Application Of Educational Engineering Approaches To The Design Of An Online Cours Unit

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Abstract. Model-Driven Instructional Engineering (IPDM) is an instructional design approach that uses models to help design and develop effective online learning activities using models to represent knowledge, learning content and teaching-learning strategies geared towards the development of transferable skills.

The objective of this paper is to elucidate, by stopping a practical case, the application of model-driven pedagogical engineering to the conception and design of an online course during the Covid 19 pandemic period.

Keywords: Engineering pedagogy, Explicit pedagogy, Guided discovery learning, educational modeling language, e-learning.

1 Introduction

The problem of distance education or e-learning is not limited to the simple availability of technological means, digital resources or training platforms... The teaching strategies and didactic approaches that will be adopted in this mode of "Education and training are no less important, they are now decisive. Distance learning cannot be improvised.

The use of model-driven instructional engineering (IPDM) can help teachers and trainers design effective digital educational content, learning activities, didactic materials, etc. online using models to represent content. , activities, situations, teaching strategies and assessment…

In model-driven pedagogical engineering, the model of the approach or strategy to be adopted in teaching-learning or training is put forward in any design of content or technological supports. In addition, it is the model of the pedagogical approach that must guide all reflections on the analysis of learning needs, the choice of teaching methods and materials, the design and use of digital learning resources, support or assessment.

The objective of this paper is to elucidate how to rely on IPDM to design a didactic unit or learning activities in the context of a mixed teaching approach: Explicit teaching and learning by guided discovery.

2 The Blended Approach Model: Explicit Teaching and Remote Guided Discovery Learning

The explicit teaching approach is a structured and systematic approach to teaching that involves clearly and explicitly defining learning objectives, breaking down complex skills into smaller, more manageable pieces, and providing a direct and explicit instruction to teach these skills. Over the years this approach has been the subject of several studies which have shown its very positive impact on the acquisition of knowledge and skills in all disciplines and all levels of education and more recently, Savage & al (2021) ; Hwang & al (2021), Chen & Lee (2021) among others.

M. Khaldi et al. (eds.), *Proceedings of the E-Learning and Smart Engineering Systems (ELSES 2023)*, Atlantis Highlights in Social Sciences, Education and Humanities 14,
https://doi.org/10.2991/978-94-6463-360-3_17

As for the guided discovery learning approach, it is a pedagogical approach that consists of giving learners the opportunity to explore a subject or problem on their own while being guided by a teacher or facilitator. the first research on its experimentation in practice dates back to the 1960s (Bruner, 1961) ; Aususbel, 1961) . During the 1980s and 1990s, there was a resurgence of interest in guided discovery learning as a teaching approach. Researchers began to explore the effects of different forms of guidance, such as prompting, feedback, and scaffolding, on learning outcomes (Mayer, 2004 ; Kirschner & al, 2006 among others).

Recently, some authors such as Li & al (2020) and Jia & Gao (2020) have shown that the guided discovery approach has a positive impact on the acquisition and retention of knowledge but also on the development of cognitive skills and learners' metacognitive skills. Researchers found that students who participated in guided discovery learning activities performed better on immediate assessments.

Furthermore, the approach that aligns explicit pedagogy and learning is often used in complex fields where structured knowledge and the ability to apply this knowledge in diverse and dynamic situations are important.

Many researches show that the mixed approach explicit teaching - learning by guided discovery, promotes understanding and transfer of knowledge in new situations (Klahr & Nigam, 2004), the learning of complex skills (Merriënboer & al, 2006) or problem solving (Loyens & al, 2012), Huang & Chen , 2016) found that a mixed approach of explicit instruction and guided discovery learning was more effective than either approach alone in teaching mathematical concepts to elementary school students.

Other more recent studies emphasize the importance and effectiveness of the approach that mixes explicit teaching and learning in the acquisition of knowledge and skills in different teaching disciplines such as mathematics (Kirschner & al, 2020; Ruhl & al, 2021), physical sciences (Wang & al, 2021), languages (Mojavezi & Tamjid, 2020).

In relation to the adoption of the mixed approach, explicit teaching and discovery learning in distance education, Smith & al (2022) and Wang & al (2021) have highlighted the impact of the use of blended approach to improving student learning, respectively, in mathematics and physical science online. Rittle-Johnson & al (2020) then Liu & Kang (2021), meanwhile, show that the mixed approach promotes student motivation and engagement.

By way of synthesis, the mixed approach of explicit teaching and learning by guided discovery proves to be very effective on the structured acquisition of academic knowledge, the development of skills and problem-solving skills; It also makes it possible to actively engage learners in the process of their learning..

3 Modeling E-Learning Activities Based On The Blended Approach:

A mixed face-to-face or more particularly remote approach means that the teacher must deeply analyze the learning needs of these students, anticipate the various difficulties that may arise or block learning, provide the necessary feedback, to design the relevant didactic materials and to design autonomous learning activities, making it possible to facilitate learning among these pupils and at the same time allowing them to develop transferable capacities and skills. In distance mode, explicit teaching is synonymous with the explicit quality of the designed learning activity. From now on, such a practice calls upon pedagogical engineering and its design models.

Modeling pedagogical language (MPL) is used precisely to design, implement, and describe coherent learning scenarios. Typically, this involves modeling learning activities.

The learning scenario represents the description, carried out a priori or a posteriori, of the progress of a learning situation aimed at the appropriation of a specific set of knowledge, by specifying the roles, activities and manipulation resources.

There are several tools for modeling a pedagogical scenario. Some of these tools are inspired by software engineering. We will use - in the context of our teaching approach - learning coupling explicit teaching and learning by guided discovery - the structure diagram (SD), the activity diagram (AD) to structure the learning activity and the Vee (V) diagram to structure the learning situation or resources.

The structure diagram: the scripting of the didactic unit :

The structure diagram is a development tool used to model the different parts of a system from previewing how the different parts interact to create the whole, to modeling the details of the small parts themselves.

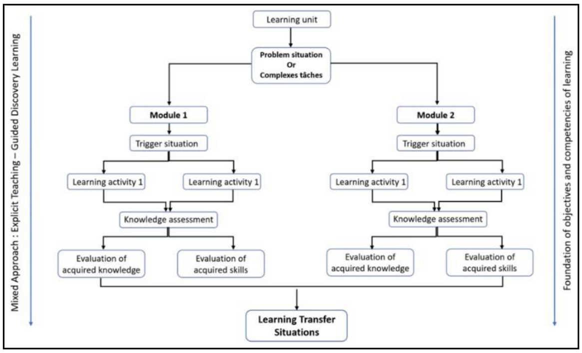
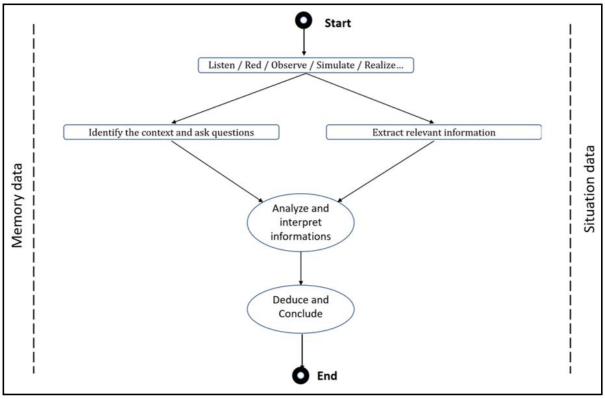


Fig. 1. Diagram of the pedagogical structure of a learning unit.

The structure diagram visualizes the operation of a system, from initial input to processing and, finally, to the desired output. It is particularly useful in determining all the interfaces involved between the different parts and helps designers to agree on how each part should be connected based on the models shown on the structure diagram.

In pedagogy, the SD structure diagram, in accordance with the tendencies of an explicit pedagogy, can be used to represent or model the structuring of lessons around the didactic unit (fig. 1).

The activity diagram: Scripting an online learning activity using the blended approach. In the field of software engineering, activity diagrams make it possible to focus on processing. They are therefore particularly suitable for modeling the routing of control flows and data flows. They thus make it possible to graphically represent the behavior of a method or the progress of a use case.



The similarity with the field of pedagogy is that the learner in a learning situation, in a cognitivist context, is always put in a situation to process data from the situation itself, from his memory and from the process of processing these different data.

The use of an activity diagram can help the designer, the trainer or the teacher to foresee the different processes that will be brought into play when the learner confronts the learning situation, and anticipate the difficulties that may arise.

The use of an activity diagram to script a learning activity will make it possible to specify the different transformations and interactions between the two blocks of information, that of the long-term memory and that of the situation or resource learning. **Fig. 2.**shows one way to use the activity diagram to model the learning scenario in a mixed explicit teaching – guided discovery approach. A practical example is presented in the appendix.

4 Modeling The Learning Resource In The Context Of The Mixed Approach: The Use Of The Vee (V) Diagram.

In the case of distance education, more particularly in e-learning mode, the learning situation, whether autonomous or directed by a tutor (teacher), is now central and decisive. from an explicit/guided discovery perspective. Its design and implementation require a precise analysis of its relevance in relation to the objectives and the skills to be developed, the precision of the nature and types of knowledge likely to be generated, and the learning tasks to be transmitted.

The Vee diagram, also known as the Vee model, is a structured approach used in engineering and project management to help guide the development process. It is also used in teaching to help students understand the connections between learning objectives, design of the learning experience, and assessment of student learning. Studies relating to the use of the Vee diagram in education are numerous (Akay & Bozkurt, 2017; Kurniasih & Irpan, 2019).

Recent studies have shown the effectiveness of using the Vee diagram in planning the teaching of scientific disciplines such as mathematics (Chen & Chiang, 2020) or chemistry (Hanson & Overton, 2021 ; Gaddis & al, 2021 ; Cooper & al, 2021), physics (Ekwunife-Orakwue & Okere, 2021) or geology (Linneman & al, 2019)

Novak and Gowin in 1984 and Alvarez in 2005 made it known that the Vee diagram works on the "think" and "do" principle. We start by drawing a big "V", we place on the left, the conceptual knowledge or the pre-acquired knowledge of the learners to put in place vis-à-vis the learning situation in question, on the right we write the data of the situation and what the learner must do to achieve the objective or to answer the main question, located elsewhere at the bottom of the diagram. The achievement of the objective or the answer to the key question results from the interaction and the interrelation between what the learner must restore from his memory and the data of the learning situation. The figures below represent respectively the upstream modeling of the didactic learning situation which aims to discover the expression of electrical energy, using the V diagram (fig 3), and its pedagogical design in the explicit mixed pedagogical context - by guided discovery.

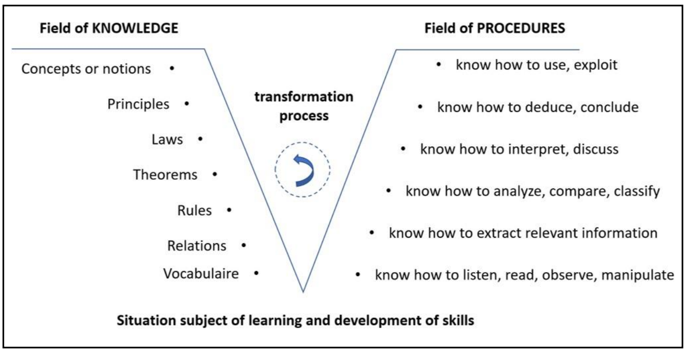


Fig. 3. Situation subject of learning and development of skills

5 Conclusion

Model-driven pedagogical engineering is of great use to a designer of e-learning resources and materials. Modeling languages (ML) inspired by software engineering can be adapted to pedagogy to represent different pedagogical and didactic processes: the design of training programs, the structuring of a didactic unit or a lesson or a learning activity. They are also used to analyze teaching and learning content.

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7 Appendix

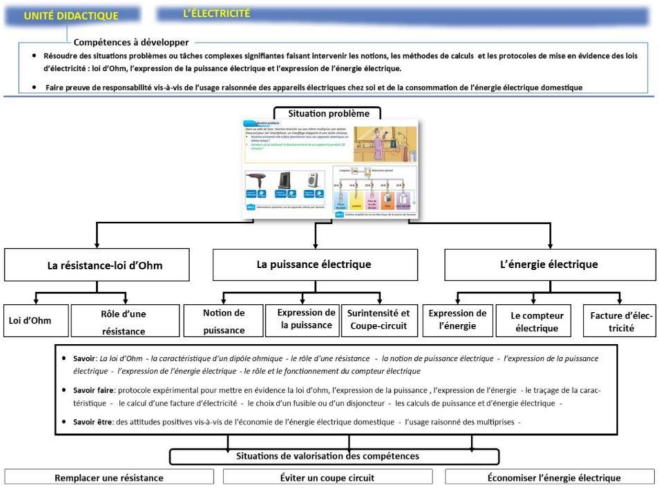

Fig. 4. Structured dicatic unit

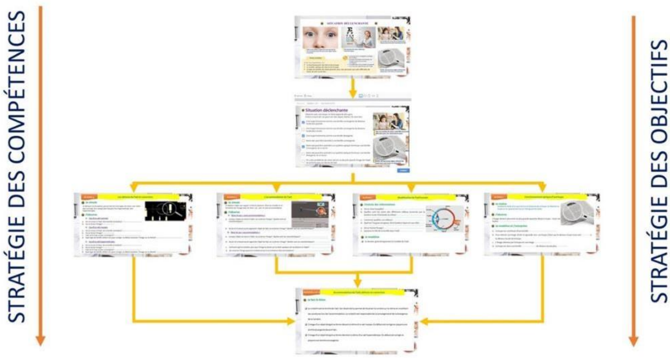

Fig. 5. Structured lesson

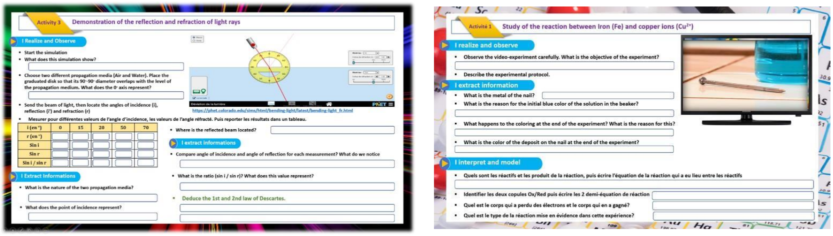

Fig. 6. Structured activity