3.5 which is a clear indication that students' have a favorable

opinion about the ADULT environment. They had a positive opinion about the proposed text. The most noteworthy exception corresponded to the item *"Pre-test sorting activity supported learning"*, having a mean (median) value of 3.42 (3.0), which implies a relatively indifferent opinion about the support offered by this activity to learning. Students also proposed that the ADULT environment offer: (1) more open-ended than multiple choice questions, (2) more types of activities such as active experimentation, case-based studies and simulation activities, (3) more types of feedback , (4) a forum were students could collaborate with each other and the tutor.

6. Conclusions and Future Plans

Previous studies of Informatics text coherence and background knowledge pointed to the importance of considering prior domain knowledge in conjunction with active processing strategies in order to determine the most advantageous learning methodologies for individual students. The goal of the ADULT environment is to provide such advantageous learning methodologies, providing the learner with the text of the appropriate level of coherence according to background knowledge and supporting him with activities. In the study presented above, students performed well in the domain of "Local Wireless Topologies" during their interaction with the system. Students having the converging and the accommodating learning style performed better in problem solving and in elaborative-inference questions whereas assimilating and diverging students performed better in text-based, bridging-inference and in posttest sorting task. These results are in accordance with the learning preferences of these learning styles but we have to repeat the experiment with more participants in order to obtain more reliable results. Students had also a positive opinion about the ADULT environment because they were activated to use their background knowledge while reading and they believe that ADULT gives them the opportunity to achieve better results in learning from Informatics texts than reading a single text targeted at an average reader.

Our future plans include: (1) the consideration of the background knowledge and the learning style to present specific learning activities such as active experimentation, case-based studies and simulation activities, (2) to provide more types of feedback such as tutoring and reflective feedback, (3) the creation of a forum where students could collaborate with each other and the tutor.

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The education industry has obviously been influenced by the Internet revolution. Teaching and learning methods have changed significantly since the coming of the Web and it is very likely they will keep evolving many years to come thanks to it. A good example of this changing reality is the spectacular development of e-Learning. In a more particular way, the Web 2.0 has offered to the teaching industry a set of tools and practices that are modifying the learning systems and knowledge transmission methods. Teachers and students can use these tools in a variety of ways aimed to the general purpose of promoting collaborative work. The editor would like to thank the authors, who have committed so much effort to the publication of this work. She is sure that this volume will certainly be of great help for students, teachers and researchers. This was, at least, the main aim of the authors.

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