

A NEW APPROACH TO KNOWLEDGE MANAGEMENT OF A LEARNING ENVIRONMENT

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ABSTRACT

A learning environment (LE) can be considered as the space where it is possible to manage knowledge or, rather, the lack of knowledge, as there is knowledge stored in the environment. In this paper, as a starting point, a definition of a LE and its components is offered. Some models are presented and some opportunities for improvement are detected.

Knowledge management (KM) aims to put knowledge into a form accessible to whomever may need it. This objective might be applied to characterize a LE and even used as its own definition. Basic ideas on KM are also included in order to reveal the structure on which a new and different model of LE is to be built.

To prove that the proposed model is applicable, an implementation was applied and evaluated during two courses of Object Oriented Programming for Systems Engineering 1st year students. It was verified that use of LE allowed students to improve problem resolution methods and skills to carry out knowledge transfer.

LEARNING ENVIRONMENTS

A LE is the space where conditions are put to work in order to let the individual acquire new knowledge, new experiences and new elements, to generate processing of analysis, reflection and appropriation, according to Avila (1). The environment must fulfill student's expectations. It must also be based on the students' participation and responsibilities. It has, moreover, to consider the different kinds of intelligence (2). According to Hiltz (3) the environment must be effective and efficient when presenting concepts from different points of view, by showing various examples and providing self-tests.

For this paper, the following definition of a LE is proposed: A LE is a space that is adaptable

(capable of recognizing student's cognitive skills and learning preferences) to benefit student's independent work, so as to offer non sequential approaches to promote a free linking of ideas. It implies that students be the center and that the students themselves choose and make their own paths, without the strictness of an inflexible schedule or a pre-established working order.

Components

An environment, as well as intelligent tutoring systems (ITS), usually presents four basic components: an environment module, a student's module, a pedagogic module and an interface module (4).

The environment module has the knowledge base. It contains knowledge which is declarative and/or procedural on the subjects taught. The student's module represents the student's own characteristics (skills and behavior). Designing it requires observing the students and interpreting their actions. The pedagogic module covers the teacher's actions: correction, planning, strategy, diagnosis, prediction and assessment. The interface module is what the user can see.

For virtual learning environments, it is advisable to keep records of the student's activities and accomplishments. It must also have an online help including access to learning, evaluation and tutoring (5). It is further recommended to allow students' access to resources (6).

Different models

The IEEE P1484.1 (7) standard describes the high-level system design and the components of a Learning Technology Systems Architecture (LTSA). The components of a LTSA system are: processes (learner, evaluation, system coach, delivery process), stores (records database and knowledge library) and information flows (behavior, assessment, learning info or performance, query index, content index, locator index, learning content, multimedia, learning style or preferences).

Wiig (8) describes an effective teaching model. The teaching process starts with a practical example; the next step is the introduction of a more general case (script) in order to show that a wider field exists. The case is then expanded, so as to obtain an initial scheme to present general characteristics. A new example, different but congruent with the previous scheme, is afterwards presented. The stages are repeated.

Azpiazu et al (9) propose tele-formation and the virtual classroom. Tele-formation or tele-teaching allows flexibility of time and space and encourages self-learning. The virtual classroom consists of the professor, the video library and the academic or institutional memory. This memory should contain: a) a learned lessons system, which is a knowledge base where positive or negative experiences appear; b) a set of best practices that allow students to choose, among different approaches to each topic, the one that results easier to learn to them and c) a system for immediate query, with a repository of answers, a query classifier and an interface.

Decision making should be left to students (6). They should choose: what to learn (selection of contents or skills), how (methods, medium, way), where (place), when (beginning, end, rhythm) and who to resort to for help (tutor, friends, professor).

Opportunities for improvement

Analyzing the IEEE P1484.1 (7) standard some opportunities for improvement may be seen, such as: a) A definition for learning-resources-structure, which is lacking; b) Establishing a direct relation between the learner entity and learning resources. Students should be able to access those resources directly, according to their own preferences; c) Including an additional module for supporting KM like, for example, a corporate or institutional memory or yellow-pages (a directory of experts for each topic); d) A teacher entity, which is not modeled; and e) Allowing a space for students' assessment of the knowledge repository.

In Wiig's model (8), an order is established for knowledge, without any other options. Azpiazu et al' (9) virtual class manages knowledge and describes its components in too general a form. A low level structure and the allowing of the already mentioned different learning styles are not included. Other KM elements such as yellow pages are not considered also.

To sum up, in the bibliographical research done no LE was up to date detected with the characteristics of the proposed one. Detected problems in those environments are that many times there seems to

be an excess of information and that the environments are not centered on the student. None manages knowledge explicitly (except for (9)). Management is an ever increasingly needed aspect, when the characteristics of knowledge society and the ever expanding knowledge are considered.

KNOWLEDGE MANAGEMENT

Davenport (10) refers to procedures that drive KM in daily process: how knowledge is created or how it is obtained from employees, how it is distributed and accessed and how it is transferred to other people and applied to business problems and decisions. According to Wiig (11) the grounds for KM are: exploring knowledge and its adaptability, finding the value of knowledge and actively managing knowledge. KM (12) may be considered as the process that: a) Integrates information (accessing, organizing, storing, searching for, recovering, navigating, codifying, referring, categorizing and cataloging it); b) Draws some sense out of incomplete information, and c) Updates information, ensuring its continuity through manual procedures, supplemented by information technologies tools.

All the reports found about experiences of KM refer to business applications, but a parallelism between KM and LE definitions might be established. Goals of KM imply furnishing users with knowledge they need, when, where and how they need it. A similar concept may be applied to define a LE and, moreover, it might be taken as a proper definition of said environment.

Corporate memories

Corporate or Institutional memories (CM) are a fundamental tool for accomplishing the joining of people and technology. They support shared knowledge and reuse of individual and institutional knowledge, learned lessons and best practices, according to Paradelo (12). Van Heijst et al (13) define CM as an explicit, disembodied, persistent representation of the knowledge and information in an organization. This includes knowledge about products, production process, customers, marketing strategies, financial results, etc. According to Nagendra Prasad et al (14) CM consists of the sum total of the information and knowledge resources within an organization. It may include company databases, machine-readable texts, reports, product requirements, etc.

To sum up, CM primary function is to enhance institutional competitiveness by improving the way in which knowledge is managed. This definition may be extended to an educational context.

A NEW LEARNING ENVIRONMENT MODEL

The proposed pattern (see Figure 1) will consist of: a) Student entity: it represents the student. It maintains the students' information, their work, log files and learning preferences; b) Professor entity: it represents and maintains the information of the teacher (personal information, expertise areas), including his or her own vision of the knowledge to present. For instance, he or she could insert knowledge, review and update it.; c) KM Module: it contains the knowledge repository. There it is the institutional or academic memory with, among others, "heuristic" knowledge. Examples are: the best practices (BP), lessons learned (LL), frequent (FAQ) and not frequent (NFAQ) questions and the yellow pages (YP); and d) Supervisor process: carries out the intelligent tutoring.

Formally, the KM module will contain: a) "heuristic" knowledge (HK): it represents learned lessons, the practical and the heuristic ones; b) "descriptive" knowledge (DK): it is the knowledge with which a situation is described, a concept or an idea; c) "procedural" knowledge (PK): it is the knowledge required to take an action, procedure or process ahead; and d) "anecdotal" knowledge (AK): it refers to anecdotes, histories and stories linked to a knowledge (12).

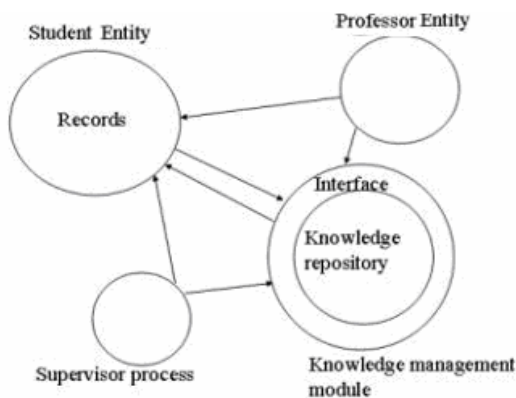


FIGURE 1 - Architecture

The consulting system, which includes the frequent and infrequent questions posed will have automatic cataloguers (9) that allow automatic re-cataloguing, for example, a not frequent question to be considered as frequent according to the quantity of carried out consultations. This assures that the institutional memory is updated. In the system of learned lessons, as well as in that of

better practices, searches by attribute and/or for content (13) will also be allowed.

The format of each component of the module of KM is: Describer-Knowledge-Counter. The describer will be one of the values: BP, LL, FAQ, NFAQ, YP, HK, DK, PK, AK. Knowledge contains the description of the knowledge itself and it also has as attributes the level of required minimum skill and in what medium it is presented (text, video, multimedia, sound, etc.). The counter will keep the number of accesses to the record. With this value the system will be able to reclassify a question or to decide which are the mostly consulted knowledge. For example, at the beginning of a new course, such a re-classifying could be made. This updates knowledge.

Implementation and Experimentation

The model was implemented in Java according to the previous description of the components. A hierarchy of classes was modeled for the knowledge and a class was used for each type of knowledge. Also the teacher and the student were modeled with classes. The developed environment was applied and evaluated in a basic course of Object Oriented Programming for 1st. year students of Systems Engineering at ORT Uruguay University. That course introduces students to programming and the paradigm of object oriented programming. Performance expectations were to identify, explain, and use classes and objects and to develop programs in an object-oriented manner.

The use of the environment is described in the following simplified example. First, the student is furnished with KM and problem solving strategies, which is done through lectures and written material. Then, he or she logs into the system and a list of available topics is displayed, for instance: Classes, Collections. The student, who knows that he or she is lacking knowledge about the topic "Classes", chooses it and a list of available knowledge related with this topic appears; in this case: basic DK (the definition of a class) and basic PK (describing the procedure to define a class). When the student selects "basic descriptive", the definition of class appears and also some other related concepts (for instance, "what is an object") and options (for instance: AK, which presents a history about the concept "class"). Also, the students might include new elements into the institutional memory.

Hypothetically, the environment helps to: a) Understanding teaching: detecting the understanding of a problem situation; b) Search for new ways to solve problems: to identify a problem

situation, conceptualize it, use it as a model and advance towards its solution; and c) Knowledge transfer: the student can solve a given test taking elements of other tests by applying analogies, inferences, deductions, etc.

The independent variable or treatment is the use of the environment. The dependent variables that indicate if the treatment had some effect are: 1) understanding of the problem, 2) ways to solve a problem and 3) knowledge transfer. The three possible cases or groups are: I) Control group; II) Training group and III) Training and environment group. All of the students were randomly distributed in the 3 Groups and the treatment to each group was also randomly assigned. The original sizes of the groups were fixed by the University.

Group I received the usual course, which includes theory and practice classes. Group II received the same course plus theoretical material about KM and problem solving strategies. Each week, at least 15 minutes of a class were dedicated to talk about these topics. Group III had the same course, material and the environment. The implementation was available in class and in a laboratory with Laboratory Assistants and 25 computers from Monday to Friday, 7:30 am to 23:30 pm. Each student of Group III used the environment at least during 20 minutes of a class every week.

Two tests were presented to each student, both with 3 problems. The first test was taken at the beginning of the course, the other at its end. Both tests were graded using ordinal scales. In each test, one question was asked for each variable. The samples were compared with Mann-Whitney and Kruskal-Wallis tests.

Experiments were made in 2002 and in 2003. In 2002, at the beginning of the course, no significant differences were found. At the end, indeed significant differences (significance level = 5%, 10%) were detected in problem solving ways and knowledge transfer between Group III and the other Groups. In 2003, there were no significant differences as to understanding teaching either in the first or in the second evaluation. Significant initial differences in problem solving ways were found (Group III was the worst). At the end, no differences were found in relation to this topic. As to knowledge transfer, no differences were initially found, but at the end, group III showed significant differences.

Also, the difference of marks was calculated for each student and problem. As shown in TABLE I, numbers from 2002 were:

	Understanding teaching	Searching for new ways	Knowledge transfer
I - Control Group (8 students)			
Improved	50.00%	25.00%	37.50%
Stayed equal	25.00%	37.50%	37.50%
Worsened	25.00%	37.50%	25.00%
II - Training Group (19 students)			
Improved	21.10%	47.40%	15.80%
Stayed equal	52.60%	26.30%	47.40%
Worsened	26.30%	26.30%	36.80%
III - Training and Environment (21 students)			
Improved	28.60%	81.00%	38.10%
Stayed equal	52.40%	9.50%	61.90%
Worsened	19.00%	9.50%	0.00%

TABLE I - Experimentation results (2002)

The results for 2003 were, as shown in TABLE II:

	Understanding teaching	Searching for new ways	Knowledge transfer
I - Control Group (12 students)			
Improved	25.00%	25.00%	25.00%
Stayed equal	33.33%	50.00%	41.67%
Worsened	41.67%	25.00%	33.33%
II - Training Group (18 students)			
Improved	22.22%	27.77%	11.11%
Stayed equal	22.22%	55.56%	50.00%
Worsened	55.56%	16.67%	38.89%
III - Training and Environment (21 students)			
Improved	42.86%	57.14%	61.90%
Stayed equal	9.52%	38.09%	28.57%
Worsened	47.62%	4.77%	9.53%

TABLE II - Experimentation results (2003)

In both cases (2002 y 2003), data were also analyzed by grouping low values (0 and 1) and high values (3 and 4). Through those analyses (detailed and grouped), and the results of the Mann-Whitney and Kruskal-Wallis tests it may be inferred that:

- No benefit was detected as to problem understanding in Groups II and III. An interpretation of this unexpected result could be that the necessary activities for problem comprehension (for instance, problem understanding or detection of important elements) are not related to or fostered by the different knowledge types and KM.

- The students of Group III show a remarkable improvement in the number of ways for solving a problem. They can find, apply and show more ways, whatever the initial differences were, undetectable (2002) or found (2003).
- Group III students improve their ability to transfer knowledge and almost none gets worse.

CONCLUSION AND FUTURE WORK

A new LE model, based on the administration of knowledge, has been proposed. It is based on KM because it integrates the information and it allows to renew it. It explores knowledge and manages it actively. It is possible to apply it to any area of knowledge of intellectual content and it is adaptable to different strategies according to the behavior and type of the students' learning.

As a theoretical contribution of this work, a definition for a LE has been offered and the architecture of a LE model, based on KM has been presented. Through experimentation, it may be inferred that the use of the environment allows students to develop more strategies for solving a problem and to perform the transfer of knowledge with better results.

In future work, an automatic and intelligent tutoring based on agents should be included as well as elements that allow cooperative work and direct interaction between students and/or teachers, in order to take social aspects of learning into account.

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