International Journal of Computer Trends and Technology
ISSN: 2231 – 2803 / https://doi.org/10.14445/22312803/IJCTT-V69I6P101

Volume 69 Issue 6, 1-6, June 2021

Original Article

Integration of Pedagogical Videos as Learning Object in an Adaptive Educational Hypermedia Systems According to the Learner Profile

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Received Date: 30 April 2021
Revised Date: 02 June 2021
Accepted Date: 07 June 2021

Abstract *- The integration of learning objects in adaptive hypermedia systems brings several benefits on an effective adaptation of the content for the learner such as flexibility, accessibility, increased exchanges and interactions. The combination between adaptive hypermedia and pedagogical activities is a fundamental element for the integration and adaptation of Information and Communication Technologies (ICT) in Education and learning objects in learning. In our work, we propose an architecture of an adaptive hypermedia learning system that generates pedagogical videos as an adaptive learning object for learners. We propose four scenarios for the activities and similarly for the pedagogical videos, each scenario is in adequacy and is mainly addressed to a learner after having identified his or her learning style and preferred learning mode according to Kolb and Filder-Silverman model.*

Keywords *- Pedagogical videos, Learning objects, Adaptive hypermedia system, Learner profile, Learning style.*

I. INTRODUCTION

The adaptive hypermedia system is the result of the fusion of Hypertext and multimedia techniques, offering a new perspective and advantages in distance learning. Indeed, research on the adaptive hypermedia system aims to improve the quality of learning. First of all, thanks to the structure of non-linear hypertexts which help the learner to build his knowledge. In addition, thanks to the integration of multimedia that improves and promotes the visual and playful aspect of the learner.

The term "multimedia" refers to a set of communication media such as the press, books, audio and audiovisual recordings such as pedagogical videos which is considered to be one of the most important learning objects. However, learners then have access to the same object in hypermedia without taking into account differences in level, knowledge, interests, motivation and objectives. This requires an understanding of the relationships between pedagogical videos and pedagogical activities in order to have an adaptation focused on the needs of the learner.

In this work, we propose an architecture of an adaptive learning hypermedia system that allows a better distribution of pedagogical videos as an example of a learning object in a pedagogical activity. This architecture will allow us to maximize the satisfaction, comprehension, speed and learning performance of each learner profile.

II. GENERAL CONTEXT

In this article, we focus our work on two essential points. The first concerns the definition of the Learning objects concept and the second concerns the learner profile.

A. Learning objects

According to the IEEE LTSC11 group in 2002, Learning objects are defined as "any entity, digital or not, that can be used for teaching or learning" [1].
In 2004, Strijker proposed a rather similar definition, it is “digital entities, usable and reusable in different educational situations” and in fact excludes non-digital entities such as library books [2].

From these definitions, it is clear that a learning object is a digital or non-digital entity, which can be used, reused or referenced during learning with the technological teaching support. This can be through computers, interactive learning environments, distance learning devices or collaborative learning environments. These objects are developed by teachers based on the content of their courses to be integrated into a pedagogical activity, a face-to-face or distance training session, etc.

There are three main classes of learning objects:

- The Learning Units allow to structure and organize the training in a space and in time
- The Pedagogical Activities define the exact modalities of acquisition, confirmation or transmission of one or more knowledge
- The Pedagogical Resources, physical or digital, necessary to the realization of the activities.

Through this observation, our work focuses on two pedagogical objects: the hypermedia system and pedagogical videos.

a) Hypermedia System

According to Brusilovsky adaptive hypermedia is: " Any hypertext or hypermedia system that reflects certain aspects of the user in the user's model, and uses that model to adapt different visible aspects of the system " (Brusilovsky, 1996). This is an area of research at the intersection of hypertext (hypermedia) and user modeling [3]. The aim of these systems is to adapt the presentation of knowledge and to help the learner to navigate in hyperspace [4].

Unlike "classic" hypermedia systems which offer the same pages and the same set of links to all users [5] This is true even for most applications which are built on systems capable of presenting different views to different users [3].

The architecture of adaptive hypermedia in general is based on two models (domain and user) [6] . In adaptive learning hypermedia, the user model is replaced by the term “Learner Model”.

1) Domain Model

The domain model is used to define the hypertext structure of the system. It is defined by experts in a particular domain, this is the main component of the adaptive hypermedia system that allows the system to know the appropriate content that will be presented to the user.

2) User (Learner) Model

A user model is a representation of information about a particular user [7]. In other words, which is essential for an adaptive system to provide adaptive effects and identify different users [8]. In the adaptive learning system, the term "Learner Model" replaces the user model to designate the representation and general modeling of information about each learner in a given context.

For a learning system to be “intelligent”, it must be able to adapt to the learner in front of the machine. This can only be achieved by knowing the learner model [9]. All of the knowledge will help to define the characteristics of the learners so that it will be easier to adapt the contents according to their learning profiles, to monitor their progress, to provide an adapted administrative and cognitive support, etc.

This model is composed of two sub-models: The first model is epistemic (cognitive) and its objective is to determine and evaluate the state of knowledge of the learner on the representations of the domain model. According to Brusilovsky, learning systems use three types of learner state of knowledge [6]:

- Binary, that means the learner can be familiar with the concept presented or the opposite.
- Discreet, by determining the different categories of learners according to their levels (for example: novice, intermediate or expert).
- Continue (values belong to an interval).

The second model is rarely used, it is the behavioral model, here the learner profile must integrate preferences, this will allow the learner to specify the way of presenting the content of the course and in particular its organization, the quality of the learning objects used or its pedagogical objectives that will determine the learning context.

b) Pedagogical videos

Pedagogical videos are an auditory and visual combination to present in a clear and structured way concepts often considered complex and abstract by learners, they are one of progressively integrated into face-to-face or distance courses such as online training, hybrid training, MOOCS, SPOOCS or flipped classes, whether for young children or for adults.

The pedagogical video helps the learner to memorize, learn and strengthen the understanding and acquisition of knowledge. It can be the basis of many pedagogical activities and also a learning and communication support for the purpose of transferring knowledge, visualizing a process or even analyzing a learning situation in various formats:

- Cartoons or animated videos for the youngest (for example stories) This type of video can anchor in the learner a broader vision thanks to the animated image, he will remember the events of the story better and will relate more to the content. It is a motivating and fun support that is appreciated by learners.
- Real-life videos (for example, videos of road situations with multiple choice questions to learn the highway code or videos that serve to illustrate the most common concepts and experiences in a subject)
- SCREENCAST videos (this is a technique that allows you to shoot a computer screen directly).
- VR (Virtual Reality) videos allow software simulation of the real and physical presence of users in an artificially generated environment.
- Interactive videos increase the rate of engagement and memorization in the learner, it offers them a more personalized experience and stimulates their curiosity

B. The learner profile

The learner profile is the most important component in an adaptive hypermedia system, due to its ability to represent the characteristics of each learner such as: personal information, level of knowledge, preferences and learning styles.

All people are different. Each individual sees and perceives learning and their knowledge differently. The learning style is a way for each learner to absorb, process, understand, retain and focus on information.

Learning styles are defined as "a set of cognitive, affective and physiological factors that characterize individuals and which serve as relatively stable indicators of how a learner perceives, interacts, reacts and responds in a learning environment. " [10].

This is a predisposition in some students to adopt a particular learning strategy, regardless of the specific requirements of the learning situation [11]. It is how each learner begins to focus, analyze and understand new information [12].

Stewart and Felicetti consider learning styles to be "the pedagogical conditions in which a student is more likely to learn." Learning styles are not really concerned with what learners learn, but rather how they prefer to learn [13].

a) Kolb Learning Style

In 1984, David Kolb published his model of learning styles which is based on two axes (Discovery and experience).

According to Kolb, "Learning is the process by which knowledge is created through the transformation of experience" [14]. Based on this, Learning is effective when a person progresses through a cycle of four stages: a concrete experience followed by observation and reflection on that experience. This leads to the conceptualization of abstract concepts (analysis), generalization, production of a new idea or modification of an existing abstract concept which are then used for an active experiment (Transfer) allows to test a hypothesis and applies his ideas in future situations, which leads to new experiences [15] .

Learning involves the acquisition of abstract concepts which can be applied flexibly in a variety of situations. In Kolb's theory, new experiences give a certain impetus to the development of new concepts. By the end of the cycle, the student has surpassed a "conscious process involving a new organization or a change of ideas. They manifest themselves in the form of significant changes for the individual in terms of skills, knowledge, values, 'attitudes, habits and ultimately in terms of self-image " [16]. By combining the four adaptation modes two by two, Kolb forms four learning styles according to the phase of the cycle favored by the learner.

b) Silverman and Felder Learning Style

In 1988 Richard Felder and Linda Silverman developed a psychological model inspired by Kolb's model, was formulated in a scientific engineering context and allows

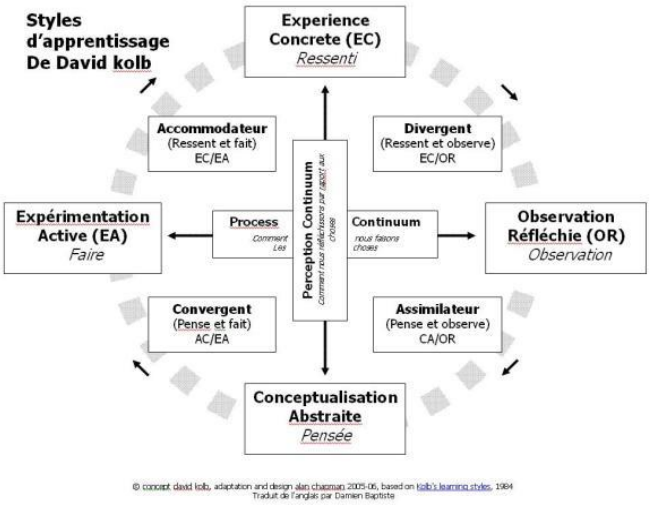

Fig. 1 The four learning styles, according to Kolb (1984)

classifying learners according to the relevant means they use to perceive and process information. According to Felder, learning is a two-part process: receiving information and processing it.

The Felder-Silverman model is based on the idea that the student has preferences in terms of how information is understood (received) and processed. This model classifies individuals according to the following axes [17]:

- Learner participation
- Learners' perception
- The learner's preferred format
- Content presentation

The table below determines the dimensions of each axis and the preference according to each type of learner:

Table 1. Dimensions and preference according to each type of learner

Dimension	Type and preference		Description
Treatment	Active	prefers to work in a team	Determine how you prefer to handle the information.
	Reflective	prefer to work alone	
Perception	Analyzer	concrete, practical, fact-oriented and procedural	The intuitive continuum determines how you prefer to perceive or assimilate information.
	Intuitive	conceptual, innovative, theory oriented	

Contribution	Visual	prefers visual representations with images, diagrams ...	Determine how you prefer the information to be presented.
	Verbal	prefers written or verbal explanations	
Comprehension	Sequential	linear, well ordered	Determine how you prefer to organize yourself and progress in understanding information
	Global	holistic, systematic thinker	

III. PEDAGOGICAL VIDEOS IN ADAPTIVE HYPERMEDIA SYSTEM

The integration of educational videos in the adaptive hypermedia system brings several benefits such as flexibility, accessibility, increased exchanges and interactions between the various actors. To make this idea more explicit, we will use the Technological Pedagogical Content Knowledge (TPACK) model developed by Matthew Koehler and Punya Mishra.

This model was developed on the basis of model Shulman (1986) Pedagogical Content Knowledge (PACK) who is a philosopher and psychologist specializing in the field of education and teacher training. This model involves the impact of disciplinary content and pedagogical knowledge on teaching practices [18] .

The TPACK model (Technological Pedagogical Content and Knowledge) adds a third component which is technology, this combination contains knowledge related at the same time to the disciplinary content (C), pedagogical knowledge (P) and technology (T). As illustrated in the figure below [18]

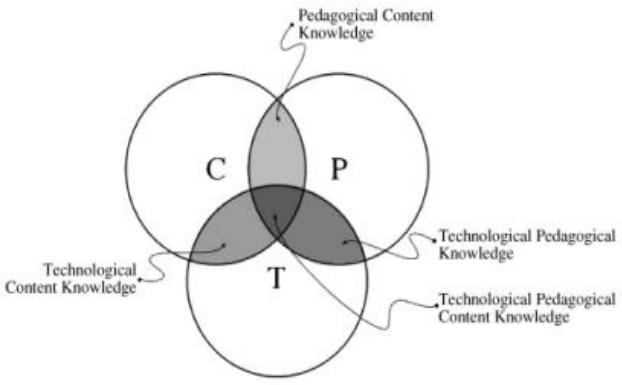

Fig. 2 TPACK model [18]

The difficulty at this level is how to adapt an instructional video to learners according to their learning style and learning mode that will lead to motivation, concentration and better acquisition?

For this adaptation to be effective, it is not enough to use the educational videos randomly, but it will take a real reflection which will make it possible to determine the requirements of the learners and to put in place an adequate strategy to meet these needs.

According to the TPACK model, the integration of an instructional video is based on a balanced combination of video, content and pedagogy to develop appropriate strategies and context-specific representations in order to adapt to each learning style.

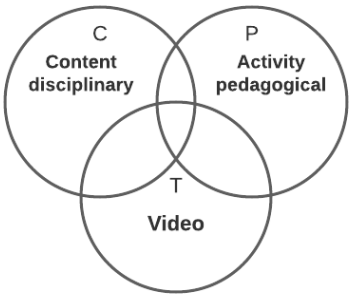

Fig. 3 The integration of the pedagogical video in a TPACK model

In the TPACK model, Content corresponds to what should be taught, Pedagogy corresponds to “how to teach = Pedagogical activity” and Technology corresponds to “with what to teach = Video”.

It is then a question of finding a balance in an adaptive hypermedia system which leads, consequently, to construct and reconstruct the relations between the three elements, any modification of one of the aspects causing an imbalance which must be compensated by changes in the other.

For this, it is necessary to set up a scenario for pedagogical videos. The latter presents an approach and a strategy for a real scenarization and mediatization of the content of the videos in a pedagogical activity which is defined as a situation created by a teacher and proposed to the learner in order to attain pedagogical objectives and the acquisition of general or specific competences related to one or more domains of life according to the modalities and specifications of the curriculum.

We are based on the four pedagogical activities proposed by Khaldi and his collaborators in their article entitled "The pedagogical scenario architecture of a Learning situation", (Situational activity, Structuring activity, Objectification activity and Transfer activity) [19]. In order

to have a system that presents the different concepts in different ways in order to find the best possible presentation for each learner profile.

Based on these activities, we defined four scenarios of pedagogical videos, each scenario is mainly addressed to a learner after having identified his learning style and preferred learning mode according to the Kolb and Felder-Silverman model. The system determines through these activities the type of instructional videos suitable for a learner profile.

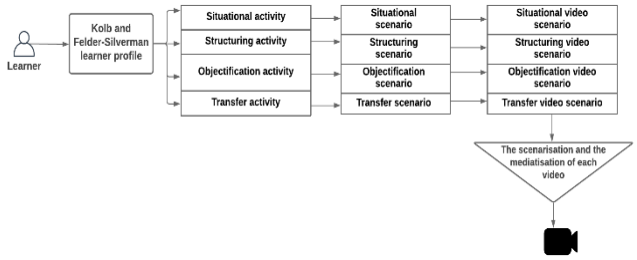

Fig. 4 The division of pedagogical activities during a learning sequence

The division of pedagogical activities during a learning sequence corresponds to the generation of hypermedia pages appropriate for each learner profile. The system associates each learner with a pedagogical activity according to the style and mode of learning proposed by Kolb and Felder-Silverman

In the situational activity: First of all, the system proposes a situational scenario that focuses on the definition of objectives (general, specific, intermediate) and also skills (disciplinary, transversal) and prerequisites (prior knowledge). In addition, for the integration of pedagogical videos, the system proposes a situational scenario that focuses on learning objects and in particular pedagogical video in order to bring the learner to watch a video introducing the objectives, the competences and the prerequisites to contextualize what will be presented in the following and to give meaning by arousing the learner's questioning (feedback)

Structuring activity: The system proposes a scenario concerning the structuring of specific knowledge by proposing learning activities related to structuring and experimentation. The objective of these activities is to promote the construction of specific knowledge and its use in the development of skills in the learner who chooses the approach for the construction of this knowledge (deductive approach, inductive approach). The system proposes a scenario of the structural video presented in a different way according to the learner's profile. This type of video leads the learner to perform his or her own analysis of the video's content (problems, phenomena, situations, etc.). The structuring activity is based on a single video or a series of videos (as part of the inductive or deductive approach).

Objectivation activity: The scenario proposed by the system in this activity allows to gather and generalize the results obtained during the structuring activity. The system proposes an objectivation video scenario that pushes the learner to make a judgment on the content of the viewed video. This judgment can be made through predetermined criteria provided by the teacher in the structuring activity, on the basis of which the learner will position himself, or he will formulate a personal opinion deduced from what he has learned in the previous activity.

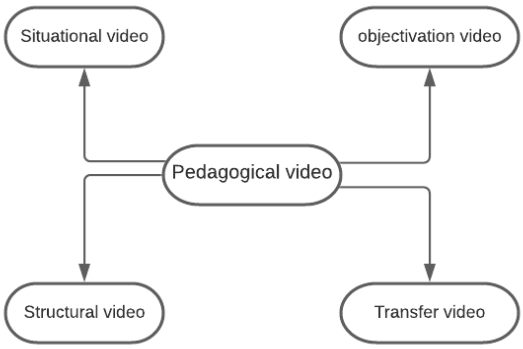

Fig. 5 Typology of pedagogical videos

Transfer activity: the system proposes a scenario that focuses on the transfer and reinvestment of the knowledge and skills covered. To promote the learner's learning in this activity, the system proposes a scenario of the transformation video with the aim of reinforcing, consolidating and fixing each learner's knowledge. At the same time, the system serves to remediate the learners' knowledge to overcome certain learning difficulties by promoting on the one hand the construction of links and the adaptation of learning in real situations, on the other hand by proposing more complex challenges to faster learners.

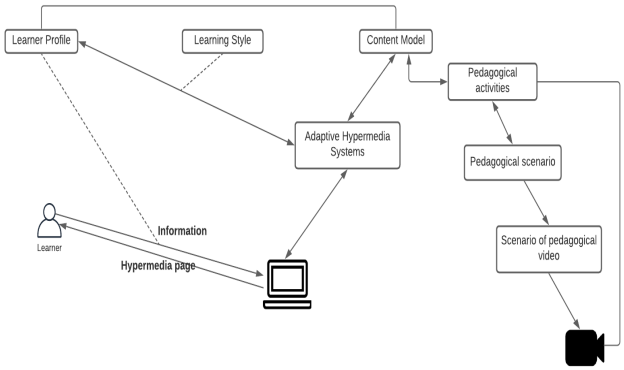

Fig. 6 Architecture of an adaptive hypermedia learning system integrates pedagogical video

In the end, the typology that we propose is modeled as follows

Finally, from what we have seen previously, the figure below shows our proposal for an architecture making it possible to adapt the educational video as an educational object in an adaptive hypermedia learning system.

As shown in the figure, the architecture of our system proposal is derived from Brusilovsky's standard dynamic adaptive hypermedia architecture

At this level, we will add to the domain model pedagogical activities that allow the system to adapt dynamically the scenario (pedagogical and pedagogical video) according to the learner profile (learning style and mode).

The following paragraph will highlight the components of the figure presented above.

- The learner model guides us to identify the learner profile through his or her learning style according to the Kolb and Silverman - Richard model.
- The domain model helps us determine the content that will be teached through pedagogical activities corresponding to each learner profile.
  - For a better adaptation, in the domain model the system proposes pedagogical scenarios according to the learner profile.
  - The system will try to integrate the best pedagogical video for each pedagogical activity based on a balanced combination of the TPACK model.
  - To do this, it will propose a scenario for each type of educational video.
  - Each type of video corresponds to a learner profile.
- The adaptive hypermedia learning system will generate an adaptive hypermedia page according to the domain model and the learner model for a better representation of information.

IV. CONCLUSION

Artificial intelligence technologies have advanced the learning paths of e-learning systems. They have contributed to the development of the notion of adaptive learning, which is a vast field of study. The learning object is a very important element that can contribute to the success of adaptive learning. Our work focuses on two main learning objects: the hypermedia system and pedagogical videos.
In this article, we have proposed an architecture of an adaptive hypermedia learning system centered on learning styles.

We have also given importance to the integration of pedagogical videos in the learning activities. According to the learner profile, based on the four types of activities (Situational activity, Structuring activity, Objectification activity and Transfer activity) and the appropriate pedagogical scenarios with the learning styles of the learners according to the studies carried out by Kolb and Felder - Silverman

As a perspective, we intend to experiment with this architecture in the context of adaptive E-learning platform.

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