(Learning ∩ Information Technologies) Cartography

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***Abstract*—Nowadays, many researches focus their efforts in studies and applications on the Learning area. However, there is a lack of a reference system that permits to know the positioning and the existing links between Learning and Information Technologies. This paper proposes a Cartography where explains the relationships between the elements that compose the Learning Theories and Information Technologies, considering the own features of the learner and the Information Technologies Properties. This intersection will allow us to know what Information Technologies Properties promote Learning Futures.**

Keywords-Learning Theories; Learning Features; Information Technologies; IT Properties.

I. Introduction

Recently, there is a considerable increase of works based on educational software as evidenced by the multiple conferences and workshops about it. However, it has also been evidenced the lack of a reference system, map or cartography to facilitate the location of such works, establish relationships between them and between the existing links among learning theories applied. Given the scope of the study area, this paper proposes a Cartography defined by the intersection between the most important *Learning Theories* and *Information Technologies*, exposing the common elements and the relationships between both sets. The main goal of this paper is to provide some criteria of order in an emerging area.

The proposed Cartography is a reference system consisting of four dimensions arranged symmetrically. On the one hand, there are the *Learning Theories* and the *Learning Features* and on the other hand, as a reflection, there are the *Information Technologies* and their properties – *IT Properties*. The article defines each dimension and the relationships between them, in order to establish a final Cartography. The Cartography shows the intersection between the two sets, *Learning Theories* and *Information Technologies*. Consequently, this intersection will answer the question: What *IT Properties* promote *Learning Features*?

The rest of this paper is organized as follows. Learning Theories and Learning Features are defined in Section II. The most relevant Information Technologies Properties are gathered in Section III. In Sections IV and V, the Cartography proposed and its implementation is mentioned respectively. In Section VI the results of implementation are analyzed. Finally, Section VII concludes the paper.

II. Learning Theories and Learning Features

Learning is defined as the relative change of the permanent behavior that reflects knowledge acquisition or skills through experience that can include study, observation and practice. Behavioral changes are relatively objectives and therefore can be measured [1].

A. Learning Theories

In the Cartography, a group of relevant theories about learning was considered. Some theories construct their approaches based in other theory's approaches.

Behavioral Theory [2] focuses on the observable behavior of an individual. The behavior is described from the stimulus-response relationship and considers that learning takes place when there is an appropriate response to a specific stimulus.

Cognitive Theory [3] tries to find out how the mind interprets, processes and stores information. The contribution related to learning is the concept of meaningful learning, which tries to establish a relationship between prior learning and the new knowledge obtained.

Constructivist Theory [2] describes the knowledge acquisition as a dynamic and interactive process. Through it the external information is interpreted and reinterpreted by the mind that builds explanatory models each time more complex and powerful.

Social Constructivist Theory [4] clarifies that human development and learning can be explained in terms of social interaction. Among the proposals of social constructivism there is the cooperative learning, which emphasizes the role of social relationships to learn.

Constructionist Theory [5] states that learning emerges in a better way when the mind is committed to build a significant product. It emphasizes the importance of the tangible.

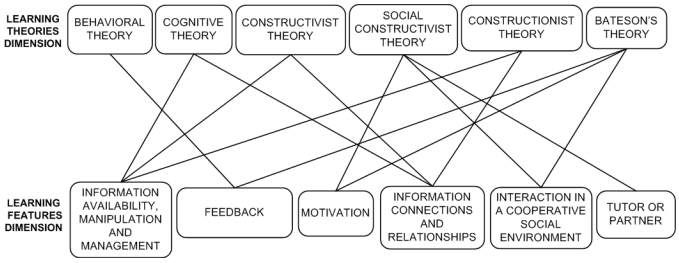

Figure 1. Relationships between *Learning Theories* and *Learning Features* dimensions

Bateson's Theory [6] was considered in this study because of focusing more on the student expectation and participation than in the stages of human development. This theory makes special emphasis on the dynamic relationships and individual interactions inside and outside the educational context.

B. Learning Features

Learning Features are defined as those features that allow students to learn in a better way, which means that student learns better if he/she has [7], [8]: 1) Feedback, 2) Information availability, manipulation and management, 3) Information connections and relationships, 4) Motivation, 5) Interaction in a cooperative social environment and 6) Tutor or Partner. For the development of the Cartography, *Learning Theories* and *Learning Features* were defined as dimensions.

The relationships between these two dimensions were established after extracting the main focus of each theory and mapping it with the *Learning Feature* that reinforced better the principles of each theory. These relationships are shown in Figure 1.

III. Information Technologies for Learning

The use of computers in education began in the 60's. Several relevant features of these devices were exploited, such as versatility, calculation and specially the ability to interact with them. Students should find answers to the stimulus received. This first approach was called Computer Assisted Instruction (CAI) [9].

The development and diffusion of *Information Technologies* had greatly increased the qualities of computers that support learning. From several studies on works related to the areas of *Learning* with *Information Technologies* it has been concluded that the most relevant *IT Properties* are [10]–[12]: 1) Creation, transmission and dissemination of information, 2) Simulation and training, 3) Customized content and multimedia, 4) Play, 5) Mobility and 6) Social and cooperative processes. This set of properties represents the third dimension of the Cartography.

Finally, the last dimension of the Cartography is formed by *Information Technologies*. For this first design the technologies chosen were [13]–[15]: 1) E-learning, 2) Web2.0-social networks, 3) M-learning and 4) Muve's-games.

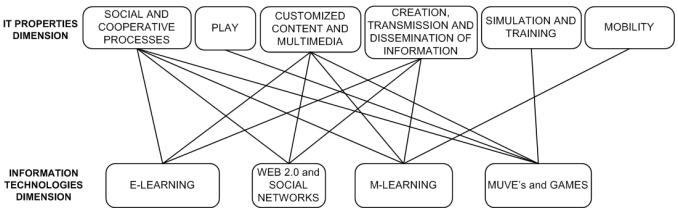

Figure 2. Relationships between *IT Properties* and *Information Technologies* dimensions

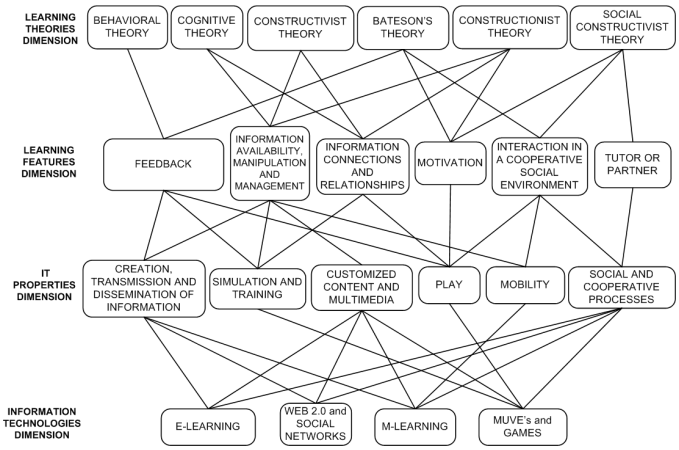

Figure 3. *Learning* and *Information Technologies* Cartography

The relationships between *IT Properties* and *Information Technologies* were established under the premise of what technologies offer or use these properties. These relationships are shown in Figure 2.

IV. Learning and Information Technologies Cartography

The Cartography includes the four dimensions previously studied and the relationships among them. The symmetry that exists in the Cartography is delimited by the areas of *Learning* and *Information Technologies*. The intersection between these two areas is reflected in the relationships that bind them. They answer the question of what *IT Properties* promote *Learning Features*. The final Cartography is shown in Figure 3.

V. Cartography Implementation

In addition to the intrinsic value of the Cartography as a methodological or orientation resource, we studied its usefulness as an analytical tool. In particular, a small study was made based on the state of the art.

A. Methodology

For this analysis, we chose seventeen works related to the areas of *Learning* and *Information Technologies* [3], [6]–[8], [10]–[13], [15]–[23] that fulfilled the criteria of being directly related to this two areas, and coming from reliable

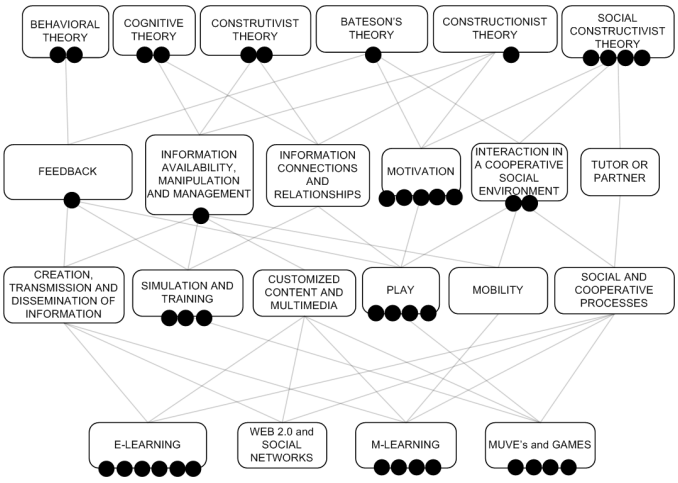

Figure 4. Density of works per attributes

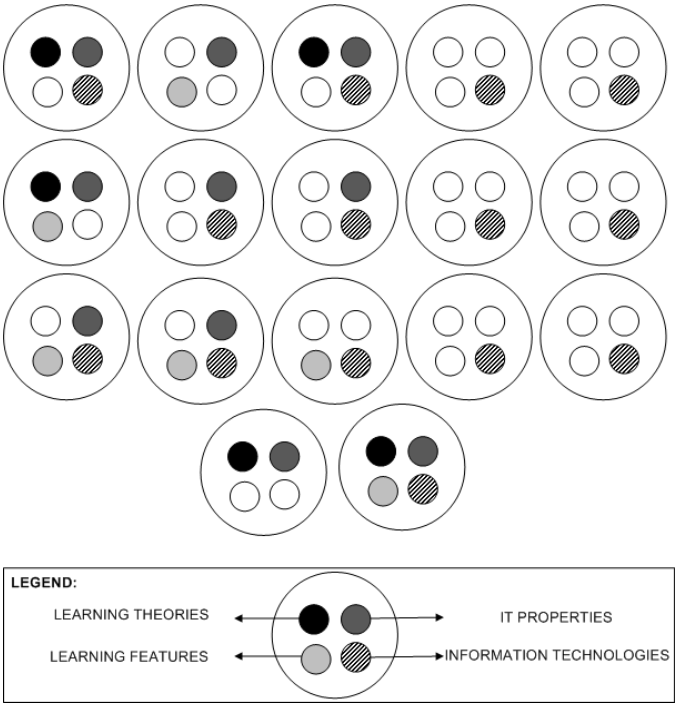

Figure 5. Dimensions per works

sources. Each work was studied to determine its position in the Cartography, it means with who or whom is related and the use of the dimensions of the Cartography.

B. Results

In order to explain the results obtained in this work, the elements belonging to each dimension were defined as attributes. According to the study, two results were obtained.

The first one shows the density of works per attributes in each dimension of the Cartography (Figure 4). Every point shows the relationship of the work with that attribute. There were works related to several attributes.

The second result (Figure 5) is a complement that shows the presence of the dimensions in each work, being represented by a circle with four sections. Every section shows a dimension of the Cartography that was defined by a different plot in order to distinguish them.

VI. Analysis of Results

From the representation of the density of works per attributes:

- Two attributes were highlighted with a higher density: E-learning and Motivation. E-learning, defined as learning and teaching activities via the Internet [15], is focused directly on the two study areas of this research. Therefore a higher density is reflected in this attribute. The high density in Motivation suggests that nowadays the emotions are being considered as an influential factor in the learning area.
- There is a notable absence of density on the dimension *IT Properties*. This is mainly due to the special attention of researchers into educational software applications rather than *Learning Theories* that support them.

From the dimensions per work the following analysis can be done:

- Approximately 80% of the works have in mind the dimension of *Information Technologies*, and almost half of them include one or more dimensions in their investigations. This means that most of the works focus their efforts on the development of technologies.
- The second largest dimension is *Learning Features*. Many of these studies are connected with the dimension of *Information Technologies*. This shows that some works include one or more *Learning Features* for the development of *Information Technologies.*
- There is a low density in the dimensions of *IT Properties* and *Learning Theories*. This indicates that few *IT Properties* are used when developing technology related with learning, which can make us believe that research about *Information Technologies* and *Learning* are made with a poor theoretical basis.

In general, from both representations we can conclude that there is a lack of cohesion between the areas of *Learning* and *Information Technologies*, hence the importance of relating both areas to link them in a better way. Moreover, the study also shows that today there are some works on IT applications addressed in a superficial way, which means that this field is in early stages of research.

VII. Conclusions

First of all, the research work developed in this document represents the entire set of links among the elements involved in the sets of *Learning* and *Information Technologies*. The reviewed literature does not have any similar work,

being this current study a contribution to this area that is just beginning. Moreover, the Cartography has proved to be a powerful tool for the analysis of *"Learning-Information Technologies"* set, facilitating its understanding and study. It was also a prospection instrument, allowing the exploration of future possibilities based on present evidence.

Particularly, the Cartography determines a reference system where information layers are placed for study, like shown in Section V. This let us to analyze a case study from the dissection of several works previously studied.

The research leaves several areas to be explored and future guidelines where the authors are still working.

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