ISSN 2278-3091
Volume 8, No.4, July – August 2019
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse70842019.pdf
https://doi.org/10.30534/ijatcse/2019/70842019

Proposal of a complete model and architecture of an intelligent adaptive hypermedia

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ABSTRACT

This article is part of our work on the development of adaptive hypermedia systems. these systems have a minimal architecture composed of three models that we have already studied, developed and proposed in different papers. As the goal of our research is the development of our adaptive hypermedia system, we must first interconnect and merge these three models into one single model, and then design a global architecture describing all its processes, engines and technical implementation preferences.

So in this article, we will start by interconnecting and merging all the three fundamental models. Then we will present our proposed global architecture. And finally, we will discuss all the basic processes and engines necessary for the functioning of our adaptive hypermedia system.

Key words : Adaptive hypermedia system; domain model; adaptation model; learner model; E-learning, Munich; AHAM; CMI5; Experience API, SCORM; Learning management system.

1. INTRODUCTION

Adaptive hypermedia system is a hot topic in the crossroads of intelligent systems that emerged with the third era of distance learning, also known as E-learning.
These systems were invented in response to the shortcoming of the traditional E-learning systems and approaches. Such as: learning management system (LMS [1] [2]) and the Massive Open Online Course (MOOC [3]).
These traditional learning systems have two main problems: the first is that they do not follow the progress made in Internet technologies and online social interactions [4], and second they are built around the philosophy of "one design for all" [5] that consist of serving the same content; structured and represented in the same way to all type of learners.
So as a result, the adaptive hypermedia systems were designed with the ability to provide the appropriate learning content and adapt various visible and structural aspects of the system to individual learner's preferences and needs [6].
Given the big interest in this new trend, many reference models such as "ALEM" [7] and "Munich"[8] has been proposed. These models are all built around three fundamental elements.
The first element is the 'learner model'. This model maintains a deep knowledge of each learner, such as: his knowledge, his cognitive abilities, and his historic, his learning style and preferences [9].
The second element is the domain model, which describes how the content of the application is structured [10]. Generally, in terms of mechanisms by which the content knowledge and objectives are related and structured.
Finally, the third and last element is the adaptation model. This model uses both the information provided by the two preceding elements to generate the appropriate learning content in a suitable representation according to the preferences and needs of the learner [11].
In fact, all these three models have been the subjects of our latest researches of which we carefully studied and elaborated many conception proposals for each one of them separately.
Thus, and as a next step of our research, we will propose in this paper the global architecture of the hypermedia adaptive system by first bringing some local modifications concerning each of the three models, and then we will make some adjustments in order to interconnect them. And finally we will present all the background processes and engines required for the operation of our adaptive hypermedia.

2. PREVIOUS WORKS

As mentioned in the introduction, we have already studied and developed several model conception proposals for each of the three fundamental models, which we will briefly introduce in this section while discussing all the modifications and pre-adjustments that we made in order to improve and interconnect them.

2.1 Learner Model

The Learner model is a very promising solution to represent and describe the information about a learner, in the purpose to provide a complete and faithful description of all aspects related to the behavior of the learner in the learning phase [12]. As a real example of the use of this model, when a student accomplishes or finish studying a course, the data in the learner model should be updated to reflect and express the current knowledge of this learner [13].

Our proposed published learner model [14] is based on six facets that represent all the dimensions and learning variables that can either represent the learner or have an impact on the learning process. In the following, we present a brief description of each facet:

1) Personal Information Facet.

This facet represents the learner's personal data. Such as: the name, birthday, gender, localization etc. In general this facet contains static information that doesn't change so often [15].

2) Competency and Knowledge Facet

This facet contains any type of information regarding the knowledge and skills acquired by a learner. Such as: diplomas, certificates, projects, etc.

3) Historic Facet

Historic facet is responsible for logging and reporting any type of actions performed by the learner within the adaptive hypermedia system. This facet is not hard to be implemented. However, the great diversity of actions and the exponentially increasing volume of data are two major predicted problems that we have already discussed and proposed solutions for managing them in our previous published work [14].

4) Learning styles and preferences Facet

In the literature, there are several theories of psychological profiles. These theories describe the learner's psychological characteristics that may have an influence on the learning activities. In our previous work, we chose the Felder-Silverman Learning Style Model (FSLSM) because it combines the majority of existing theories and describes the learning style in many details compared to other theories [16].

5) Cognitive Capacity Facet

This facet describe the level of cognitive abilities of the learners whatever the domain of knowledge to acquire.

In our previous work we were inspired by the referential proposed in the work of the CAFOC of Nantes / CFA of the Pays de la Loire [17].

6) Emotional State Facet

Learners are empathetic creatures that perceive emotions as information comparable to factual data, which makes emotions a valuable additional feature set [18].

Indeed, emotion classification automizes the process of understanding the deep feeling of humans through their scripts, as demanded in various applications, such as: customer feedback, tourist, elearning and human computer interaction[19].

Emotion and its effect on the learning phases will be managed by this facet.

In our proposed work, we took the four-quadrant model of Kort [20] as a reference while adding a third dimension, namely the control dimension, also called dominance [21].

2.2 Domain Model

The domain model describes how the elements (knowledge and concepts) of the course are structured. These elements could be videos, articles, homework, quizzes [22].

In a very brief way, this model describes the mechanisms by which all the content and knowledge are linked and related.

In our published paper [23] we discussed first all the problems and shortcomings of existing reference models such as: Munich [8] and AHAM [24]. And the E-learning technical standards such as: SCORM [25] [26] [27] and CMI5 [28].

Then following the shortcoming of these existing models we proposed a new abstract and independent conception based on our new architecture that we called 'objective oriented architecture'.

2.3 Adaptation Model

The adaptation model represents the mechanism responsible to adapt content, adapt links and adapt the representation and structure of the content to be delivered to the learner.

We present in the following a brief description of each one of these adaptation techniques:

- Adaptation of the links: allows either to restrict the possibilities of navigation in the hypermedia or to propose to the learner new links of concepts.

- Adaptation of the content: adjust the content of the pages by providing the most appropriate content to the learner.

- Adaptation of the structure: allows displaying the same page in several structures and different forms.

- Adaptation of the presentation: allows displaying the same content of the page in different customized styles (size text, color and font.)

For its proper functioning, this model needs in addition of its own information, a set of data regarding the learner and the course content.

And like the other models mentioned above, we have already studied and published our own adaptation model proposal [29], which we have developed in response to several problems and shortcomings of existing models, and also by proving its ability to be implemented that we illustrated in several screenshots of our developed web application.

3. OUR PROPOSITIONS

In this section, we will start by presenting our proposed conception of the three models, linked and adjusted in one single UML2 class diagram –figure 1-. And in order to make it visible and readable, we used different colors to differentiate the different models, facets and their components.

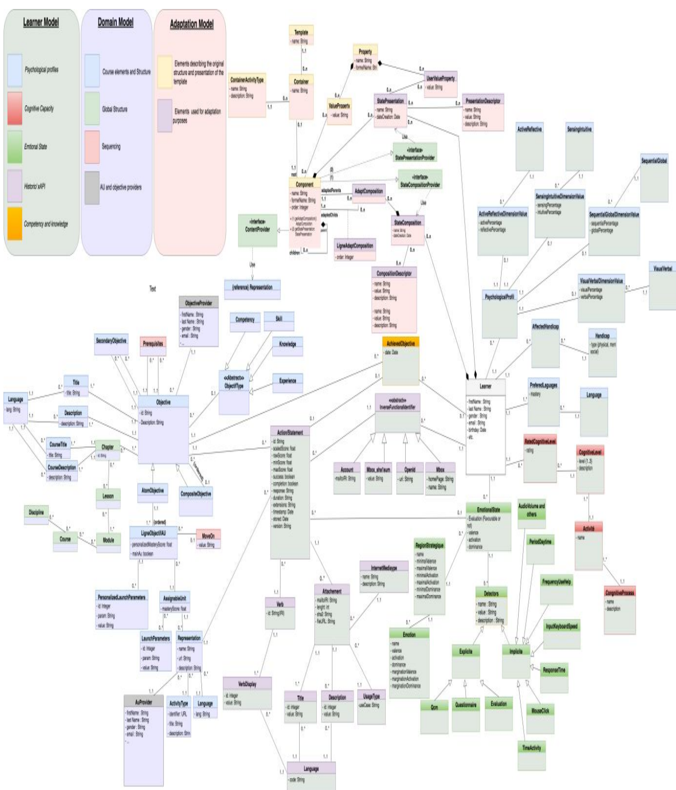

Figure 1: UML class diagram of the three fundamental models for adaptive hypermedia systems

In the following sub-sections, we will discuss and explain all the modifications and adjustments that we made in order to improve and interconnect the three models.

3.1 Historic Facet of the Learner Model

As cited before, our proposed learner model had a facet named historic where we record and track all types of learning experiences. This has been implemented in our previous work [14] on a really basic way where we stored all the transactions made by this learner in a several Insert/delete/update/select statements.

The problem and shortcoming of this proposition was the lack of semantic and interoperability with other systems, where there is no system that can use our historic data stored.

So, and as mentioned in our previous work, the Experience API (xAPI) [30] and its use case 'CMI5' [28] will always be for us the source of inspiration because they represent a very promising specification that allows online learning software to record and track all types of learning experiences.

Following our intention to fully support those specifications, we have already in a previous work [23] implemented the course structure described on these two specifications on our proposed domain model. And we intend in this paper to introduce the 'xAPI Statement Data Model' which is the main part of this specification that describe the structure and properties of the statement (historic) for any sort of learner experiences and events.

In short, the xAPI statement data model is in the form of: "Actor + Verb + Activity + Additional Properties". And It is only by using this structure (Figure 2) that we can already feel the extensibility and the open world of this specification. Hence the need to put some rules back on top of it and personalize it to make suitable for our particular use case.

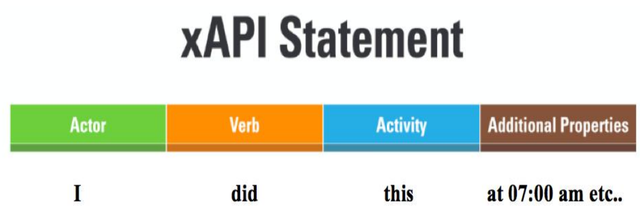

Figure 2: Structure of the xAPI Statement

So, since we are going to manage this information with an object-oriented architecture and then store it in a relational database, we didn't study all the xAPI specifications. We have focused our studies only on the section related to all what is structural information and properties of the xAPI statement.

In the following table (Table 1), we will present the details of the main properties of the xAPI statement that we chose to implement by explaining all the adjustments we have made in order to adapt them to our use case.

TABLE I. DESCRIPTION AND ADJUSTMENT OF THE MAIN PROPERTIES OF THE XAPI STATEMENT

xAPI Properties	Descriptions	Adjustments	Classes
Actor	Whom the Statement is about, as an Agent or Group Object.	The actor can only be an Agent, which is the learner itself on our case.	Learner
Verb	Action taken by the Actor.		Verb ,VerbDisplay, Language

Object	The Object defines the thing that was acted on. It can be an Activity, Agent/Group, Sub-Statement, or Statement Reference.	The object can only be an Activity (chapter, exercise, quiz…)	Representation
Result	Details representing a measured outcome of an activity (Object).		Properties under the Action / Statement Class
Inverse Functional Identifier (IFI)	Value of an Agent or Identified Group that is guaranteed to only ever refer to that Agent or Identified Group.	Each learner (Actor) can have several values of the IFI but in different formats (mbox, account ...) and use one of them to identify him on an activity	InverseFunctional Identifier and its children (inheritors)
Timestamp	Timestamp of when the events described within this Statement occurred. Set by the LRS if not provided.		Properties under the Action/Statement Class
Stored	Timestamp of when this Statement was recorded.		Properties under the Action/Statement Class
Attachments	It could be an essay, a video or an image of a certificate that was granted as a result of an experience.		Attachment, Title, Description, UsageType, Language

As shown in Table 1, the 'Object' property of xAPI will refers to an activity. In the context of adaptive hypermedia, the term activity refers to the learning content that resides in the domain model and precisely it refers to the real representation of this content.

Also we thought about assigning to each xAPI statement the recorded emotional state and the associated learning objective of the learner. These information will be added to the competency and knowledge facets based on the results at the end of the activity of the learner. This has been implemented in our global model by a direct relationship between these different elements.

In short, we wanted to collect all the information we could have about the learner's activities as well as all his objectives, goals and achievements. In Figure 3, we show an example of how the information will be carried on the different models.

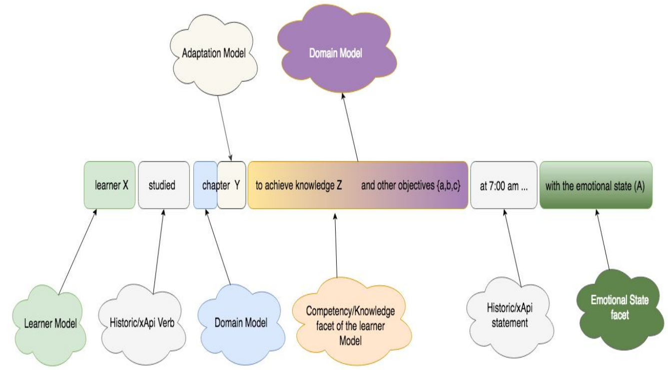

Figure 3: Example of how the learner activity will be stored by our proposed model

Finally, there is other information that the xAPI statement can report, such as language and other preferences etc. but we have chosen not to introduce them into the historic facet of the learner model because it has been already introduced on our proposed models on different facets such as -Emotional state facet-.

3.2 Competency and Knowledge elements

Defining and modeling the learner's knowledge and his competencies has been the focus of our previous work where we have chosen the competency-based approach to introduce it on our learner model.

Unfortunately, over time and with the progress of our research and work on the domain model, we have noticed some problems and criticisms regarding how we designed it.

Indeed, by using and differentiating several elements that seem similar such as skills, competency, performance, etc., the level of complexity increases and requires more management of the data and also the development of several processes.

Also, we believe that it's not appropriate to maintain the real information about the knowledge and competency of the learner on its model itself (learner model). This information belongs to the domain model; it’s there where we invented a new architecture that we called "Objective Oriented Structure" that consists of making the learning objective the main element around which the knowledge and contents of the course are built.

So, in response to these reflections, we extended our 'objective oriented' architecture to support the diversities and differences between skill, competency and knowledge while linking them with the learner as achieved objectives and removing all the previous work we have done in this facet.

3.3 Others

In addition to these previous changes, the following is a summary of others adjustments that we made:

- We changed the name of the class 'Page' to 'Container' in the class diagram of the adaptation model. This class will refer to the element that will contain all the graphical components that goes together to present a specific type of activity. Our vision of multi-type presentation support was the main reason of this change. Indeed, we anticipate that our adaptive hypermedia will be in the form of a web service that provides the adequate content to learners, regardless of the type of device used. We also added for each container a type of activity (Class ContainerActivityType) that describes the scope and use of this container (Exercise, course, demonstration ...)
- It was expected that both adaptation and domain models will be connected, but the question were always where and how exactly. In fact, this connection needs to be dynamic and made in real time because the same content extracted from the domain model can be displayed in several forms (provided by the adaptation model) according to the preferences of the learner and vice versa. So, we have delegated this process to a "ContentProvider" interface that will be explained later in this paper to choose the appropriate content and associate it with the component in question.
- On the domain model, we have two elements that continually require providers to feed and manage.

  The first element is the objective. This element represents the main piece in the graph of knowledge constructed by means of the composite patter design [31] (Classes : Objective, AtomObjective, CompositeObjective) where each node (objective) of this graph will be introduced and managed by a provider that specify its type (Skill, knowledge, competency).

  The second element is the physical representation of a learning unit (Video, Image, Text). The reason behind adding providers is because we predict that students may be familiar with content developed or introduced by a certain provider, from which we can exploit it in the context of adaptation.

4. GLOBAL ARCHITECTURE

The above proposition represents the core and the indispensable models for the functioning of the adaptive hypermedia. In figure 4 we will explain the global architecture by going from the storage and data persistence layer to the client side which is the learner device.

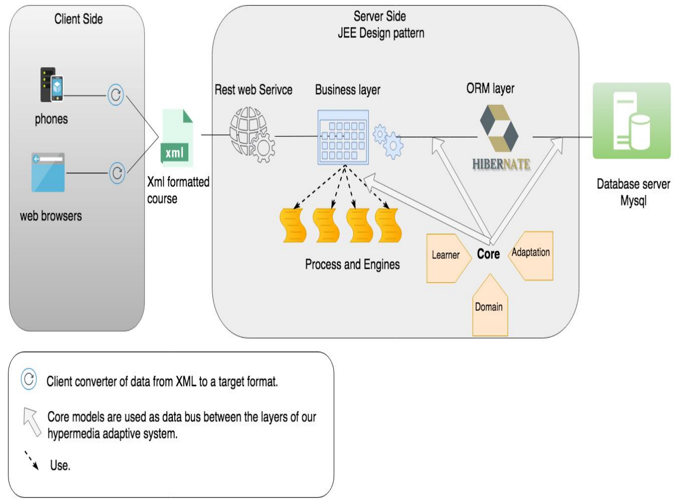

Figure 4: Global Architecture of our Adaptive Hypermedia System

4.1 Storage and Data Source

This layer represents the forms of storage and data resources of the core models (domain model, adaptation model, learner model and intelligent model).

We have distinguished three forms:

- Structured data: this is the raw data of the basic models; we chose the relational model as implementation. NB: we mention that we can migrate at any time to another form of implementation without updating or modifying the other layers.
- Files: represents the physical resources of learning processes such as figures, videos, etc. These files must reside on the same server as the hypermedia adaptive.
- External data: refers to data and files stored outside the adaptive hypermedia server and they are expressed by URLs.

4.2 Adaptive Hypermedia Server

Represents the application server of our adaptive hypermedia system. This side is built following the recommendations of the JEE design pattern. As shown in Figure 4, the server side includes three main layers:

1) *Core Models.*

Represent the data and elements of the core models structured and expressed by UML classes representing the three models (learner, domain and adaptation) and the intelligent model that we proposed in a work previous [32]. These models are used as a data bus between the different layers of the implemented JEE architecture.

2) *Process and Engines.*

This layer contains all the algorithms and processes necessary for the functioning of the adaptive hypermedia system. This layer contains four main processes:

- Collector and detector of emotional state variables: its function is to collect and preserve the environment data and behavior variables of the learner during his learning phase while indicating whether it is favorable or not for the learning activity.

- Content provider: This process is responsible for collecting and constructing appropriate learning content to be delivered to the learner while presenting it in the most suitable format and structure. This process is based on the information provided by the cores models such as: cognitive ability, emotional state, historic, learning style and knowledge. we distinguish four sub-processes:
  - Template and container provider: chooses the right template and the most appropriate container for the learning activity in question.
  - Content structure provider: since each learner has in addition to the default structure of the container, many custom structures. This sub-process must be implemented to choose the most appropriate one.
  - Content presentation provider: this sub-process chooses for each component of the container the most appropriate presentation
  - Content data provider: search for the available and suitable content on the domain model based on the work of the three previous sub-processes.
- Content Builder: Uses the learning content generated by the previous process and express it and transform it into XML format that describes and provides all information about the course content and its structure and presentation rules. The choice of the XML technology will prevent us from worrying about the generation of the course in several formats to support all types of learning device, such as phones, desktop applications, Web applications, etc. All these learner devices will use our formatted XML content to produce their own version of the course while respecting first the content and then the rules of representation and structure expressed by XML.
- Intelligent model supervisor: As we have already explained on our published work [32], our hypermedia system will have two phases for its core: The first phase is that all behaviors information and data are extracted from the three models (learner, adaptation and domain) whereas the intelligent model is simply there observing and learning by defining and connecting the different elements of these three models. So we have planned a process for that. The second phase is when our intelligent model has learned enough and can take control and replace the three core models to be the main model that drives the adaptive hypermedia system, so again we have planned a process to communicate and manage this intelligent model.

4.3 Client Side

This part represents the window with which learners will communicate with the adaptive hypermedia system. By using the XML delivery process, we can support any type of device and technology as long as for each new device and technology we develop a program that will exploit the XML formatted course to reproduce it into the target format.

5. CONCLUSION AND PERSPECTIVES

In this paper, we presented first the UML2 class diagram of the core of adaptive hypermedia systems, which is composed mainly of the three fundamental models, namely: learner model, domain model and adaptation model. Then we discussed all the modifications and adjustments we made in order to interconnect these models. And finally we presented the global architecture of our adaptive hypermedia while detailing all the functionalities of its layers.

So as we get closer to the implementation phase, the time reserved for theoretical research will be less, but that does not preclude the fact that we will continue in parallel the research on similar theories and works. In fact, we are planning in the near future to start developing our adaptive hypermedia while continuing our theoretical researches.

REFERENCES

1. William R. , Sunnie L. W. (2007) . **What are Learning Management Systems, What are They Not, and What Should They Become?**. *TechTrends*, Volume 51, Number 2. https://doi.org/10.1007/s11528-007-0023-y
2. Ramón G. J., Tomas P. (2011) . **The use of learning managements systems: A Longitudinal Case Study.** *ELEED*, issue 8 pp 1-12.
3. Andrew N. , Jennifer W. (2014). **Origins of the Modern MOOC (xMOOC). Center for Benefit?** *Cost Studies of Education, Teachers College, Columbia University, NY*.
4. D. Dagger, A. O'Connor, S. Lawless, E. Walsh , VP. Wade, (2007). **Service-oriented e-learning platforms: From monolithic systems to flexible services**, *IEEE Internet Computing*, Volume: 11, Issue: 3. https://doi.org/10.1109/MIC.2007.70
5. Kaya,G., Altun,A. (2011). **A Learner Model for Learning Object Based Personalized Learning Environments**. *Commun. Comput. Inf. Sci*., vol. 240, pp. 349–355. https://doi.org/10.1007/978-3-642-24731-6_35
6. Brusilovsky, P. (1996). **Methods and techniques of adaptive hypermedia**. *User Modeling and User Adapted Interaction*, v 6, n 2-3, pp 87-129. https://doi.org/10.1007/BF00143964
7. Tadlaoui, M., Chikh, A., Bouamrane,K., (2010). **ALEM : Un Modèle de Référence pour les Applications Web Adaptatif Educatif**. *Actes de la 1ère Conférence internationale LEAFA 2010« e-Learning For All »*.
8. Koch, N., Wirsing M., (2002). **The Munich Reference Model for Adaptive Hypermedia Applications An Overview of the Reference Model**. *2nd International*

Conference on Adaptive Hypermedia and Adaptive Web-based Systems, pp. 213–222. https://doi.org/10.1007/3-540-47952-X_23

9. Drissi, S., Bensebaa, T ., Lafifi, Y. (2009) . **Une nouvelle approche pour l'adaptation d'un hypermédia pédagogique au profil cognitif de l' apprenant en utilisant XML**. *2nd Conférence Internationale sur l'Informatique et ses Applications (CIIA'09).*
10. Wu, P. M. E., Houben, G. J., De Bra, P.M. (2000) . **Supporting user adaptation in adaptive hypermedia applications**, *Proceedings Conferentie Informatiewetenschap 2000*, vol. Vol. 00-20, pp. 88–98.
11. Franzoni, A. L., Assar, S. (2009**). Student Learning Styles Adaptation Method Based on Teaching Strategies and Electronic Media**. *Educational Technology & Society*, 12 (4), 15–29.
12. Behaz, A., Djoudi, M. (2009). **Approche de Modélisation d'un Apprenant à base d'Ontologie pour un Hypermédia adaptatif Pédagogique**. *Conférence Internationale sur l'Informatique et ses Applications (CIIA*).
13. Bull,S., (2004). **Supporting Learning with Open Learner Models**. *Intl Conference on ICT in Education, Athens*.
14. Tmimi, M.,Benslimane, M. Berrada, M., Ouazzani K. (2017**). A Proposed Conception of the Learner Model for Adaptive Hypermedia**. *International Journal of Applied Engineering Research*, vol. 12, no. 24, pp. 16008–16016.
15. S. Jean-Daubias, T.T.H. Phan, 2011. **Different levels of modeling for learner profiles.** Research Report RRLIRIS-2011-009, *Computing Environments for Human Learning*.
16. Sridhar Iyer, 2011. **Learner Modeling.** *National Workshop on Adaptive Instruction CDAC*, Navi Mumbai, Dec 15-16, 2011.
17. Anon, 2008. **Developing cognitive capacities and working methods of apprentices -**March 2008 *GIP FCIP Experience - CAFOC* of Nantes / CFA of Pays de la Loire the Loire.
18. O.Oueslati, A.Ibrahim, S. Khalil, H. Ounelli, 2018, **Sentiment Analysis for Helpful Reviews Prediction,** *International Journal of Advanced Trends in Computer Science and Engineering, Volume 7, No.3, May- June 2018.* https://doi.org/10.30534/ijatcse/2018/02732018
19. I. S. Makki, F. Alqurashi, 2018, **An Adaptive Model for Knowledge Mining in Databases "EMO_MINE" for Tweets Emotions Classification,** *International Journal of Advanced Trends in Computer Science and Engineering, Volume 7, No.3, May- June 2018.* https://doi.org/10.30534/ijatcse/2018/04732018
20. Kort, B., Reilly, R., & Picard, R., 2001. **An Affective Model of Interplay Between Emotions and Learning: Reengineering Educational Pedagogy-Building a Learning Companion**. In T. Okamoto, K. R. Hartley & J. P. Klus (Eds.), *IEEE International Conference on Advanced Learning Technology: Issues, Achievements and Challenges* (pp. 43-48). Madison, Wisconsin: IEEE Computer Society.
21. Albert Mehrabian, 1996. **Pleasure-arousal-dominance: A general framework for describing and measuring individual differences in Temperament**. *Current Psychology*, 14(4), 261- 292. doi: 10.1007/bf02686918.
22. Madaio M., (2015). **Adaptive Learning Systems The State of the Field**. *C21U Seminar ,UnConference Room at C21U*.
23. Tmimi M., Benslimane M., Berrada M., Ouazzani K., (2019). **A Proposed Conception of the domain Model for Adaptive Hypermedia**. Submitted to *Education and Information Technologies*.
24. De Bra, P.M., Wu P. M. E. , Houben, G.J., (1999). **AHAM : A Dexter-based Reference Model for Adaptive Hypermedia**. *Proceedings of the 10th ACM Conference on Hypertext and Hypermedia: Returning to Our Diverse Roots*, pp. 147–156. https://doi.org/10.1145/294469.294508
25. Advanced Distributed Learning -ADL-, (2009). **Content Aggregation Model (CAM)** . *SCORM 2004 4th Ed. v1.1*.
26. Advanced Distributed Learning -ADL-, (2009). **Run-Time Environment [RTE**]. *SCORM 2004 4th Ed. v1.1*.
27. Advanced Distributed Learning -ADL-, (2009). **Sequencing and Navigation (SN).** *SCORM 2004 4th Ed. v1.1*.
28. Cohen E. *et al.*, (2016) **AICC / CMI5_Spec_Current cmi5 Specification Profile for xAPI**. *Aviation Industry CBT Committee (AICC).* Available: https://github.com/AICC/CMI-5_Spec_Current/blob/quartz/cmi5_spec.md. Accessed 19 june 2019.
29. Tmimi M., Benslimane M., Berrada M., Ouazzani K., (2019). **Implemented and Tested Conception Proposal of Adaptation Model for Adaptive Hypermedia**. *International Journal of Emerging Technologies in Learning (iJET).* Vol 14, No 02. https://doi.org/10.3991/ijet.v14i02.8230
30. Chew, L. K., (2015). **Tracking Learning Experiences Using the Experience API**. *eLearning Forum Asia 2015 (ELFA).*
31. Sellarès,T., (2006). **Composite Pattern.** ***University of Girona***, *Software Engineering*. Available: http://ima.udg.edu/~sellares/EINF-ES1/CompositeToni.pdf . Accessed 19 june 2019.
32. Tmimi M., Benslimane M., Berrada M., Ouazzani K., (2018). **Intelligent Model Conception Proposal for Adaptive Hypermedia Systems**. *International Journal of Advanced Computer Science and Applications (IJACSA)*, 9(8), 2018. https://doi.org/10.14569/IJACSA.2018.090825