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SEVIBA: VIRTUAL REALITY FOR LEARNING TO LEARN AND TO DEVELOP SYSTEMS THINKING BASED ON SYSTEM DYNAMICS MODELS

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ABSTRACT

This paper presents Seviba, it is the result of a learning process whose main goal was to propose methodological guidelines for the development of learner–directed learning are based software. In order to favour the development of system thinking, SEVIBA bases the study of viruses and bacteria on System dynamics models and computer simulation. As a result of knowledge making, students are prepared to develop thinking skills which let them assume the study of complex phenomena, through the application of system Engineering.

Lastly, a final reflexion presents some guidelines for the development of learner–directed learning based software which favours system thinking.

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INTRODUCTION

The research presented here is an alternative to the development of software base on a constructivism approach for the learning of system thinking, in this case, through the study of viruses and bacteria. System dynamics models and computer simulation are proved to be effective for the comprehension of these microorganisms. Computer based models allow the illustration of the life cycle of viruses, the work of nitrificant bacteria, and the complex interactions of these microorganisms with humans in terms of epidemics. These models based a constructivism approach are more dynamic, integral, and highly pedagogical tools for making knowledge. The application of system thinking and system dynamics reinforces the teacher's work. This learning environment is designed to give learners freedom to learn as much as they can by favouring the development of the system critical thinking skills proposed by Richmond[3], this can be reachead customization the learning process, generalization toward to similar contexts as well as developing specific skills and abilities.

This is the reason why, the main goal of this research is to propose methodological guidelines for the development of learner–directed learning based software in order to favour the development of system thinking through system dynamics models and computer simulation. This learning means will have these characteristics and purposes: to propose the development of constructive thinking as well as learning in a ludic way i.e by playing. To provide concept and process testing through simulation, which leads learners to prove their hypotheses or ideas and to contrast them. They can do it through several different languages for representing knowledge such as: conceptual, causal, graphic, and audiovisual language.

To make this tool effective, a learning environment is required that takes advantage of the new roles of teachers, learners, and software in order to achieve a collective making

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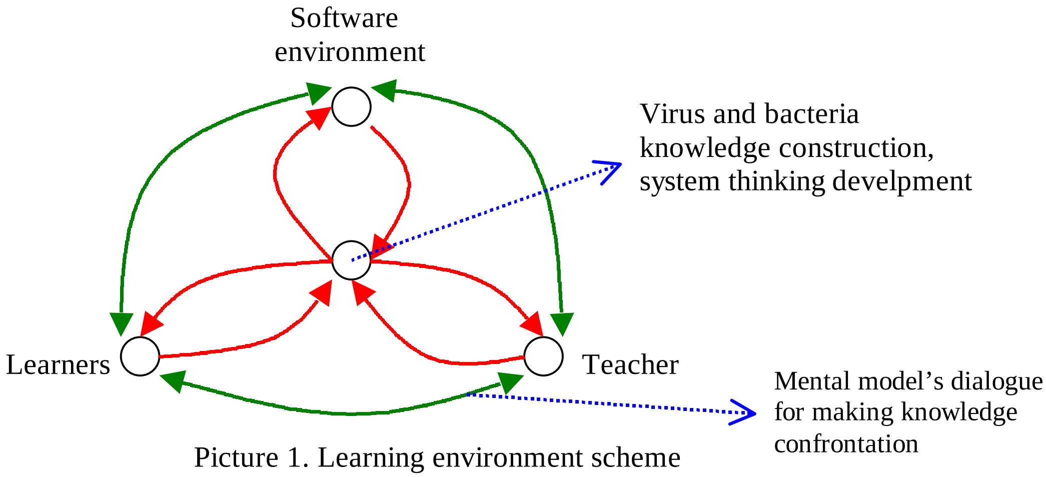
[3] RICHMOND, Barry. System thinking: critical skills for the 1.990s and beyond. System Dynamic Review. (1.993).

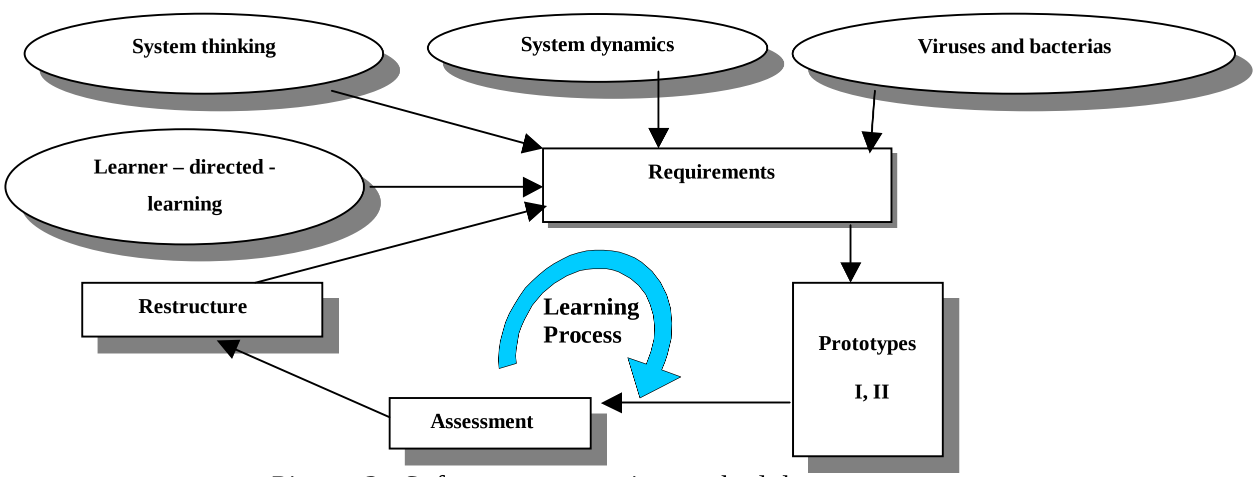
knowledge and development of system thinking. Picture 1 represents the learning environment.



Picture 1. Learning environment scheme

METHODOLOGY

The methodology for the development of this software arises from a conceptual framework which integrates Constructivism approach, System thinking, System dynamics, as well as the basic concepts and processes about viruses and bacteria, and their relation to humans, in order to determine the basic requirements for the implementation of Prototype I. This prototype was tested and evaluated in accordance with the initial requirements determining the aspects to be restructured for prototype II; for the implementation of prototype II was taken into account that making constructivism based software must be coherent with the pedagogic model to be applied so that the methodology to be used becomes a generative – constructive learning cycle. (Picture 2).



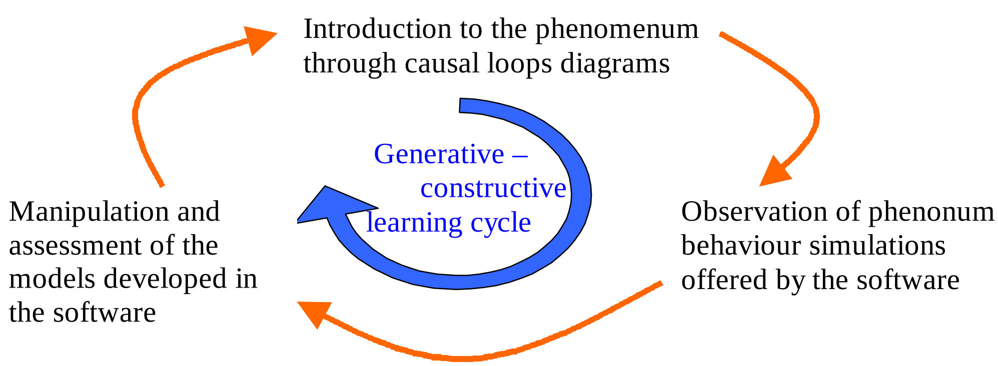
Picture 2. Software construction methodology

SOFTWARE PEDAGOGICAL STRATEGY

The purpose of the strategy is to facilitate the integration of System thinking and Constructivism approach and to contribute to the development of a generative–constructive learning.

Teacher's strategy

This is the outline of the teacher's strategy:



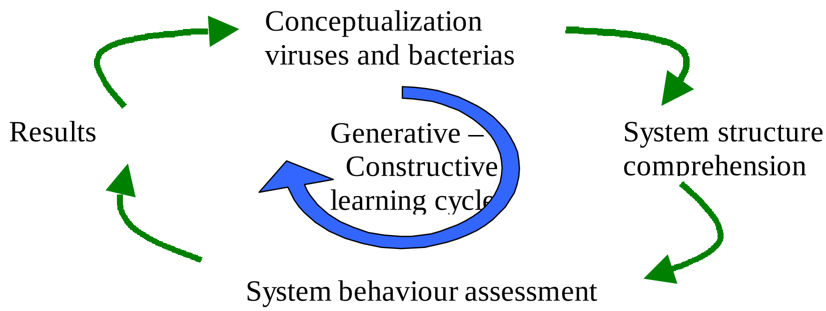
Picture 3. Teacher's Strategy

To achieve an introduction to the System thinking world, it's basic that teachers handle causal loops language due to the fact that the learning process is cyclic. Therefore, teachers and learners must know the system dynamic language in order to take advantage of how the system dynamics language to explain the basic concepts and processes on viruses and bacteria. Handling this language prepares the learner for the observation of the phenomenum simulations, which describe and determine processes, elements, and characteristics of the system. The outcome of this language knowledge is that learners and teachers acquire the faculty to manipulate and evaluate developed models by comparing the system behaviour with expected results as well as by evaluating its impact and consequences.

System thinking learning strategies within the software

The strategy studying of the system thinking within the software was developed base on the feedback experience model OADI (Observe, assess, design, and implement) proposed by

David Ford[4]. The analysis of simulation offered by the software and the handling and assessment of developed models are the basis for the system thinking learning strategy within the software:



Picture 4. System thinking learning strategies

Concept acquisition is achieved in the basic concepts section through multimedia technology. Virus processes (life cycle, interactions with humans concerning epidemics) and bacteria processes (work of nitrificant bacteria and reproduction) are explained in a dynamic way through causal loops diagrams. The development of operational thinking by this software enables the understanding of the system structure as well as the development of dynamic, cyclic, structural, and generic thinking. The evaluation of the system behaviour is done through the simulation of the models corresponding to nitrificant bacteria labor and epidemic, the comparison of results according to made decisions about given situations, and lastly, through the mental model modification, namely, the development of dynamic, scientific, continuous, structural, operational, and cyclic thinking. Therefore, the results stage is carried out through constructive learning assessment.

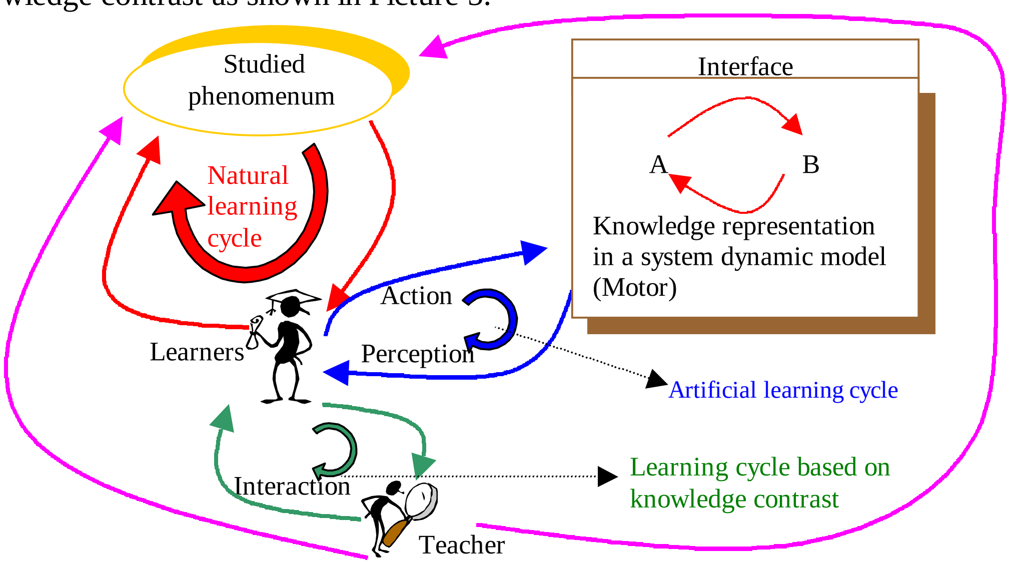
Characteristics of evaluation in the software. Software designed for the development of System thinking requires evaluation in accordance with the caracteristics mentioned before. This evaluation tests the comprehension of the learner base on their mental models as well as the development of a critical spirit and constructive thinking. Therefore, this software assessment determines knowledge acquisition evolution, that enables students to look for appropriate solutions according to situations given.

[4] FORD, David. System Dynamics as a Strategy for Learning to learn. En: THE INTERNATIONAL CONFERENCE OF SYSTEM DYNAMICS. (1.998:Quebec). The International Conference of System Dynamics. Quebec:1.998.

Every question was designed to be open to debate, experiment, make decision, study of real life situations, and make hypothesis. Moreover, the questionnaire was organized into categories according to each critical thinking skills.

Knowledge construction process through the virtual world

This process begins when the learner interacts with the virtual world, which is made up by an interface and a system dynamic model. This interaction lets to the learner think about phenomenum, which generates an artificial learning cycle. As Sotaquirá[5] suggets, in the virtual world it must be possible to experience make decision followed by feedback about its consequences. Therefore, the virtual world must be a model that simulates the dynamic behaviour of the organization in the presence of different action choices and under different organizational and environmental scenes. An ability to interact with the phenomenum studied is acquired when developing artificial learning. The modification of the learner's mental model gives the learner the faculty to make decisions that make the comprehension of the phenomenum easier, generating then a natural learning cycle. On the other hand, the teacher creates the learning environment and a the same time, interacts with the student and the phenomenum to be studied. In this way, the theacher favours a learning cycle base on knowledge contrast as shown in Picture 5.



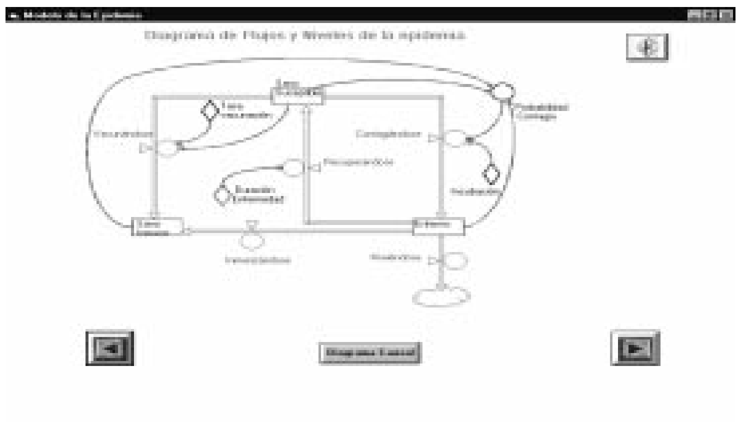
Picture 5. Representation of the virtual world for knowledge construction

[5] SOTAQUIRA, Ricardo. Modelamiento Conceptual de Organizaciones Humanas. Bucaramanga,1.999. Tesis de Maestría en Informática (Magister en Informática). Universidad Industrial de Santander. Facultad de Ingeniería de Sistemas.

RESULTS

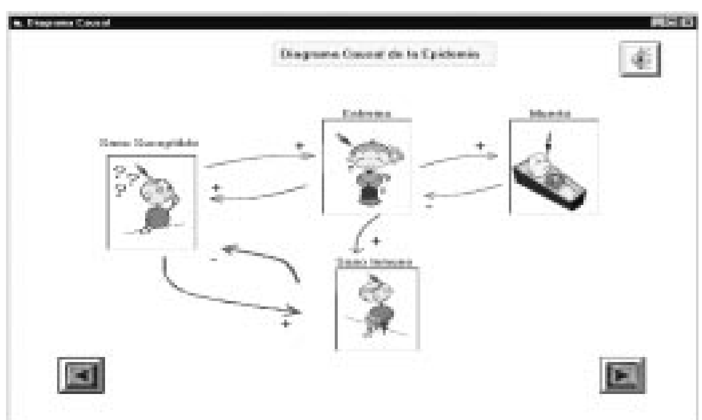
Software

Picture 6 presents a simple stock and flow diagram of the epidemic used in the software for the learning of system dynamic basic concepts, where the function of the different elements were defined within the model to be studied.



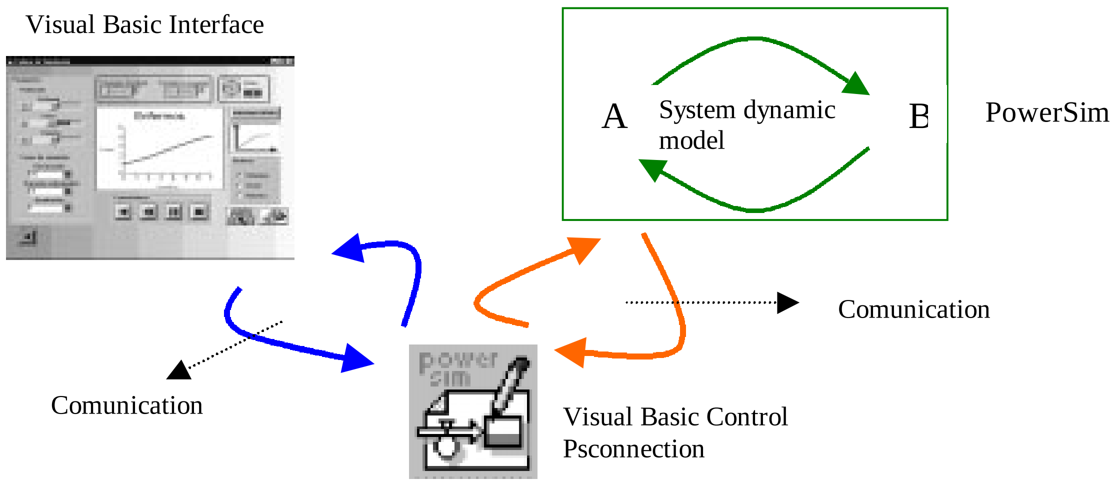
Picture 6. Simple epidemics stock and flow diagram

Picture 7 represents the epidemic's causal loop diagram, where the student can understand the dynamic generated by this structure, the influence among the system components, and the relations generated by these influences.



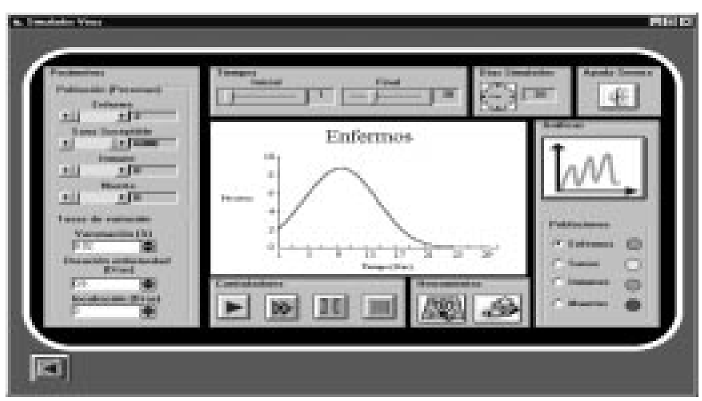
Picture 7. Epidemic's causal loop diagram

Picture 8 presents the basic architecture of the software, which is integrated by an Enterprise Visual Basic 5.0 interface and simulation models base on system dynamics developed with Powersim Constructor 2.5d software. The communication between these applications was made by using Control Activex Pscnct32.



Picture 8. Software Architecture

Picture 9 represents the simulation cabin where students have the chance to interact with the epidemic model by modifiying the state of the variables of the model to be simulated as well as by contrasting their mental model of the phenomenum behavior with the real results of the simulation.



Picture 9. Epidemic model simulation cabin

This software was evaluated in 9th and 10th grades at Inem School in Bucaramanga, Colombia.

Proposal of Methodological guidelines for the development of learner–centered–learning software for favouring system thinking

Now, we will present a final reflexion and some guidelines recommend:
Select the phenomenum to be studied within the software and establish why it is convenient to develop it through a learner–centered–learning and system thinking.

Determine a methodology in accordance with learner – centered – learning, which should become a generative – constructive learning cycle.

Specify the software characteristics in accordance with a learner–centered–learning, which should favour the development of system thinking.

Define a strategy for favouring system thinking learning within the software.

Determine a pedagogical strategy to enable the appropriate of the software use.

Establish the learning environment for making the knowledge construction process easy through the use of the software.

Define the evaluation for and within the software in accordance with the system thinking and learner–centered–learning characteristics. Evaluate the learner's system thinking development stage.

Like there is not a unique way for making knowledge, there are not unique methods for developing learner–centered–learning software.

CONCLUSIONS

The new computer software generation arises as a result of the integration of system dynamics and learner-centered-learning, which offers a solution to traditional education problems. It gives learners the chance to explore and make decisions for making knowledge and approaches them to the system dynamic methodology.

Moreover, it makes easy for learners the comprehension of its basic foundations, its contribution to the educational process, and the advantages of its application in the whole system.

The traditional software ingeneering does not satisfy the needs of the actual society because its design is not base on a real reflection about educational model. As a result of this failure, the traditional software educational continues delaying the development of real and true learning.

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