Information systems and educational engineering:

Bridging two concepts through meta modelling

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Abstract: In this article we present our work on the specification of a learning environment allowing a teacher to implement co-operative learning situations (CLS) based on the notion of situational problems. To this end, we approach the specifications of our environment based on a meta-model that we define to support CLS.

Key words: educational engineering, information systems, meta-model, learning object, components

1. INTRODUCTION

Pushed by technological 'innovation', educational engineering has evolved significantly in the last decade. Numerous current research details the development of the technologies for open distance learning. These are centred on the establishment of standards for meta data and learning objects. The research reported here has been conducted by public (LTSC, LOM 2001, at <http://ltsc.ieee.org/>; ARIADNE, 2001, at <http://ariadne.unil.ch/>; PROMETEUS, 2001, at <http://www.prometeus.org> or IMS, 2001, at <http://imsproject.org/>), and private concerns (Asymetrix, Oracle, Microsoft, etc.). This work aims to support the interoperability and the re-use of applications and 'at electronic' services. Wiley (2000) summarises the general consensus concerning the definition of a learning object (in the literature, certain authors use the term educational object (De la Passardière et Giroire, 2001) or even 'learning object'): '[il] représente toute ressource

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numérique (quelle que soit sa taille et son type) pouvant être réutilisée comme support d'apprentissage (à travers le réseau ou non)'.

Other research focuses primarily on the educational specifications (modelling aspects) of a learning environment. These works, based on high-level languages, 'drive' the educational designer in the specification of such an environment by separating the contents of the structure and the environment. However, to take into account all the dimensions of a learning environment - specification, co-operation and distribution - it is essential to rely upon an information system approach in implementing four inextricable and additional constituents: models, formalisms, method and tools (Rodriguez-Artacho et al., 1999; Koper, 2001; Sallaberry et al., 2002).

Our work is centred on the development of co-operative work environments to support the implementation and the resolution of problem based situation learning (PBLs) (by groups of learners). The role of the teacher in a new training approach, including information and communication technologies, is modified: as the teacher expresses both knowledge and competences, he becomes (successively) a tutor, a coach, a 'facilitateur', a guide (even sometimes co-teaching). To transform a vague idea into precise requirement specifications - in our educational case - is through a very active research domain in terms of requirement engineering. In the next section, we present our way of building learning environments. Our approach supplies teachers with the means to specify co-operative learning based on PBLs in all its dimensions.

To support the different specified learning objects, the interactions, and the collaborations, we have implemented a meta-model of data which integrates the static and dynamic aspects of such an environment. A repository working alongside such an environment allows the development of guides, tutoring, and appropriate help for learning environments (dealt with in Section 3).

2. OUR LEARNING ENVIRONMENT: SYSTEMS, TOOLS AND LANGUAGES

Preparing, teaching and estimating are three original stages in the implementation of an educational situation. These processes should take into account different parameters such as educational conditions, educational objectives, necessary feedback, adaptation to a modification of the educational situation, and so on.

When the educational situation is 'mediatised' via a network of computers, the teacher should keep a dominating role of animating, guiding, and manipulating the situation itself, even if the exploitation conditions

change, since: (i) learners are not necessarily physically in the same place, (ii) the activity of learners is collected through a mediation by the computer tool, (iii) the teacher's activity in his roles of follow-up, mastery, control and orientation of the learner activity is also mediated by the computer tool.

Furthermore, by contrast with traditional learning, based on the notion of course provision and reading, collaborative learning is interactive: the students participate actively in the production, assessment and organisation of information. The instructor structures the learners' activities carefully, emphasises a particular content and controls the students' work. The construction of knowledge is thus perceived as a process of progressive problem-solving, which encourages students to be innovative, to create intellectual capacities and to develop and acquire some expertise. This is demonstrated by Harasim (1999) who explains such a system: Virtual-U (on the web-site at www.vu.vlei.com).

For our part, we have chosen an educational theory based on the pedagogical situation problem which seems appropriate to us (Marquesuzaà, 1998) to elaborate a co-operative learning situation. Indeed, this educational object includes all the necessary elements to place a group class (and its constituent sub-groups) into a project situation with: (i) global objective, functional and formal success criteria, (ii) materials and other tools facilitating situation problem-solving, (iii) sometimes, a fairly precise guide describing certain modalities and other distribution of the tasks among participants (and groups of participants).

Figure 1. Educational and computer life cycles

To develop such environments, our research focuses on the coupling of the educational life cycle and the computer life cycle. We defined a meta-model in Section 1 which, on the one hand, integrates a learning theory and, on the other hand, can be interpreted from several other points of view. So, objects manipulated by the teacher's designers during the preparation phase

are stored in our repository. In this way, we join Rodriguez-Artacho et al. (1999) who suggest separating the creation process into two types of task: the construction of abstract models to describe a target domain and the definition of learning views, and scenarios on the domain models, to reach specific educational objectives. We add control and assistance services to the regulation phase when learners exploit objects prepared by the teacher.

To set up such learning environments, we see the appearance of new information systems which are able to implement the re-use of learning objects, and put in place different 'granularities'. This notion of 'granularity' is important for the description of an educational situation. For example, to make reference to a complete web-site by means of its URL, either to integrate a learning object of lower level, or to put a question into multiple choices, does not recover it from the same abstraction. One will find in De La Passardière and Giroire (2001) a state of the art account of the works about the XML language applied to learning objects which allows the indexing of 'educational' web products and the introduction of dynamics into proposed activities.

The three system categories which we distinguish are: (1) existing IDLE platforms ('Integrated Distributed Learning Environments') such as WebCT, Learning Space, which offer closed environments and a pseudo methodology for building learning environments (the implemented information system in this category does not allow the visualised opening to let any teacher build adaptable environments), (2) a global information system allowing learning objects to be referenced and found (this approach is followed by certain teachers (especially scientists) to build on-line courses, either by developing interactive intranet sites, or by developing education by means of a development platform-environment such as ARIADNE (2001) (CDE and Multi-purpose Object Oriented MOO (Bessagnet and Painter, 2001) are good examples, but, technical competence is also necessary for its suitable use and damages a democratisation of teachers' use), (3) the approach through meta-languages (works are introduced in this domain and we can quote the EML language (Koper, 2000) or one of its extensions with the PALO language (Rodriguez-Artacho et al., 1999)).

The project we describe here is situated in this last category to which we add a component of re-use in information systems engineering. Our works differ from ELM and PALO for two major reasons: on the one hand, in our environment, specification tools of a co-operative educational situation are given to the teacher-designers, and on the other hand, our meta data model allows us to take an evaluation stage easily into account using tutoring and guide functions which allow the obtaining of feedback, an indispensable condition for a learning environment.

3. META-MODELS AS CO-OPERATIVE LEARNING SUPPORT

'Metadata' in on-line distributed learning networks represent a set of elements that describe electronic learning materials. Metadata are the attributes of learning objects as they define the individual characteristics of each information component. Learning objects are defined as any entity that can be used, re-used or referenced during technology supported learning" (Zschocke, 2001). We developed a meta-model with all the characteristics required to store these types of information.

3.1 Description of our meta-model

On the basis of this meta-model, we propose an environment in which the teacher has the possibility of defining a global educational project; several learners with different roles should collaborate to resolve the various situation problems (at the same time) and reach the educational objectives (at the same time). The system integrates also another type of participant: an instructor who is in charge of following and assisting learners in their problem-solving. This monitor can be a human being (a physical person) or it can be automatic. The participant has resources and appropriate services and can interact with the system.

The concepts of objective, success criteria, role and resources are designed as object classes in an aggregation association with the situation problem (Figure 2). The situation problem specifies scenes for which every participant has a given role. These various classes of objects are strictly connected to the static aspect of our environment. The meta-class actor connected to the meta- class role allows teachers and learners to be modelled in their role of co-learner, co-teacher, guide, assistant, etc. Detailed examples for the design of roles were defined in Sallaberry et al. (2002). Every activity (or task) of a participant is the educational action (or a set of actions) undertaken in one, some or all the activities.

An action is the technical atomistic decomposition of a task. An action is electronically detectable (click, file, e-mail, etc.); this could be an event. The assistance is the presentation of resources or information aimed at facilitating the learning. By analysing an educational activity in its regulation phase, we introduced the class History Machine allowing the class role to be specified. So, the class History Machine is composed of ModelElement with History. The elements State, Transition, Event and Action (issued from the UML meta-model) generalised by the super-class ModelElement with History allow the dynamic aspects to be integrated into the meta-model of our information system (Figure 2). These object classes

stemming from the UML meta-model (classes' state and transition, for example) as we cover the needs appropriate for co-operative educational situations. So, the role played by a participant is described by a continuation of actions and collaborations described notably by the class History Machine.

3.2 Example of use

We have specified a PBLIS taken from Neiss (1995) and Koper (2000). In this example, entitled 'a bottle project for learning about graph', we have specified the context of the educational situation. In our approach, we model the different tasks and their links by means of two types of UML diagrams: collaboration diagrams and state transition diagrams. By storing information such as states, transitions, events, actions and roles, our system is able to provide tutoring functions. It is thanks to the potential of these dynamics from the specification phase that our environment distances itself from EML or from PALO.

4. CONCLUSION

In this article we have presented a specific information system appropriate for the educational engineering domain. Three inextricable and additional constituents are taken into account:

- A method: the originality is based on the duality of the educational life cycle and the computer life cycle. The educational dimension of our information system requires that educational specifications are elaborated in a close 'language' which teachers automatically transform into computer specifications.
- Models: We have presented and argued the meta-data model appropriate to our system. The force of this meta-model is its capacity to store both static and dynamic aspects appropriately in our IS. But we have described only the educational aspect of the model. We are working on an extension of this model to take account of the technical aspects which need to be stored.
- Formalisms and tools: In our approach, we model the different tasks and their links by means of UML diagrams, which supply an easily understandable graphic formalism used to specify educational situations. In the future, an interface that is more appropriate for teachers rather than data processing specialists will also be developed so that they can produce their specifications directly and independently.

Our work still requires several further developments. In the short term, we shall take further our efforts on the platform to accommodate the educational objects created from the meta-model that we have detailed. This platform will include functions to implement services and distributed components to fulfil the educational objects we described in this article.

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BIOGRAPHIES

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