Adaptive e-tutorship using students context in technology enhanced learning environments[1]

Tutoría adaptativa con base en el contexto de los estudiantes en ambientes de aprendizaje mediados por tecnología

Tutoria adaptativa com base no contexto dos estudantes em ambientes de aprendizagem mediados por tecnologia

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Abstract

A context model for a pedagogical scenario explains its users (teachers, designers, and software developers) how a Technology Enhanced Learning (TEL) environment will support an educational process so that its structure should express as clearly as possible all elements which compose it (at both of educational and software design levels) and their relationships and should allow making analysis of its behaviour for its future improvement. By means of this work the definition of a context modeling process for adapting tutorship acting during a learning activity in TEL environments is done. The solution will influence the auto regulation of teachers/instructors/tutors/trainers' acts concerning adaptive students' guidance and assistance and also the maintenance and upgrading of teaching strategies/abilities and learning objects.

Keywords

Context modeling, Model Driven Architecture, Technology Enhanced Learning, Instructional Design, Adaptive e-tutorship, Adaptive e-learning, Track Analysis, Usage Tracking Language, UTL.

Resumen

Un modelo de contexto para un escenario pedagógico explica a sus usuarios (profesores, diseñadores y desarrolladores de software) la manera como un entorno de aprendizaje basado en tecnología llevará a cabo el proceso educativo. Por lo tanto, su estructura deberá expresar lo más claramente posible todos los elementos que lo componen (tanto en el nivel educativo como en la fase de diseño del software) y sus interrelaciones, y deberá permitir realizar análisis de su comportamiento para su futuro mejoramiento. Este trabajo define un proceso de modelado del contexto para adaptar acciones tutoriales llevadas a cabo en actividades de aprendizaje mediadas por tecnología y para influenciar la autorregulación de dichas acciones en lo relacionado con la asistencia y monitorización personalizada de las necesidades de los estudiantes frente a la temática específica tratada y el mantenimiento y actualización de las estrategias de enseñanza/aprendizaje y de los objetos de aprendizaje (contenidos).

Palabras clave

Modelado del contexto, arquitectura dirigida por modelos, entornos de aprendizaje mediados por tecnología, diseño instruccional, tutoría adaptativa, aprendizaje adaptativo, análisis de trazas, lenguaje de definición de trazas, UTL.

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Resumo

Um modelo de contexto para um cenário pedagógico explica a seus usuários (professores, designers e desenvolvedores de software) a forma como um ambiente de aprendizagem baseado em tecnologia irá realizar o processo educacional. Portanto, sua estrutura deverá expressar com a maior clareza possível todos os elementos que o compõem (tanto a nível educacional quanto na fase do design de software) e suas inter-relações, e deverá permitir a análise de seu comportamento para seu melhoramento futuro. Este trabalho define um processo de modelagem do contexto para adequar as ações de tutoria implementadas em atividades de aprendizagem mediadas por tecnologia e para influenciar a auto-regulação de tais ações naquilo que se relaciona com a assistência e monitorização personalizada das necessidades dos estudantes perante a questão específica tratada e a manutenção e atualização das estratégias de ensino / aprendizagem e dos objetos de aprendizagem (conteúdos).

Palavras-chave

Modelado do contexto, arquitetura dirigida por modelos, ambientes de aprendizagem mediados por tecnologia, design instrucional, tutoria adaptativa, aprendizagem adaptativa, análise de traçados, linguagem de definição de traçados, UTL.

Introducción

Much research work has been developed trying to achieve by Information and Communication Technologies student-centred education considering that concepts like learning, knowledge, skills, competences, learning outcomes and qualifications make up the core of current educational perspectives (see Peña, Gómez, Mejía and Fabregat, 2008). This work is in-line with these research objectives and focuses their own on proposing a context modeling process to help teachers/tutors adapt their tutorship actions (adaptive e-tutorship) considering students' performance (to enhance adaptive e-learning) on Technology Enhanced Learning environments.

This approach also intends to motivate direct participation of teachers and instructors who are not IT (Information Technologies) experts in instructional design and students' monitoring tasks using tools that could make easy for them the definition and evaluation of their own pedagogical scenario and teaching/tutoring skills (in view of both academy and enterprise environments). The capitalization of the solution will suggest: a re-engineering process of the TEL application, tutoring actions given "on the fly" that in turn may update the existing ones of an Intelligent Tutoring System (ITS) or identification of pedagogical/digital illiteracy in teachers/tutors that could help the institutional staff to design training/qualification programs for teachers/tutors to improve this performance.

Currently the adaptation decision making process in some TEL environments is a responsibility of humans as tutors, teachers or the learner himself while in some others this process is system-based for dynamically adapt its performance and its configuration, as in Intelligent Tutoring Systems (Weber and Brusilovsky, 2001; Arruarte, Fernandez-Castro, Ferrero and Greer, 1997) or Adaptive Educational Hypermedia (AEH) (Peña, 2008). Anyhow these decisions of any kind of adaptation are based on the interpretation of the learning context which could give answers to the following questions for teachers/instructors/tutors/trainers: Who are the students involved in the activities? How are they acting? What do they need? Who should be assisted? and questions coming from students: What to learn? When is this? How do we? Why should we (Paquette, 2003), etc. In short both humans and the TEL environment need information of the learning situation for taking an adaptive decision of performance (Choquet, 2007).

The context modeling process here proposed will involve and link context at educational design, implementation, production and evaluation levels of the TEL application for models which will describe learning activities and indicators. Indicators are values which currently have been calculated (Pham Thi Ngoc, Iksal, Choquet, Klinger, 2009; Randriamalaka, Iksal, and Choquet, 2007) as a result of the interpretation of user tracking actions (interaction analysis) on a learning environment (Choquet and Iksal, 2007) so they must support creation and maintenance of user models which in turn will define the adaptive engine for tutorship decisions.

The Model-Driven Development (MDD) methodology (Völter and Stahl, 2006) will be used since it gives educational designers (teachers for this proposal) as well as software designers the ability to define, communicate and test a solution while creating artifacts that become

part of the overall solution (Hofstader, 2006). MDD offers a better understanding of the resultant context especially if it comes from the pedagogical domain. The chosen testbed scenario is the Hop3x environment which it is currently used as a teaching/researching tool and it allows participation of teachers in the pedagogical design and in the learning activity run-time.

This document is structured as follows: section 2 describes context considerations which support this research work. Section 3 offers a case study with context for learning Java programming by the Hop3x TEL environment and finally section 4 offers conclusions and future work

1. Considerations

The term context has been used for many years in many domains and currently to support adaptively characteristics in many systems. Some authors define context as conditions in which something exists or occurs and in consequence it requires a focus on process and relationships between product and process (SIL). To model it, it is necessary the identification of dimensions, variables and relationships (Dervin, 1997). Dey and Abowd (2000) define context as any information that can be used to characterize the situation of an entity considering an entity as a user, a place or a relevant object in the interaction between a user and an application including the application itself. These concepts support the theoretical frame of this work which is introduced next.

1.1. Tutoring acts based on context

A process in e-learning situations where an adaptive tutorship action will take place is considered context-aware because it looks at the who's, where's, when's, what's (that is, what the student is doing) and how´s of entities and use this information to determine why the situation (the tutorship needs) is occurring. All of these considerations will influence teachers'/tutors'/trainers' actions auto regulation in front of students' assistance and guidance and also maintenance and upgrading of teaching strategies/abilities and learning objects in TEL applications (re-engineering of the pedagogical scenario). At the corresponding level of the software life-cycle these TEL applications will offer contextual reconfigurations, contextual commands or context-triggered actions depending on the context features (Dey and Abowd, 2000). Figure 1 shows a global schema of the targeted process seen as a reengineering one supported by the REDiM's project approach (REDIM).

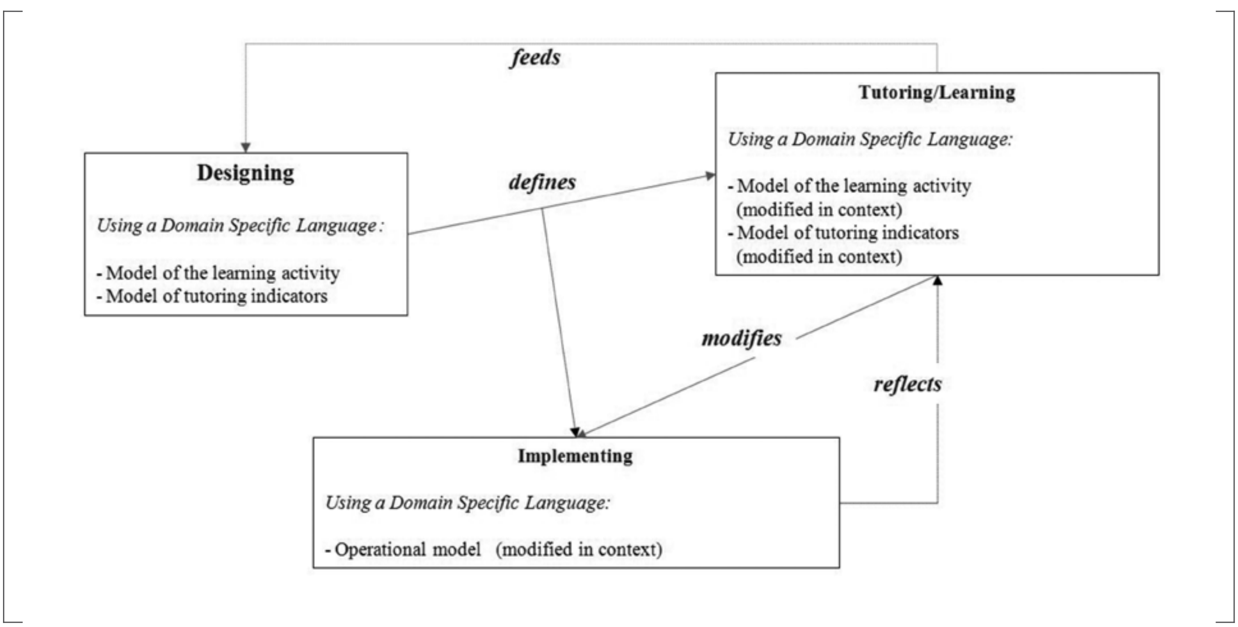

Figure 1. Context Modeling Process Schema for Tutorship Adaptation in Technology Enhanced Learning Environments

Context for this work is built with elements of the curricular domain, the learning situation (learning activities), the students' characteristics, the students' actions, the students' accessibility, the students' knowledge state, the teaching/learning strategies, the learning contents, the tutoring acts, etc. and it is used to characterize, detach and classify constraints, situation-related requirements, a resultant profile of information need and necessary information flow for identifying adaptive tutor acts in TEL environments. Some of this context information should be given to the TEL application but some of it also should be calculated, by example, the adaptive tutorship process consists in offering to students opportune feedback and accompaniment depending on his/her needs and these needs have to be identified or calculated from students' actions on a learning environment – interactivity context (Peña *et al.*, 2011).

As Langlois states, the identification of students who require improvement in any aspect of their performance often initiates a positive and constructive process of assistance and remediation. For the adaptive dimension of this decision-making, variables as the learning style (using Felder's learning style model (Felder, 1996) as proposed in Peña, (2008)) and the student knowledge state (using Bloom's taxonomy (Bloom, 1956) for structuring and assess learning goals as proposed in (Baldiris, Santos, Huerva, Fabregat and Boticario, 2008)) are considered.

Figure 2 shows a use-case diagram of the context modeling process with context elements and their relationships.

1.2. Context Modeling Metamodel

The metamodel representation of the aforementioned context modeling process is shown in Figure 3. It was designed to involve and link context of: a particular learning design (for adaptive e-learning); the students who will carry out the learning activities; the teachers/tutors/trainers who will support these learning activities (keeping in mind not only his/her subject expertise but also his/her pedagogical skills and digital literacy); the interactivity environment and the access infrastructure (hardware, software, connectivity, institutional policies, etc.) as means to allow, motivate and ensure the whole life-cycle of learning (Peña *et al.* 2011).

Details of these context models are:

The pedagogical scenario context: which allows definition of descriptive and predictive pedagogical

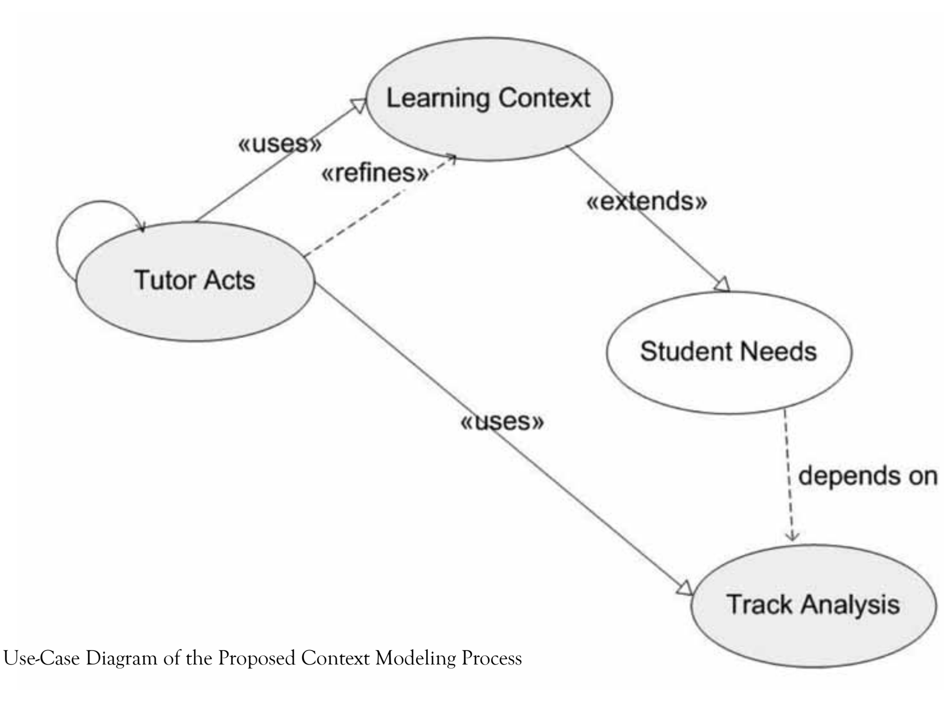

Figure 2. Use-Case Diagram of the Proposed Context Modeling Process

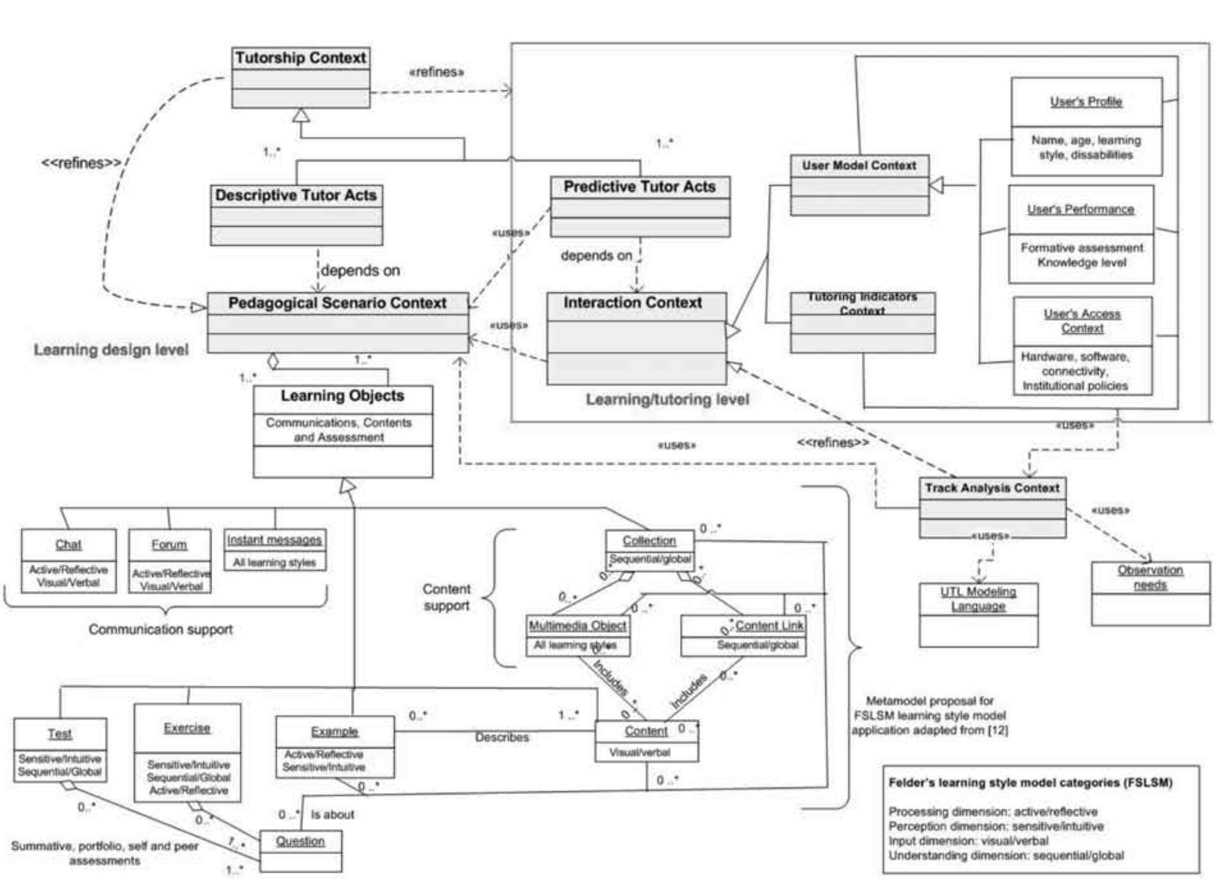

Figure 3. Context Modeling Process Metamodel for Adaptive e-tutorship to Support Adaptive e-learning

scenarios for adaptive learning supported by the context of Learning Objects structured using directions of the Felder's learning style model for content's and feedback/recommendation's personalization. This context provides learning activities for learners to fulfill one or more interrelated learning objectives. This means that a Unit of Learning (following specifications of Educational Modeling Languages (Koper, 2002)) should not be broken down to its components without considering its semantic and pragmatic meaning and its effectiveness towards the accomplishment of learning objectives.

This context is intended to be improved or refined based on the tutoring patterns resulting from the track analysis context (at the learning/tutoring scenario- runtime level of the TEL application).

Dimensions, variables and relationships between elements of a pedagogical scenario context are: the main dimension that is managed as Units of Learning (the final product) supported by context of learning models, domain models and theories of learning/teaching models (to allow multiple pedagogies). The learning model context which involves elements of the "how" learners learn according with learning theories agreements which its context implicates principles and models of instruction as they are described in the literature or as they are conceived in the head of learners.

Characteristics of the learning situation context will determine the educational philosophy, the instructional model or a more practical design of Units of Learning. By example, a deeply context of this model should be related to the "what" a learner or a group learn (e.g., knowledge, competencies, skills, attitudes, etc.); in "which" domain they describe, analyze, experiment, study, solve problems, explore or answer questions; "how" the learning and transfer processes occur; "how" are the students motivated to carry out the activities; "how" is collected the learning result, "which" means (hardware, software, physical infrastructure, institutional policies, etc.) allow to carry out the activities, "how" is the learning activity monitored and assisted by tutors, etc. In short, the learning model includes the learning activities and their context.

The domain model context which describes the type of content used to support learning and its organization (e.g., subject domain, Learning Objects and curriculum sequencing rules).

The user model context: which includes values of the users' attributes involved as identification, goals, learning style, competencies, acquired competencies (resulting from the formative assessment process), interests, preferences regarding accessibility, etc., to assess the learning model context and it is used also to determine performance patterns for the adaptive support. Part of this context is continuously upgraded from elements of the interactivity context (at runtime of the TEL application).

The track analysis context: which uses the Usage Tracking Language (UTL) (Choquet and Iksal, 2007) to model tutoring and learning indicators and to capitalize them as design patterns with the aim of creating re-usable methods and tools to assist teachers/tutors in processes of monitoring and analyzing the progress of a learning situation. This will fit the tutorial acting and guide the re-engineering processes of the involved pedagogical scenarios as needed.

An indicator in this context is defined based on (IA) as a variable that describes features concerning to: (a) the quality of the learning activity from the point of view of the cognitive process, b) the quality of the interaction process or (c) the quality of the collaboration process carried out on a social context supported by TEL environments. The UTL was designed as a generic language to describe tracks and their semantics, including the definition of the observation needs and the means required for data acquisition. It could be used also to structure tracks from raw data (acquired from and provided by the interactivity context) to calculate indicators, which offer data with meaning for teachers to model the tutorial acting and also for students to know his/her learning progress.

Figure 4 shows a schema with the negotiation and discussion vectors existing between actors of the modelization and observation analysis of a TEL application usage on a learning context at each level of the learning life-cycle. The context modeling process as an integration of the aforementioned contexts using the UTL language (see more information in (Peña et. al., 2011)) is shown in Figure 5.

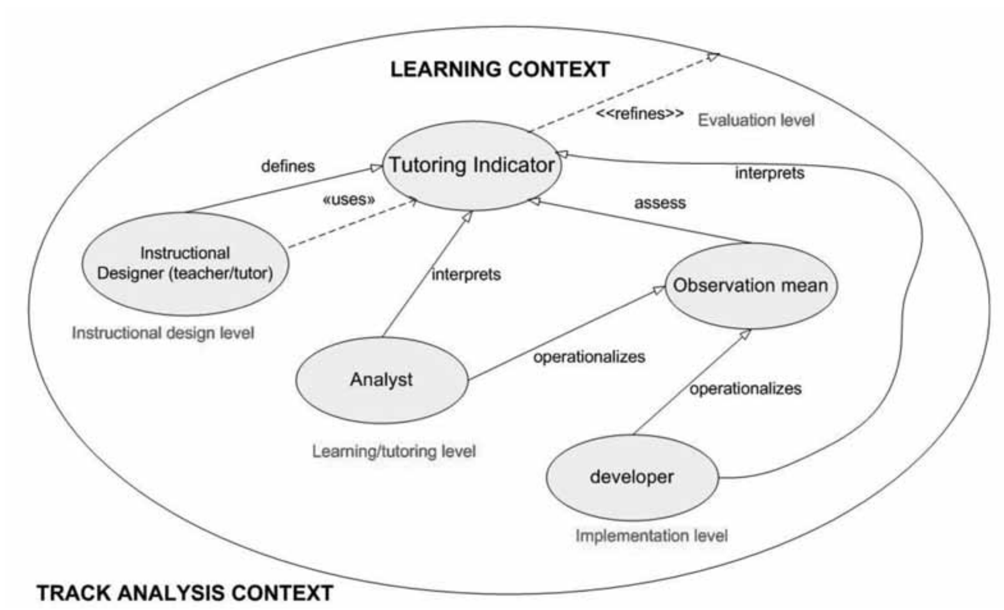

Figure 4. Schema of the track analysis context considered as part of the learning context in a TEL application.

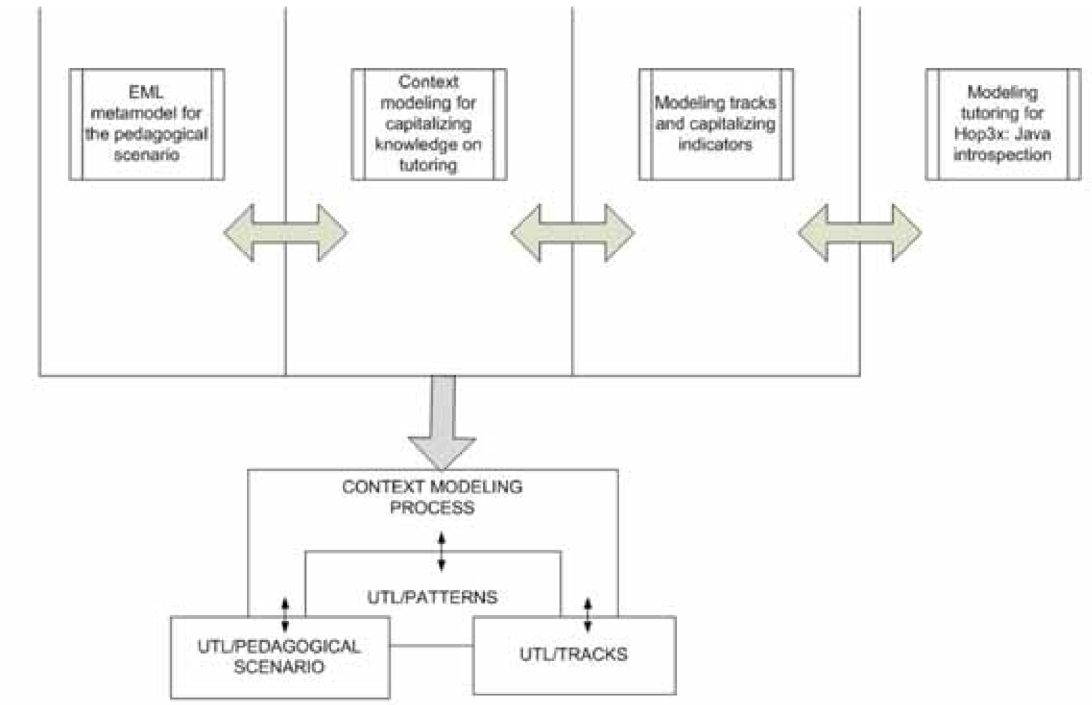

Figure 5. Schema of the context modeling process as an integration of the different involved contexts using the UTL language

2. Case study: adaptive tutorship when students solve java programming problems

Results from some research studies (McCracken et. al., 2001; Ratcliffe, 2002) have concluded that learning object-oriented programming requires considerable effort from students who do not have acquired knowledge about object-oriented design. In consequence experts recommend including concept and procedural designs when modeling the learning domain and link them in appropriate manner in the curriculum sequencing to facilitate students the knowledge acquisition in this matter using classroom or TEL contexts. Wei, Moritz, Parvez and Blank (2005) have stated also that object concepts (as the object itself, classes and instances) are often introduced in the first few lessons of the course using a considerable quantity of demonstrations before proposing procedural elements of the programming language in order to avoid the development of misconceptions which can be difficult to correct later, especially in beginners.

The Hop3x environment is a Java client-server application which was developed as a learning/research tool to allow the learning of object-oriented programming by Java language while testing the context modeling approach proposed in this document. Context for the adaptive e-tutorship which in turn supports adaptive e-learning by this environment is modeled as follows considering the seven principles of good practice for instructional designs supported by technology (Chickering and Ehrmann, 1996) and the aforementioned directions given for teachers/researchers of this knowledge field:

The pedagogical scenario context: which uses Task Based Learning as an active learning strategy in order to offer students elements to know what they are learning, write reflectively about it, relate it to past experiences, and apply it to their daily lives. The learning goals are related with applying knowledge about object design, object programming, program documentation, correct use of Java programming directives, correct use of the time planning, etc.

The domain elements are structured in contents represented by a set of exercises of Java programming linked by a set of pedagogical decision rules (with knowledge level as a pattern-decision) which defines the curriculum sequencing of the activity. Some of these rules are mandatory and determine how and by which sequence the exercise should be resolved. A Java programming exercise in this context has two main objectives: a general one and an operational one. The way of achieving the operational objective could determine particular characteristics of the student performance which could be modeled to obtain indicators for personalization of the tutorship act.

Some pedagogical decision rules are proposed also to assess the entire process of learning; it means that could not be enough to obtain the correct answer of the exercise for getting a good grade, since other factors as the sequence used to do it could influence the final assessment of the experience (formative assessment). Tasks are structured also using different levels of difficulty (basic, medium, high) with content-support and tutoring/learning tools that match learning styles based on Felder's learning style model in order to allow students improve his/her knowledge level as they advance in the curriculum development.

The student learning style and the knowledge state are variables considered to define appropriate content, means or tutoring strategies to support the adaptive tutorship (context-based teaching as a way to vary content help for individual needs (Randriamalaka, Iksal and Choquet, 2007)). This also will help students learn in ways they find most effective and broaden their repertories for learning. Animations by example, allow an instructor to emphasize the important parts of a subject by removing unnecessary and distracting details. Animations have the ability to visually present subjects and ideas that would be difficult to illustrate in the real world. These elements help to make learning more effective.

The Concept Mapping strategy with the state of the learning situation is designed also as a tutoring tool for students to monitor their learning progress. The tutorship act is designed to be carried out "automatically" matching student needs on runtime but involving teachers/tutors in monitoring these activities with a possibility to contribute in the improvement of its performance in real-time. Elements for scripting tutoring acts were identified using three layers: the one to manage constraints, the one to manage possible alternatives and the one to manage things to be forbidden. These elements articulate cognitive processes with instructional events and instructional actions.

According with the context modeling metamodel introduced in Section 2, there are some tutoring actions that are predefined during the learning design phase and others that are built "on the fly" based on the interpretation of the interaction context by the human tutor (observation needs). In both, the learning objects used to offer this guidance are chosen considering the analysis of the student context (individual or by groups). As this metamodel also was proposed to help teachers to improve and test his/her pedagogical scenario, actions as dividing a task in subtasks, rewriting the subject of a question using different semantics or removing the whole task are taken into account as part of the tutorial model context. For instance, some of the observation needs (to be interpreted from the track analysis context) designed to help this process are: the learning style of the group or for an individual – this could condition the "way" and the "content" to support feedback/recommendation delivery; the number of students that have used "incorrectly" the time planning for the task – this could help in the improvement of self-assessment tasks, in suggesting an example about how to self-regulate the time assigned to task, etc.; the number of students that have gotten a particular compilation error certain number of times - this could help in the identification of concept's misconceptions or programming skills, or digital illiteracy, etc.

The user model context: is managed by separated parts for students and tutors. Attributes as: identification, name, age (for students) and interests are valued once as fix data at the beginning of the whole experience. The learning style is "captured" once on runtime by means of the application and interpretation of the Index of Learning Style questionnaire (ILS). The knowledge level valued as beginner, medium or expert is "captured" also by means of the application of a knowledge domain assessment at the beginning of the experience and it is upgraded with patterns resulting of the interactivity context interpretation (track analysis). This value conditions the student advancing in the development of the learning activity. Values coming from the formative assessment (which part of them are results of the track analysis) upgrade patterns concerning competencies, acquired competencies, etc.

The track analysis context: uses the interpretation of the student actions on the interactivity context to implement the observation needs proposed by tutors. The UTL language interprets actions from raw data and calculates the appropriate tutoring indicators.

Currently there are implemented 68 indicators from this activity. For instance, some indicators which are built to help students to monitor his/her learning progress are: situation where tutoring was required, type of feedback/ recommendation offered, reaction in front of the tutorial action, summary of the learning situation using concept maps, recall of the whole actions carried out. Figure 6 shows a screenshot of the tutor's interface monitoring the sequence of actions executed by a student when resolved all the proposed learning tasks about Java programming.

A window with the resultant information scripted by the UTL language from raw data of that student is also highlighted to illustrate the process accomplished in background to structure the information to be displayed.

The tutorial act interface to allow teachers/tutors the students' feedback delivering is shown in Figure 7. From it, tutors may tabulate the following elements to create a tutorial act repository:

- ***Type of intervention:* that could be reactive, if the tutor answers to a student request, or proactive, if the tutor takes the tutoring initiative based on previous analysis of the student's learning context, for instance, traces, indicators, knowledge level and knowledge state. The how to build the tutoring message, by which learning objects should be supported and by which media should be delivered is resulted from the analysis of the learning style and the technological context.**

- ***Dimensions of the tutorial intervention which* according to Després (2001) should be: didacticals, if acting has to be with the contents taught; methodologicals, if feedback is oriented to the organization of the studies; technicals, if any technical problem concerning the involved hardware/software triggered the tutoring act; or, motivationals, if the student required some encourage to develop the activity.**

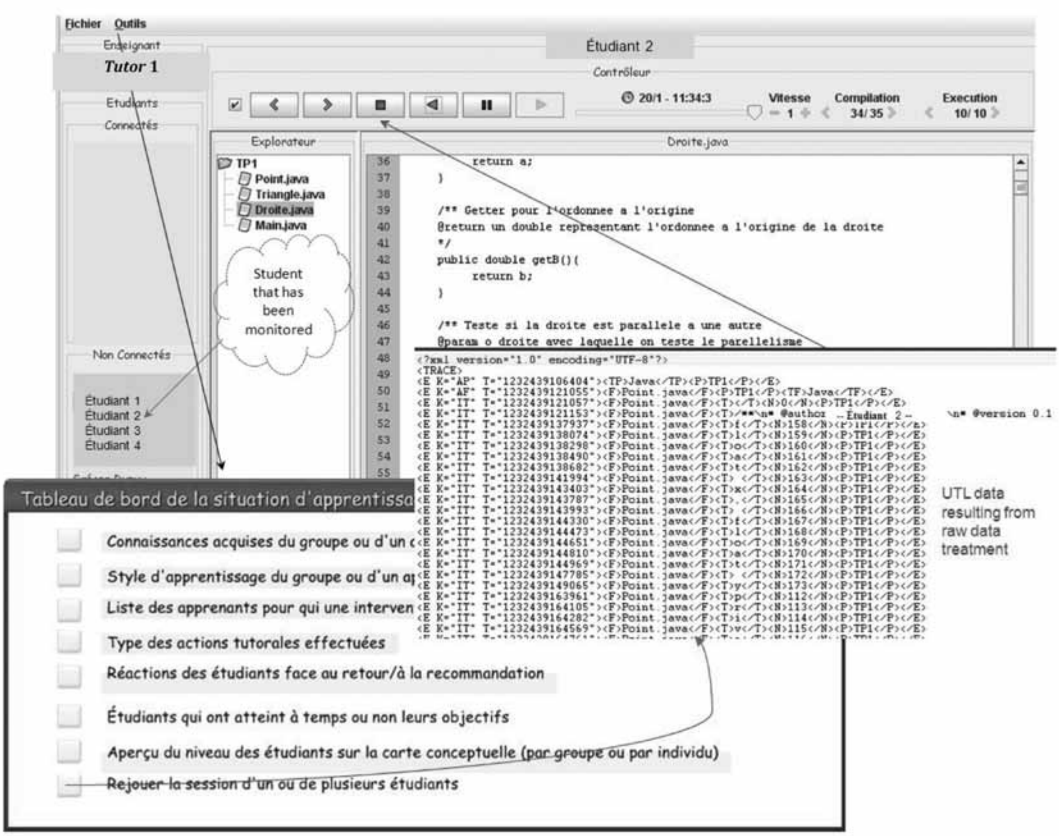

Figure 6. Screenshot of the Hop3x student monitoring interface in the tutor's session

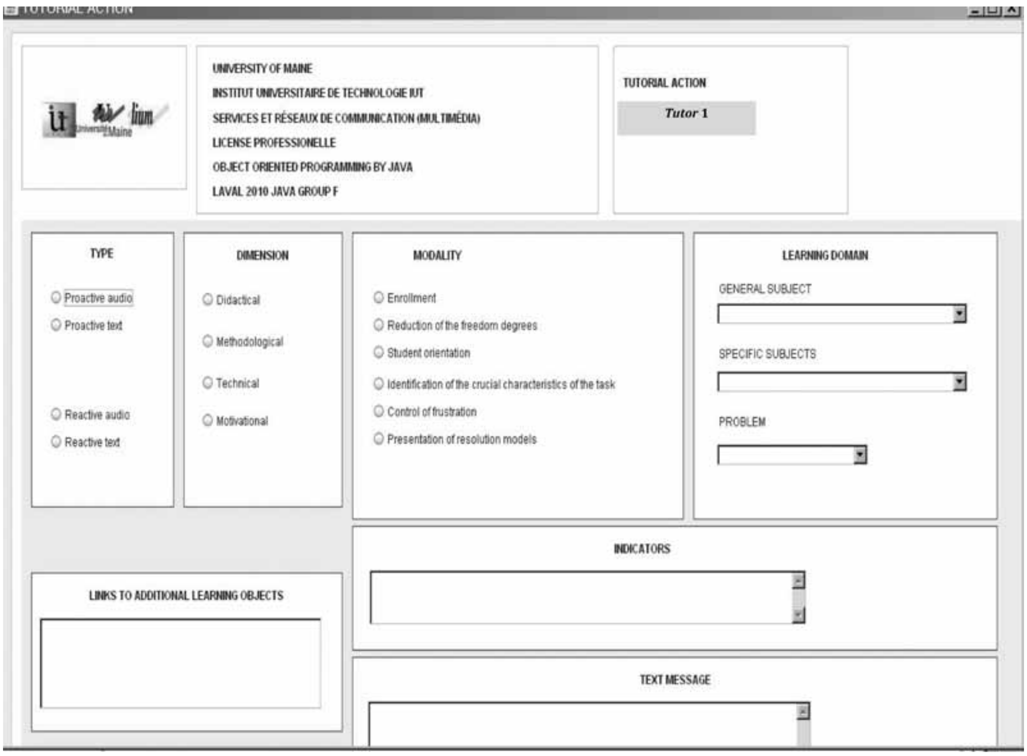

Figure 7. The Hop3x Tutorial act interface

- *Modalities of the intervention* as defined by Bruner (1983), which include: enrollment, if the tutorial act is focused on the students' interests towards the tasks' requirements; reduction of the freedom degrees, if the tutorial act is focused on the simplification of the task by reducing actions to achieve the solution; student orientation, if the tutorial act is focused on the achievement of the learning outcomes by preserving motivation; identification of the crucial characteristics of the task, if they are appropriate for its development; control of frustration, if the tutorial act is focused in avoiding the task abandon and finally, presentation of resolution models, if they are considered necessary to help in the problem solving but without giving the whole answer.

- *Indicators:* these data are calculated according to the achievement of the task or problem learning objectives based on the students' tracks analysis.

- *Message:* this information could be saved in different formats depending on the students technological context (e.g., text, audio, multimedia, etc.) to make easy its delivery.

- *Links to complementary learning objects:* if it is necessary, these data should allow by link references, access to one or more learning objects which should complement the tutoring support. Later, the effectiveness of their use by students should be tested by pattern matching to the proxy server's tracks.

Finally, the analysis of the resulting repository of tutoring acts that is built session by session should guide its usage for different purposes (reengineering of the pedagogical scenario, tutors acts self-regulation, reusing to support "on the fly" tutoring decisions, teachers/tutors pedagogical and digital literacy, etc.) as it is proposed in the context modeling process introduced in this work.

3. Findings

Concerning the tutors' performance. Teachers/ tutors have showed a high motivation to carry out the experience since they could check the effect of their actions in the students' performance. However, certain tendency to remain as the main actors of the educational process (supporting teachers' centered education) still exists, since the students have had just a few opportunities to find by themselves the solutions helped by the feedback given in tutoring. Nevertheless, as this performance was collected in tutoring tracks, many recommendations after the session were identified to help tutors self regulate to allow students participate in their learning processes as the main actors.

Teachers as tutors should have enough time and motivation to train their digital and pedagogical abilities for searching the learning objects repositories that will support their prescriptive tutoring interventions. So these could be accessed by the help buttons of the Hop3X students interface or to reinforce the "on the fly" tutoring intervention during the learning sessions. In summary, teachers/tutors should be fully involved in choosing subject and content support for the activity before starting tutoring/learning sessions by TEL systems. The digital and pedagogical literacy acquired by tutors could influence the success of the tutoring activity, especially, if, firstly, tutors were called to participate in the improvement of the curriculum (instructional design) and secondly if they had to give appropriate tutoring when it was requested.

The institutional staff should provide enough and useful training courses for teachers/tutors to develop their digital and pedagogical abilities needed for tutoring learning sessions by TEL systems in any educational modality. For the case, it could be an exemplifying exercise to carry-out a simulacrum of the experience with conditions near to the real world using the Hop3X environment.

Teachers/tutors claimed for the whole participation in the definition of the observation needs before committing themselves in tutoring sessions so indicators could be used as much as possible to support their tutoring decision making.

Concerning the students' performance. The motivation to carry out the experience was relative and influenced by many variables of the learning context: knowledge of the domain, preferences, availability for the experience, the wishes for acquiring or improving the programming skills in Java, the learning style, the used technology, the institutional policies, etc. Advised students worked well and tried to reach at maximum the learning objectives, however as there was not any "incentive" to value the acquired learning by this education modality, many students did not feel responsible for reaching the learning outcomes. In general, just six of the twelve problems proposed were solved at all during this practical work.

Concerning the UTL and the Hop3x performance. The indicators relevance should be improved. There was a lot of information that tutors did not use (because of unfamiliarity or because it was not helpful to the tutoring decision). Nevertheless, variables as the learning style and the knowledge state were identified as important attributes which may guide the structure of personalized learning designs before sessions and also may influence tutoring decisions. For example, the student knowledge state could be considered as an indicator to define learning paths.

Problems already solved could be a resultant indicator of the evaluation of some learning objectives. The idle time could be an important indicator that may help the improvement of many elements of the learning scenario. For instance, it is possible to know what the students are really doing during that time: if nothing influences the learning; if browsing the Internet to look for some learning objects in which case the proxy server should capture these tracks to verify useful links; if using current prescriptive tutoring acts that could be accessed directly by clicking on the help buttons of the student's interface, in which case, other indicators may help identify which of these prescriptive tutoring recommendations were more visited or used to support the learning activity, etc. The number of indicators for "bad performance" in Java programming was reduced when the tutoring act was delivered and considered by the students and this situation could be observed by teachers/tutors to identify the effectiveness of their actions.

The UTL performance was excellent; nevertheless the handling of small students' groups is recommended for synchronous tutorship in any educational modality (blended or distance learning) if the quantity of indicators to manage is considerable.

Concerning the identification of elements for reengineering processes. The learning objectives were not clear neither for tutors nor students. The how to solve problems, the why problems should be solved and by which time each question should be solved, were not enough understandable. The only clear objective about the time was the one considered for the whole experience (3 hour lab).

The learning objectives should be fairly defined and their accomplishment should be tested by parameters given by indicators.

The coffee break time has to be determined before starting the session, this will allow stopping and restarting the learning indicators calculation according to tutors' and students' availability.

The problems' description should be improved considering the same semantics used to introduce the content support in classes. For instance, problem two concerning the "redefinition of the Equals method" must be rewritten or changed its contents at all because it was very difficult for students to understand its goals. The students' may begin sessions with problems adapted to their level of knowledge and a balanced learning style previous analysis of the group learning style. This may motivate the activity and the definition of dynamic learning paths according with the students' performance.

The Hop3x teachers' interface should allow working with two screens to support comfortably the students' observations.

Audio configuration for Linux systems was not possible. For that reason every tested person was forced to use only Windows systems. Hop3x interfaces should be open to work with any operating system.

The Hop3x students' interface should also offer tools to help students know their learning situation at any time. They should familiarize with their own indicators, which at the same time could be used as learning objects to support their activity.

4- Conclusions and future work

A context modeling approach was introduced in this paper as a tool for helping teachers/tutors to reinforce their skills and abilities in carrying out reengineering processes on his/her pedagogical scenario using adaptive tutor acts based on the whole learning context (the Units of Learning context, the student model context and the interaction context). Variables as the learning style and the knowledge state were considered as basic elements to build the students observation needs required to support the track analysis and the tutoring indicators generation.

The UTL language is a versatile tool that could be used for complex tasks derived from a track analysis as user modeling, context modeling as many others which involve a big treatment of information. In TEL systems could be used as a transparent coat to carry out personalization or classification processes considering information collected as tracks. Its XML architecture based data format may be processed easily by computers without considering complex database schemas.

Current work is carrying out towards the formalization of this context modeling process in order to provide a uniform way for specifying the models' concepts, sub-concepts, relations, properties and facts, to allow sharing the contextual knowledge and reuse its basic information. User-friendly tools to help teachers/tutors to model, build and test directly their own tutorial act on current TEL environments are being developed also since at the moment this work is carried out by experts in track analysis.

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NOTES

1. Article of scientific and technological research - the thematic was research area of the project REDIM - Réingénierie des EIAH Dirigée par les Modèles - Professor-investigator-guest: Clara Inés Peña de Carrillo.

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