Integration of Technological, Pedagogical and Psychological Requirements in the Learning Object Concept

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Manuscript submitted October 10, 2014; accepted December 18, 2014.

Abstract: Current investigation identifies and recommends the integration of technological, pedagogical and psychological requirements for the development of learning objects. A more comprehensive concept is required, comprising information with the interaction of videos, images, sound and texts for the construction of Learning Objects. Further, higher consistency and quality in development are also needed, comprising, among other things, reuse, interoperability, updating and granularity. From the pedagogical point of view, teaching strategies are incorporated, coupled to requirements traditionally used in learning-teaching activities which provide consistency and adherence to pedagogical needs involving students, teachers, knowledge and learning object. Following studies by Felder and Soloman in Psychology, new requirements are proposed for their incorporation when conceiving learning objects which derive from perception, retention, processing and comprehension, related to learning styles. The latter suggest the personalization of learning and respect for the way students learn.

Key words: Learning objects, learning styles, personalized education, requirements.

1. Introduction

Information and Communication Technologies (ICT) made feasible the employment and interaction of different types of media and methodologies in Education through the insertion of several and different digital contents in the Internet. Learning Objects emerged, or rather, the digital resources that may be re-used to foreground learning for distance and presence modes. These objects essentially contain the insertion of the media, such as videos, images, sounds and texts. The list may be compounded with technological requirements of software development, such as reuse, interoperability, updating and granularity. These aspects trigger consistency and quality to Learning Objects.

The concept of Learning Objects has been foregrounded on technological issues, with special emphasis on models and technological standards required by the market. There is only a slight observance of minimum interdisciplinarity that would contemplate and integrate principles and technological and pedagogical paradigms in the construction. More recently, studies by [1]–[3] verified the integration of pedagogical and technological requirements within the concept of Learning Objects, including pedagogical, documental and technological analysis from the point of view of the student, teacher and knowledge so that learning could be apprehended.

At the same time, the psychological approach in Education has trigger studies and discussions of the processes to understand the relationship between teaching and learning, coupled to pedagogical approaches. Among such

studies, one may find research work that investigates the different forms of learning, individually related to one´s own style to understand, retrieve and retain concepts. For instance, learning for some students is given through reading; some give priority to videos and others learn through schemes and graphic representations. Such different learning methods are study objects of the learning styles theory. Therefore, the psychological approach underscoring learning styles may also be incorporated in the elaboration of a Learning Object.

Current research proposes the integration of a third requirement in the construction of personalized Learning Objects that would comprehend psychological aspects with regard to the identification of the student´s learning styles. The integration of technological, pedagogical and psychological components may foreground personalized study and consolidate the development of the Massive Open Online Courses (MOOC). Rooted in the movement of open educational resources and of connectivity, they are defined as open courses available on the WEB, in virtual learning environments, or in other means that offer the widening of knowledge within a process of co-production for a great number of students.

By appropriating the theoretical fundaments of learning styles for the establishment of personalized learning objects, one expects to collaborate towards the process and development of digital materials for students´ personalized learning.

2. Learning Objects

Great progress in ICT and the employment of the Internet triggered the development of many research works and products in Education. The Internet has provided during these last years a different form of distance learning through the availability of several media and resources. The encapsulation of these media has provided a new component in the process: Learning Objects. Learning Objects are any digital and technological unit that may be used and reused during the learning process. They may have hypermedia and instructional contents, other learning objects and support software [3]. Learning Objects are digital elements of a new teaching and learning methodology foregrounded on the computer and the Internet, based on an orientation towards objects, valuating their establishment and reusability for different contexts [4]. Many research works analyze aspects of concept, use, reuse, portability and employment of learning objects [1], [5]-[13].

With regard to the pedagogical aspects of a Learning Object, the main theoretical focuses are directed by theories of behaviorism (with emphasis on observable behavior) [14], humanism (emphasis on the person) [15], constructivism (emphasis on the genesis of knowledge) [16], [17] and cognitivism (emphasis on mental development) [18], even though many developers did not initially have such perceptions in mind.

In a practical way, [1] developed the theory of didactic transposition that presents relevant topics and items that suit themselves precisely to the construction of the Learning Object. These characteristics will be detailed below.

When the psychological issue is investigated, no consistent results show the inclusion and observance of the learning style theories [8], [19], [20]-[25] in the concept of Learning Objects, integrating them to technological and pedagogical issues.

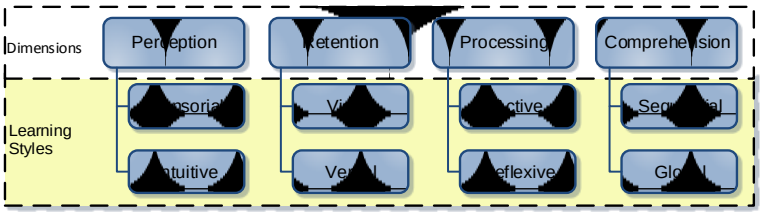

Fig. 1. Representation of learning style models according to Felder and Silverman.

The concept of [22], [26] was selected for a better definition of the proposal.

According to [22], [26], learning style may be defined within four dimensions and eight styles (Fig. 1).

The Perception dimension corresponds to the manner the student perceives information and indicates the way he analyzes the surrounding milieu, made up of sensorial and intuitive styles. The Retention dimension

indicates which sensorial channels the student frequently uses when he receives information composed of visual and verbal styles. The Processing dimension identifies the selected way the student processes received information made up of active and reflexive styles. The Comprehension dimension indicates the manner the learner uses to organize thought and understand the contents given through sequential and global styles.

The identification of learning styles is undertaken by an ILS questionnaire in [22] available at http://www4.ncsu.edu /unity/lockers /users/f/felder/public /ILSpage.html. Aspects that comprise the learning styles will be identified in the next section.

3. Technological, Pedagogical and Psychological Requirements, Associated with Learning Objects

Through a detailed analysis of the literature, [2]-[5], [13] relevant topics and requirements that every area (technological, pedagogical and psychological) should investigate were joined.

So that a Learning Object may be built, the most important technological aspects to be taken into account are: 1. accessibility; 2. adaptability; 3. compatibility; customization; 4. Description in metadata; 5. trustworthiness; 6. durability; 7. efficiency; 8. structuring; 9. evolution; 10. functionality; 11. granularity; 12. homogeneity; 13. interoperability; 14. legibility; 15. maintenance; 16. metrics; 17. motivation; 18. browsing; 19. objectivity; 20. quality of information; 21. graphic and interface quality; 22. reparability; 23. reusability; 24. Instructional sequencing and 25. visibility.

The pedagogical requirements, which are basic for the concept of Learning Objects, are underscored by the didactic transposition theory of [1]-[3]. Chevallard´s tetrahedron presents the analysis of the four faces or vertexes: didactic, pedagogical, mediatic and documental, coupled to the pedagogical requirements through the 4 vertexes: student, teacher, knowledge and the Learning Object (Fig. 2).

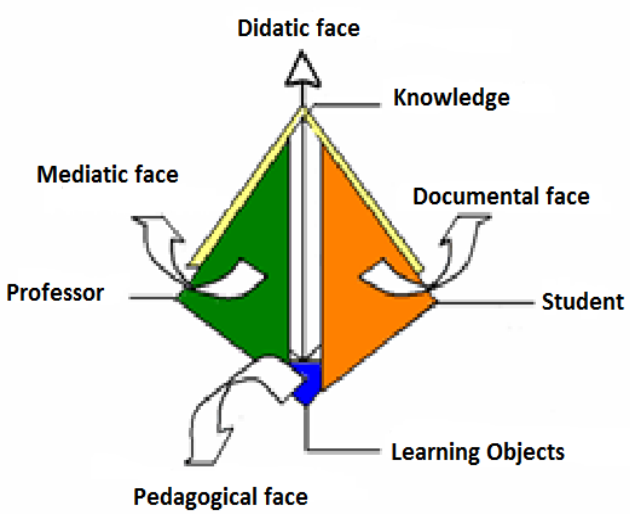

Fig. 2. Pedagogical tetrahedron. Source: [2].

With regard to the student´s pedagogical requirements, the following aspects should be taken into account in the concept of Learning Objects:

1. Accessing the site from any place and at the preferred time, with usage facilities; 2. Undertaking learning; 3. Discovering concepts in a playful way; 4. Developing a learning methodology; 5. Stimulating brain development; 6. Fomenting the learning capacity; 7. Interacting with the several components of the environment, such as teachers, tutors and peers; 8. Motivating access to clear and correct contents in an attractive way; 9. Solving problems and retaining knowledge; 10. Undergoing changes by using Learning Objects for the development of knowledge.

With regard to the teacher´s pedagogical requirements, the following aspects should be taken into account in the concept of Learning Objects:

1. Analyzing the quality of information and deepening knowledge on contents in Learning objects; 2. Trusting in the effectiveness of the use of Learning Objects and in the learning power that emerges; 3. Defining an instructional sequencing; 4. Developing learning and teaching methodologies; 5. Understanding that knowledge is the development of thought; 6. Interacting in a learning social milieu when relating with teachers, tutors, peers and students; 7. Inserting information, scientific knowledge and practice in Learning Objects; 8. Mediate the relationship between the student and information; 9. Being a mediator, tutor or supervisor; 10. Making possible learning conditions and means; 11. Preparing the student for thinking; 12. Triggering changes in the student and in oneself; 13. Testing and verifying whether contents in the Learning Objects are clear and correct; 14. Using Learning Objects in the planning of activities and employing the plan to foreground lessons; 15. Aiming at student´s motivation; 16. Aiming at objectivity and legibility in the theme to be approached.

In the case of pedagogical requirements on the comprehension of knowledge and information, a Learning Object should be constructed aiming at the following aspects:

1. helping in the construction of knowledge by the interaction between subject and means; 2. Helping in the internalization process in which modifications in the subject occur; 3. Developing learning and teaching methodologies; 4. Stimulating brain development through a development of thought; 5. Establishing relationships between the subject and the real world; 6. Foment the construction of student´s knowledge mediated by the teacher; 7. Inserting clear and objective information in Learning Objects to make easy the student´s construction of knowledge; 8. Intermediate and mediate information (knowledge) by ICT; 9. Trigger changes in the student and teacher; solve problems; 10. Retain the required contents to help the teacher transmit information; 11. Reuse Learning Objects where learning occurs in different manners; 12. Inserted according to pedagogical criteria and principles; 13. Exchanging information with other subjects to internalize knowledge; 14. Employing culture, language and symbolic systems of human groups.

Table 1. Pedagogical Requirements of the Pedagogical Face

Pedagogical face
Access the site from any place and at any time
Learn to learn with the students
Help the teacher to be joyful with the students
Control information contents to avoid mental and physical stress
Give support to teaching and present a differentiated educational environment
Develop Learning Objects that may be used by students
Incentive students to understand contents that frequently make them frustrated due to their high complexity
Have scientific, theoretical and practical knowledge
Enrich the student´s learning
Teach and transmit information to the student
Foreground the theoretical concepts for the student´s practice
Identify the user´s intellectual level
Interact with the student through discussion lists, synchronized interactions such as chats and graph-interactive resolutions of problems with Learning Objects
Interact with the several components of the site
Motivate through behavioral aspects
Motivate and give support clearly and correctly to student coping with technology
Have facility in the use and quality of information
Foresee differentiated didactic strategies for initiating and experienced users
Provide learning through discovery within a pleasurable and unforgettable stance
Provide condition to teacher to intermediate in the interaction of the students with Learning Objects
Solve educational material´s development and reuse problems
Make the student the subject of his own learning process
Make the activity pleasurable
Be an apprentice in the face of new technologies
Provide the solution of problems with the serenity and assurance that the student requires
Use Learning Objects to prop lessons
Use tools available by technology

With regard to the pedagogical requirements on the concept of Learning Objects, the following aims should be undertaken:

1. presenting a differentiated pedagogical site; 2. Helping the teacher in the planning of activities; 3. Keep and disseminate trustworthy theoretical and practical contents; 4. Supporting teaching; 5. Enriching student´s teaching; teaching and transmitting information to the student; 6. Being easily available to students; 7. Modifying student´s stance during the learning process; 8. Motivating access and maintaining trust in contents with clarity and correctness; 9. Complying to technical criteria for the incorporation of educational principles which are basic to the learning process; 10. Exercising the role of mediator between the teacher and knowledge; 11. Having information and renovation quality; 12. Proving learning through discovery in a playful and unforgettable manner; causing changes in the student and teacher; 13. Solving problems on the development and reuse of educational material; 14. Following patterns so that the search process and the use of information may be undertaken successfully; 15. Being developed to be used by the teacher and serve the student; 16. Exercising the role of mediator since it modifies the student´s stance within the learning process.

A joint study of the four faces of the tetrahedron, combining two by two, identifies another set of pedagogical requirements which are equally important in the concept of Learning Objects.

The following requirements make up the pedagogical face in Table I and the following requirements are underscored on the didactic face in Table 2.

Table 2. Pedagogical Requirements of the Didactic Face

Didactic Face
Understand the difference between the logical structures of scientific knowledge
Direct the apprentice, supervise, signalize, situate and define routes
Understand the technological resources to construct knowledge
Establish on-line help systems with tutors
Establish learning situations with a high degree of freedom to make the student endeavor autonomous work, with types of differentiated help
Develop applied didactic strategies to comply with Learning Objects
Develop pedagogical methods, strategy and procedure sets that determine and fix the type of intervention in the program, an example of a trial-and-error technique
Stimulate the use of a research method in which theory and practice coexist
Structure contents and establish logical bonds between the items
Provide planned situations in which apprentices live through experiences that result in modifications
Provide autonomy to the student and lead him to think for the occurrence of learning
Free the student from restrictions imposed by ready knowledge
The teacher as a researcher, in research and in the search for subsidies that lead the student to understand new knowledge
Organize information in a supervised manner and transmit efficiently.
Have clarity and contents
To be concerned with teaching
Provide satisfaction in teaching
Underscore the importance of the teacher and his competence within a constructivist stance
Retain knowledge and give more mental fastness
Revise the teacher´s formation
Make the student a protagonist
Work the contents in an organized way
Translate pedagogical intentions into general and operational aims
Employ ICT to contribute towards the learning of student and teacher
Validate contents: operations that demonstrate that the product reacts well to formation aim brought about by its establishment

The following requirements are underscored in the documental face in Table 3.

Table 3. Pedagogical Requirements of the Documental Face

Documental Face
Support and motivate the student in the learning process
Show the way for the solution of problems under analysis
Construct documents for the use of Learning Object
Make available to the student information on a certain content
Interact between object and student with the help of hypertexts, images, sounds and VHS
Making one decide on browsing in Learning Objects may motivate towards deepening of one´s knowledge.
Make possible to the student the use of Learning Object with ease and efficiency
Provide the student with learning through browsing in Learning Objects and the comprehension of knowledge through the use of the Learning Object
Reflect on the characteristics of the Learning Object
Converge a set of criteria developed on the quality of the object within the point of the program-makers
Have trust, functionality and legibility

Table 4. Pedagogical Requirements of the Media Face

Media
Free knowledge from physical space and from the person of the teacher.
Make information available quickly
Offer trustworthiness and motivation.
Offer support material.
Disseminating knowledge through Learning Objects in remote places may be an alternative.
Have legibility.
Have efficiency.
Have structure
Employ the technological innovations of communication to transmit new information.

Table 5. Requirements of the Teacher´s Universe

Pedagogical requirements of the teacher´s universe
Didactic
Promote a motivated learning
Develop methodologies of learning and teaching
Prepare the student to think
Establish systematic methodologies and procedures of thinking
Mediate the relationship between the student and knowledge
Make possible conditions and means for learning
Pedagogical
The teacher is the didactic fomenter
Develop wisdom
Understand that knowledge is the development of thought.
Interact in a learning social environment in relationships with teachers, tutors, peers and students
Cause changes in the student and in oneself
Deepen knowledge on the issue
Retain the necessary content to help the teacher transmit knowledge
Documental
Contain contents
Serve the student
Comply to technical criteria to incorporate the educational principles which are basic within the learning process
Have support material

The following requirements underscore the **media face** in Table 4.

Another combining study using the faces of the tetrahedron three by three identified the last set of combined pedagogical requirements, joining the didactic, pedagogical and documental requirements of each dimension:

1) Requirements of the teacher´s universe (Table 5);
2) Requirements of the student´s universe (Table 6);
3) Requirements of the universe of the Learning Object (Table 7);

4) Requirement of the universe of Knowledge (Table 8).

Table 6. Requirements of Student´s Universe

Pedagogical requirements of student´s universe
Pedagogical
Develop the abstraction process
Provide conditions for the development of reasoning
Start the logical process
Develop practice based on theory
Provide autonomy
Relevance of learning theories exists in the pedagogical
Didactic
Development of the student´s participation
Support the critical reflection of reality
Make possible conditions to be independent
Employ devices to help the student in fixing contents
Employ methodology for the disseminate of contents
Employ technology to help in the process
Documental
Develop tutorial Create support material for consultation

Table 7. Requirements o f the Universe of the Learning Object

Pedagogical Requirements of the universe of the Learning Object
Pedagogical
Employ teaching strategy based on the application of technology without any restrictions of place, time and occupation.
Provide an autonomous learning with the support of the communication media.
Define the new roles and methodological focuses for students, teachers and pedagogues.
Facilitate learning based on competence.
Transmit information in an adequate and structured way.
Documental
Solve current problems with regard to storage and distribution of information by digital means.
Be flexible if the object was planned to be used by many people.
Contexts.
To be rewritten for each new context.
Mediatic
Develop activities between new Technologies and teaching-learning methodologies in virtual sites.
Organize information and granulate objects.
Have the role of the mediator between teaching and learning.

Table 8. Requirement of the Universe of Knowledge

Pedagogical Requirement of the universe of Knowledge
Didactic
Adaptation to external world
Help in the construction of one´s own knowledge
Transmit information as learning occurs
Achieve knowledge
Mediatic
Use technology to enrich the teaching and learning process
The teacher´s presence through the help of technology enriches the teaching and learning process
Documental
Create tutorials that would help in research
Employ tutors to help students in their doubts

According to learning styles [22], the requirements that comprise the psychological issue are related to retention, perception, processing and comprehension [26]. The important aspects to be observed following each dimension and style are given in Table 9.

Table 9. Dimension and Learning Style Requirements

Dimension	Requirements	Learning styles with regard to the individual
Perception	Related to the manner the student receives contents; for instance, the types of exercise	**Sensorial** Appreciate facts and data; they are down-to-earth, practical, methodical and detailed. They are patient in details.
		Intuitive They like symbols, diagrams, models, theories, innovation; they are creative. They are better in abstractions but not in details, which may lead towards carelessness in tasks.
Retention	It is related to form, such as the manner contents are presented; for instance, the types of media	**Visual** There is an easiness in the reception of information in visual representations, such as diagrams, films-images, graphs and others
		Verbal They have a good listening memory, easiness in dealing with the written or spoken word and like to take notes.
Processing	Represents how much the student likes to participate in activities; whether he has any leadership; whether he prefers reflecting for more time on the subject	**Active** Prefer to study as a team, through a more extroverted and dynamics method, with experimentations that do not make possible the apprentice´s passivity.
		Reflexive They prefer reflection for processing. They are theoretical and like to work individually with time and space for abstraction and formulation of hypothesis.
Perception	Represents the type of aspect that the student prefers with regard to contents: either fragmented or wholesale	**Sequential** They understand better with the logical sequence of steps in a fixed progression of complexity and difficulties. They deal better with fragmented knowledge so that they would later construct a general idea of the issue. They learn linear reasoning processes when they solve problems
		Global: The need a general idea of the contents for comprehension and interrelate de-contextualized fragments. They are prone to take intuitive attitudes, with divergent thought and synthesis

4. Conclusion

Studies developed in current research are directed to identify the main requirements that a Learning Object should assume so that it may contemplate technological quality, pedagogical adequacy and personalize student´s learning through students´ learning styles, and psychological requirements. Taking into consideration technological, pedagogical and psychological requirements, the first Learning Objects produced are differential with regard to what exists within the academic milieu and in corporative education. The incorporation of learning styles is given as an innovation. The incorporation of these requirements may produce new methodologies in software development, with an interdisciplinary team made up of professionals from different areas involved in the production of Learning Objects. In Distance Education, it may be easily incorporated to the production sectors of digital didactic material. It may be thus consolidated in the development of "Massive Open Online Course" - (MOOC), with a focus on the contents to be employed in open courses through the WEB by

virtual learning environments.

Acknowledgment

The authors would like to thank the Brazilian Council for Scientific and Technological Development (CNPq) and the Cesumar Institute for Science, Technology and Innovation (ICETI) for its financial support.

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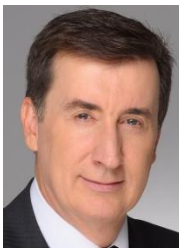

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