

# Application of some ideas from the axiomatic design principles for construction of a learning management system in Romanian higher engineering education

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**Abstract.** In education, the communication processes are critical. The result of education process depends on a significant manner by the quality of the incurred communication. To enhance learning in higher engineering education, an application of axiomatic design for the construction of a Learning Management System is proposed. The clients of such a system are identified, and their expectations were gathered as well. Functional requirements and design parameters to be designed are compiled regarding the two principles of axiomatic design. Finally, we investigate four design options to select the optimal design solution.

## 1 Introduction

Learning is a complex cognitive process. It can be under study in different extends: individual, group or organizational learners. Learning and teaching are often presented with a certain amount of indistinguishability. Nevertheless, the two are different by their meaning, and a particular relation occurs in between [1-5]. Learning can be under study from a theoretical or an experiential perspective, but the main characteristic - learning is a process - claims the process of learning to be under control. There is a particular granularity involved, aligned with the interested parties classifying the objectives of a higher education organization, and the learning management system concept is introduced as a method to control the related process. Work focus on identifying the needed information, constraints, modules and interfaces to develop an effective Learning Management System (LMS).

The social dimension of learning is well known and accepted [6-7]. The interested parties are the representatives of universities, committees and education beneficiaries [8]. Based on social network theory, the concept of bridge tie creates a beneficial impact [6, 9] by clear and structured information. All interested parties are equally represented.

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## 2 Interested parties

There are multiple interested parties in connection with the LMS benefits. Two major actors are implied: *Society* and *University*, both as *Agentive Social Object* class [10].

The *Society* represents a generalization of the *Student*, *Professor* and *Other* organizations. The *University* got the function of *education*, where *Professor* and *Student* act the specified roles of *Teacher*, *Assessor* and *Learner*. The major actors, *Society* and *University*, both generalize *Professor*, *Student* and *Other* organizations actors. The generalization goes into details with granularity if taking account of part-whole relations. In the case of the *University*, all entities involved are agentive, and the relation is classified by the functions of *education*, *teaching*, *learning* and *assessment*.

For the case of *Society*, the part-whole relation can be agentive to the same extent as for *University*. However, in the present work, it is under study only the metonymy. A member relation type [7] relates the *Professor*, *Student* and *Other* organizations to the *Society*. In the same manner, the *University*, as a metonymic part of *Society*, got the function of *education*, and communication would act between *University* and *Society*, and also, between *Professor*, *Student* and *Other* [8, 11].

### 2.1 Voice of customer

The interested parties play specific roles. The actors have specific requirements they have to fulfil. The *University* having the function of *education* will call the *Professor*, with the function of *teaching* (*Tch*), as the source of knowledge (term knowledge apply here for the tuple of {knowledge, behavior, attitude} [4]) to be transferred to the *Student*. In addition, the *Professor* got the function of *assessment* (*Asm*).

The *Student* deploys the function of *learning* (*Lrn*). The function of *education* is deployed as an aggregation (*Agg*) of *teaching*, *learning* and *assessment*. We have by consequence a knowledge transfer, from *teacher* to *student*, using certain defined channels. The *assessment*, by another hand, is a metrological part (proper part) of *education* (*Edu*) and represents the evaluation of transferred knowledge effectiveness. The *University* assign function of *assessment* to the *Professor* [8].

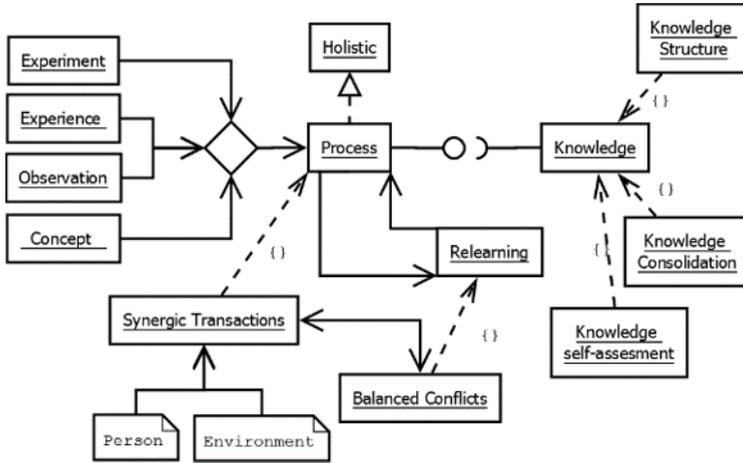
### 2.2 Interaction specificity in teaching-learning environment

Education claims for a communication process across involved actors. Each connection branch has own features supplying a particular identity over specified interface. The communication between teacher and students, composing the *knowledge transfer* function, and between student and teacher forming the *feedback* [12], is here for exemplification.

The communication channels are bidirectional, and there is a two-way relationship between teaching and learning [1]. The process is controlled by the LMS, with the objective of consistency preservation in teaching-learning [1, 11, 13, 14], and to enhance the education environment. The criteria used in this construction are those defined by Entwistle [1], Kolb and Kolb [13], Doignon & Falmagne [14] and Iosif et al. [2].

## 3 Learning process modelling

Learning process model considered for this study, illustrated in figure 1 is based on the Experiential Learning Theory [5], embedding Entwistle [1] and Iosif et al. [2] results as well. Key features to retain here are (i) learning is a holistic process and (ii) relearning is an integral part of learning.



**Fig. 1.** Learning process model.

The learning model reveals the expectations expressed under the form of management of interactions for (i) teacher-to-teacher, (ii) student-to-student and (iii) teacher-to-student [15-17]. Finally, the *University* expectations come regarding the management of dedicated facilities as requested by quality assurance for education [8]. The four sources the information flows from (see figure 1) emphasize the formation of a new knowledge depend on more than one information source, but, on another hand, there is a specific relation across these sources. It is an equilibrium described by ELT [5, 13], under the control of *Professor*, and perceived by *Student*. Depending upon the equilibrium proposed by *Professor* and perceived by *Student*, the later will finally adopt a more conceptual development path, or he/she will become a practitioner focusing on action side. It is obvious that we refer here to knowledge in the tuple of {knowledge, behavior, attitude} (§2.1), but we observe too the equilibrium depicted in figure 1 acts as a regulator for behavior and attitude in the same tuple, as perceived by *Student*.

**3.1 Interested parties**

The axiomatic principles [18] guide the process of LMS design, and the defined goal is to propose an informational structure able to facilitate the fulfilment of interested parties expectations presented in Table 1.

**Table 1.** Professors, students and university expectations.

Interested party	Identification	Expectation
Professor	CR1	Management of interactions (teacher-to-teacher, student-to-student and teacher-to-student)
Student	CR2	Knowledge structure and content
	CR3	Knowledge consolidation
	CR4	Knowledge self-assessment
	CR5	Management of dedicated facility

The definition of *education*, with the meaning:  $x$  is the knowledge for transfer, by teacher  $T$  to student  $A$ . Transferred knowledge effectiveness would be under asses by university  $Y$  as a quantifiable measure of supplied education, which is formalized herein by equation (1).

$$Edu(x, Y) = Agg[Tch(x, T), Lrn(x, A)] \wedge Asm(x, Y) \tag{1}$$

There are two possible perspectives we note in (1): (i) transfer efficiency and (ii) transferred knowledge effectiveness. The implementation of LMS pose both aspects [3, 19].

### 3.2 Customer and Functional Requirements mapped to Design Parameters

Four options were analyzed against the fulfilment rate of functional requirements (FR) by the Design Parameters (DP). These options describe an LMS with different degree of integration and interactivity in relation with named FR.

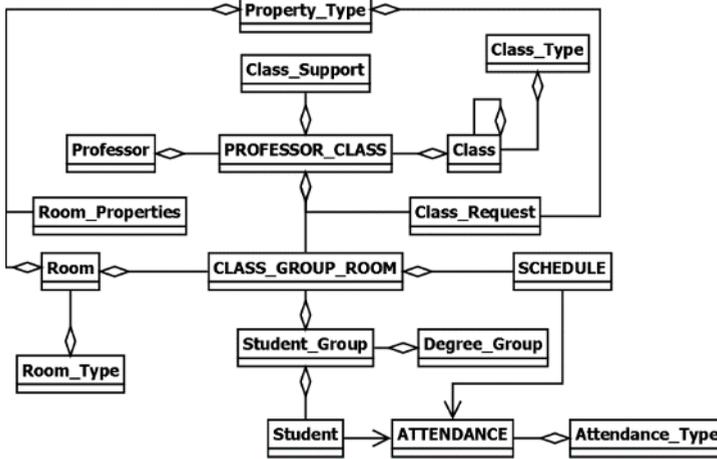


Fig. 2. Learning management system model for option one (baseline).

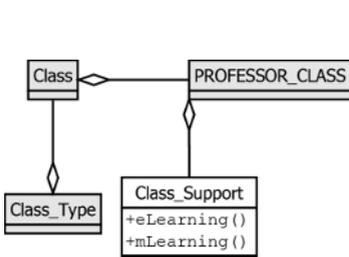


Fig. 3. Enhancing method option two - eLearning

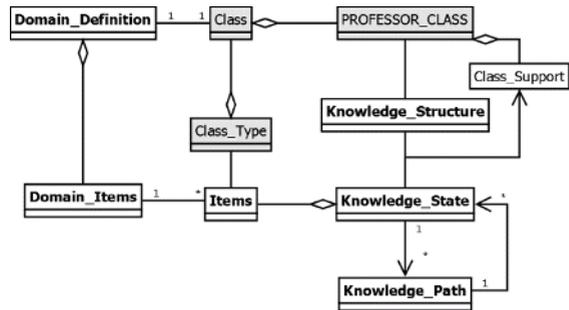


Fig. 4. Enhancing method option three – Knowledge Space

Design option one (see figure 2) focus on the definition of *Professor* and *Student*. Class, classroom, related facilities and their properties are defined in the informational view. By defining a joining entity of class-professor-group, the *University* should be able to manage in a satisfactory manner the available resources and to monitor the *Student* attendance (the efficiency and effectiveness of it) to specified class activities.

Option one supplies the necessary management level and is currently applied in higher education. The knowledge transfer from *Professor* to the *Student* is based on the *Professor* charge. Supplying of electronic data (class support information) to students is present, but is constraint by the in charge professor depending upon this information is made available.

Design option two (see figure 3) enlarge the option one above and introduces the technology of eLearning and mLearning. Knowledge transfer to student preserves the features shown by option one, but enter the mobile availability of information transfer by student request, improving the relearning as an integral part of the process.

Design option three (see figure 4) implements the concept of knowledge space (KS). The knowledge structure becomes part of the curricula. By applying the concept, the knowledge scope and utility apply also, helping the students to get a better understanding over the specified curricula. The knowledge path gets an extensional definition, adding a proper contribution to the degree the student master the transferred knowledge.

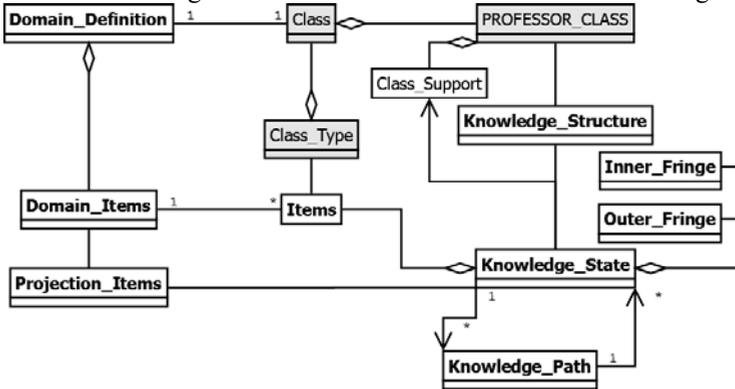


Fig. 5. Enhancing method option four – Learning Space

Design option four (see figure 5) implements the concept of learning space. It offers benefits of accuracy in the definition of how the knowledge is related one to another within the same knowledge domain. The design option four has the most interactive features among all considered designs, supplying not only the knowledge transfer but curricula understanding as well. It brings the benefits of knowledge space concept by an improved knowledge structure.

One particular challenge occurs in the implementation of option four. There should be a mechanism in place to capture the student's feedback, to evaluate it, and later, *Professor* to apply these observations into practice, thus creating a new and improved learning experience. Inner and outer fringe can develop such a mechanism but it is outside of present scope (see figure 5).

The calculus summary and formulae for information content are presented in detail on [20].

## 4 Conclusion

One particular aspect we should highlight against the optimal design solution. The particularity of the options proposed above is that each of them is based on the previous model. By considering each option being a knowledge state, overall, the four options come in respect with the KS.

By the particularity noted above, the university can decide progressively on the design option to implement. This strategy will allow the *University*, *Professor*, *Student* and *Other* entities to adapt themselves to the described communication platform requirements. As the integration and interactivity are intensively present, the *University* can progressively create the needed steps to gain proper skills for his members.

The design of an LMS has studied in this paper. The applied methodology for the stated design is complying with the axiomatic principles with the goal of bridge tie

implementation. The customers of the designed system were identified, along with their specific functions and roles, to establish the expectations that each involved actor would pose against the developed LMS.

The identification of customer expectations, related functional requirements and design parameters, conducted to a design proposal with the identified configuration option four as the optimal solution. The optimal solution, as the informational content principle point out based on the expected degree of fulfilment, is proposed as an evolving configuration, by a modular information platform.

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