# ACCESSING HYPERMEDIA SYSTEMS EFECTIVENESS IN LEARNING CONTEXTS

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Abstract: Hypermedia systems are increasingly being used in teaching/learning environments. Biomec is a hypermedia system that has got, as it main goal, the interrelation of concepts coming from Sports and Basic Mechanics, just as it is intended in an area of knowledge denominated Physics of Sports. The final objective of Biomec is to increase the efficiency of the learning processes in this area of study. The system development has been grounded in learning theories, with contents being organized according to the theory of Ausubel (1968) and the theory of cognitive flexibility (Spiro et al., 1992). Apparently, a hypermedia system like Biomec is suitable to the teaching/learning of Physical Education. However, only an astringent evaluation, with its target public, can assert what are its real benefits. This work presents a methodology for the evaluation and improvement of this kind of systems.

## 1 INTRODUCTION

Biomechanics can be defined as an area of Bioengineering that intends to understand the biological functions of the human movement, at the light of basic concepts of Mechanics. The teaching in this discipline needs to use dynamic representations of physical phenomena and laws and concepts coming from Mechanics, relating them with the human movement.

One of the problems faced by Biomechanics is the development of didactical material with characteristics appropriated to its specificities. Printed materials, as the didactical books, are not able to show dynamic images, just illustrations and photographs, allowing illustrating one moment or instant of the movement, but not all its dynamic complexity. This didactical need can be filled by computerised means, which allow the inclusion of video, animations and simulations of real situations, supported by hypermedia systems.

A hypermedia system is an electronic document that has got its pages or knots organized in several ways, being the hypertextual network the more common one. This kind of arrangement facilitates the non-linear assessment of the content. Besides, these systems are able to support multimedia documents, like photos, sound, video and animations.

This work presents a methodology for the evaluation and improvement of this kind of systems. It makes use of concept maps and techniques of multivariate data analysis.

## 2 THEORETICAL REFERENTIAL

It is common sense, among the teachers of Biomechanics, that the student in general begins the course with low knowledge in Physics. The students seems to find little usefulness in this kind of knowledge and consider having to study Physics an arduous task, in spite of the value the concepts have in the understanding of the content of the discipline. As a result, they fail in assimilating the concepts, jeopardising the learning process and its outcomes.

As the Physical Education studies, learns and teaches with the human movement, computational media may have a positive influence on the teaching/learning process of the discipline. This is possible by using tolls such as simulators, video, static images and hypermedia systems.

Learning is a concept difficult to define. It makes part of a quite obscure area of our psyche and we do not know yet, for sure, what really means to learn



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and, consequently, how to evaluate the results of the process.

Several theories concerning the subject can be found in the literature, such as the constructivism of Piaget, neo-behaviorism of Skinner and other, significant learning of Ausubel (Ausubel, 1968), instructionism of Brunner and connectionism (Conklin, 1987), that it is the most recent approach to the subject (Ohlsson, 1993).

The theoretical referential used in this work is connectionism, which links some quite interesting perspectives: psychophysiology; computer science and cognitivism. Connectionism understands the human memory as a semantic network that is, as a representational outline of the knowledge by means of an intricate scheme, formed by concepts and its interrelations. These elements can be graphically represented as knots and links, respectively (Conklin, 1987). A semantic network may be distinguished from a generic representational outline by the indexed nature of its content.

The units of the semantic network are tied up to each other by means of connections, built and developed along the years by the knowledge accumulation, experience and learning. These connections are more complex than it can be graphically represented and are able to link to each other by the meaning and by the content, building a multidimensional relationship. According to the connectionism, learning elapses from the increase in the number of connections between the concepts.

The development of Biomec is based on connectionism, the theory of significant learning of Ausubel and cognitive flexibility. Connectionism needs a flexible material and a hypermedia system, as Biomec, is the medium adequate to the approach. The theory of significant learning of Ausubel was used in the organization of the contents and the cognitive flexibility theory guided the implementation of the non-linear navigation.

The main goal of the present work is to describe a methodology for the evaluation of Biomec. This methodology can be used to evaluate any similar hypermedia system developed to improve the learning processes.

# 3 A METHODOLOGY FOR THE EVALUATION OF BIOMEC

When developing a didactical material, the evaluation stage is fundamental for the confirmation of the theoretical presuppositions that have supported its development. It is not enough to develop the material; it is fundamental to evaluate it near its target population.

## 3.1 Methodology proposal

The evaluation of the Biomec prototype was done studding its impact on the process of teaching/learning of students of the discipline Biomechanics, at a Faculty of Physical Education and Sports. The concept maps done by the students and their attitudes with relation to the Physics were appraised, before and after its interaction with the system. Besides, the system was analyzed by a group of teachers of the discipline, by means of a questionnaire.

The evaluation of the attitudes in what it concerns to the Physics was accomplished using a model that can be classified as experimental, because the scores of the attitude scale were compared with the results of another independent group. The investigation involves two equivalent intact groups, belonging to a previous research (Rezende and Imbiriba, 1999). The hypotheses of this study are:

- Substantive hypothesis: a substantive difference exists, in the attitude with relation to the Physics, between the group that used Biomec and the group that didn't use the system.
- Null hypothesis: there is not a significant difference, in the attitude with relation to the Physics, between the group that used Biomec and the group that didn't use the system.
- Alternative hypothesis: a significant difference exists, in the attitude with relation to the Physics, between the group that used Biomec and the group that didn't use the system.

The evaluation of the accomplished learning was done using a study model that can be qualified as pre-experimental. It involved an intact group of students whose concept maps on Physics of Sports, elaborated before and after their interaction with the system, were compared. The hypotheses of this study are:

- Substantive hypothesis: there exist substantive gains in the learning accomplished by the students of the discipline Biomechanics that used Biomec, verified by means of concept maps.
- Null hypothesis: there are not significant gains in the learning accomplished by the students of the discipline Biomechanics that used Biomec, verified by means of concept maps.
- Alternative hypothesis: there are significant gains in the learning accomplished by the students of the discipline Biomechanics that used Biomec, verified by means of concept maps.

## 3.2 Instrumentation

The methodological approach involves a group of procedures that seek, fundamentally, to access the potential of Biomec as a teaching/learning tool.

The attitude scale, with relation to the Physics, was developed by Rezende (1988). This scale contains 29 statements (items), distributed by four sub-scales: content, teacher, applicability and sensations. Sixteen items have positive polarity and the other negative polarity.

The questionnaire uses a five points Likert scale, coded in an interval scale (5, 4, 3, 2, 1) for the positive polarity statements and in the inverse order for the negative polarity ones.

Reliability was accessed through the Cronbach alfa coefficients, which evaluate the internal consistency of the attitude scale, obtained separately for each of the four subcategories of the scale. The internal consistency levels are shown in Table 1. The values confirm the results of another previous study (Rezende, 1988), showing good reliability in all the categories and also indicating homogeneity among the categories of the scale.

Table 1: Reliability coefficients for the four categories of the attitude scale

| **Sub-scales** | **Cronbach alfa** |
|---|---|
| Teacher | 0,82 |
| Content | 0,79 |
| Application | 0,78 |
| Sensation | 0,81 |

A concept map is the representation of the significant relationships among the concepts of a subject area in the form of propositions. It is constituted by concept terms linked by words to form a semantic unit (Novak and Gowin, 1996).

Concept maps are good to make clear the key ideas in that the teacher and the student owe to focus the learning task. The elaboration of concept maps is a technique that allows the graphical externalisation of concepts and propositions (Novak and Gowin, 1996). The concept maps were elaborated by the students, at the beginning and the end of the educational process.

In agreement with Novak and Gowin (1996), the concept maps evaluation should be done in the following way:

- points should be given to all the forms of relationships that are valid or that form valid propositions. It should be tested if the line that connects them indicates the relationship between the two concepts and if the relationship is valid. If these conditions are satisfied, one point should be attributed for each valid and significant proposition;
- the valid levels of hierarchy should be counted and punctuate X times more than the relationship. For this to happen, the map should reveal a hierarchy, what implies to observe if each one of the subordinated concepts is more specific than the previous ones. If these conditions are satisfied, five points should be attributed for each valid hierarchical level;
- transversal connections must be verified; the transversal connections that reveal valid relationships between two segments different from the concept hierarchy may denounce an important integrative reconciliation that can be a better indicator of significant learning than the hierarchical levels. Ten points should be attributed for each traversal connection that reveals to be valid and significant. In case it is valid but not significant two points should be attributed. Specific examples can be asked to the students, to certify that they know what kind of event or object corresponds to the designation of the concept. The valid examples can worth one point each.

The teachers of the discipline also interacted with Biomec. The interaction was observed and the teachers answered to a questionnaire. The results will serve as a base for the evaluation of Biomec in the pedagogical, contextual and technological ambits, of its documentation and of its relevance for the discipline.

## 3.3 Data collection and analyses

The data of the attitude scale with relation to the Physics was collected using a scale applied in the end of the students' interaction with the system and will be compared later on with the results obtained in a previous investigation (Rezende and Imbiriba, 1999).

The data of the concept maps was picked up by means of the representations developed by the students before and after the interaction with Biomec. A previous appointment with the students was necessary to teach them how to develop the maps, in agreement with Novak and Gowin (1996) proposal.

The teachers' questionnaire was applied after their interaction with the system.

The significance level of the difference between the attitudes with relation to the Physics of the different groups will be verified using statistical procedures. The test of the null hypothesis will be accomplished by means of the Qui-square test (Dawson-Saunders and Trapp, 1994), with alfa=0,05. The use (or not use) of Biomec will be taken as independent variable. The scores, general and by category, obtained with the Likert scale for the same test will be used as the dependent variables.

The evaluation of the concept maps will be performed calculating scores accordingly the method indicated by Novak and Gowin (1996), which take in consideration the propositions, the hierarchy, the crossed connections and the examples. Another form of evaluation can be used, which involves comparing the maps produced by the students with a selected reference. All the mentioned characteristics receive punctuation, in agreement with the scale designed by the authors. Some of the questions will receive a qualitative treatment.

The test of null hypothesis in the study involving the concept maps will be accomplished by means of a t-test (uniform distribution of the result) or a transformed t-test (non uniform distribution of the result), with alfa set to 0,05.

## 4 CONCLUSION

When developing new didactical materials, it is fundamental to access its real value and outcomes. A well-conducted evaluation can help developing a good tool, by accessing its field performance. The final goal is to create a didactical instrument that really helps the student to learn more and better.

Apparently, a hypermedia system like Biomec is adequate to the teaching/learning of Physical Education. This area needs a didactical material able to represent different forms of knowledge and different concepts and their relationships in a multidimensional and dynamical form and that is exactly what Biomec does. On the other hand, by beginning the learning process with concepts that really makes sense in the cognitive structure of the Physical Education students (according to the significant learning theory), and allowing for the non-linear navigation through the contents (according to the cognitive flexibility theory) it is expectable the achievement of improved outcomes.

However, only an astringent evaluation, with the target public, can assert what are its real benefits.

This work has presented a methodology for the evaluation and improvement of the hypermedia system Biomec. It makes use of concept maps and techniques of multivariate data analysis and can be used to evaluate any similar hypermedia system developed to improve the learning processes.

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