MICROWORLDS : A SYSTEM DYNAMICS APPLICATION IN LEARNING KEYNESIAN MACROECONOMICS

Hugo Hernando Andrade Sosa[1], Jaime Daniel Mejía Castro[1], Ricardo Vicente Jaime Vivas[1] and José Alberto Pinto Mantilla[2].
Universidad Industrial de Santander
A. A. 678. Bucaramanga, Colombia
Tel/Fax : (57)-(976)-349042
E-mail : HANDRADE@UISCOL.UIS.EDU.CO

ABSTRACT

Teaching economy in colombian universities is so difficult, specially in curriculums for students of fields different to economy, in which economy courses are often so little motivating, and they are developed with a very specialized terminology, difficult to be well understood; in addition to that, there are big troubles in testing in real world whether student's ideas to control an economic system are effective or not. Computer science offers new tools in all human activities, including education. Here it is presented HICEFE[3] (Computational tool for Comprehension and Experimentation with Economic Phenomenon), that is a proposal to incorporate computational technology in teaching economy, and to reinforce the application of a systemic approach in the educational process, feasible of being used in different study fields. Models that conform the tool have been made with System Dynamics methodology, to be presented like microworlds that offer to the user the opportunity to study economic phenomenon, evaluating the student's understanding by experimenting with simulated solutions to problems.

1. ANTECEDENTS

Two traditional approaches try to determine the route of education : conductive and constructive approaches. Conductive approach focalizes education in looking for the appropriate set of answers to the environmental stimulus. In situation A, answers have to be A_1, A_2, A_3, ..., A_n. Frequently this feature of the educational system disencourages students to continue, since it affects their capability to analize solutions or alternatives different to those that belong to the set defined to each situation. Constructive approach gives to the student -obviously with the teacher like a guide- the responsibility about his own learning process, and the student is who looks for information, he is who analizes it, and he is who discusses it with other people, achieving a deeper comprehension and a better knowing about his study field, that lets him build a growing model with his own criteria. Most of economy knowing of humans, developed by the hard work of studious people, has been formalized in technical concepts and complex mathematical equations, assembled in a body named econometrics, which supports the economic predictions; certainly, it is a heavy equations body to represent distinct features of the economic situations, but this equations have reached such a technical degree, that is practically impossible for people understand them when

---

[1] Escuela de Ingeniería de Sistemas e Informática. Group of Research in Models and Simulation SIMON.
[2] Escuela de Economía.
[3] Spanish symbol of Herramienta Informática para la Comprensión y Experimentación de Fenómenos Económicos.

they don't have a specialized preparation in economics. One of the consequences of that, is the low level in student's capability to integrate the long list of concepts they have studied, and to discuss deeply the troubles and economic processes of the nation or of the world.

2. WHY SYSTEM DYNAMICS ?

2.1. MODELLING AND EDUCATIONAL SYSTEM

For the constructive approach, systems thinking is more a complement than an alternative; systems thinking lets the student have a bigger capability to analize in a global way the system that is being studied, with a viewpoint that has been built by himself. The teacher's role has to be projected to the proposition of new experiences, while the student's role has to be projected to the management of the system instead of the reception of concepts. Systemic approach seeks to reinforce the guide role of the teacher, keeping the importance that the rhythm was defined by the student; it is the objective to achieve an integral knowing about the phenomenon, that requires a complete preparation and a bigger experience of the teacher, to point the reaches of the study, and to generate worries in students to maintain their interest in the issues. It has been noted that students reach a best understanding of phenomenon inside a system, when he studies them like a process instead of memorizing statistical behavior patterns, this means, students builds a mental model of the phenomenon at the same time he studies it. Such a model lets student foresee reactions inside a system when a stimulus appear. It is also true that individual capability to control the system behavior doesn't depend only on his concepts list about it, but also depends on the quality of his model of the system; if that model is not consistent, there will be mistakes when student wanted to operate the system. System Dynamics methodology features are appropriate to model complex phenomenon like those inside an economic or productive system.

2.2. MODELLING TO TEACH ECONOMY

First, it's not possible to expect an inmediate response of the economic system to a management policy. On the other hand, economic systems are intrincate nets that include feedback loops that many times are not borne in mind to formulate econometric models, but System Dynamics makes it relatively easy to integrate this feedback loops, in order to get near representations of reality. This two reasons motivated the beginning of the study of keynesian macroeconomics, to obtain models useful in teaching, to make softer the terminology and to make it easier for the student to comprehend economy and to build models, specially for students in curriculums that are not directly related with economic sciences.For those students, tools have to be provided not only to support learning process, but also to get a growing student's interest in concepts, objective that is possible to be gotten by using tools that let users experiment, speculate and check their knowing.

3. HICEFE

3.1. MODELS

In order to build models, teachers and students involved in this project began studying keynesian macroconomics. Conceptualization and representation in causal loops diagrams were built keeping

graduality in the complexity of models, with the opinion of people that work teaching economy or modelling with System Dynamics, and ever bearing in mind sociological aspects. As complexity was growing, new elements were included to represent distinct Keyne's theoretical proposals. Terminology to express theoretical concepts in causal loops diagrams was important to give familiarity to them; it was identified the need that the elements included in models let students design management policies to the system through changing simulation parameters.

3.2. USING THE TOOL

HICEFE consists in an interface incorporated to EVOLUCION 2.0[4], to let users have an easy navigation through predefined models built along this project. According to the user's experience in applying System Dynamics, HICEFE offers a determined degree of manipulation of the models in different study phases.

3.2.1. CONCEPTUALIZATION

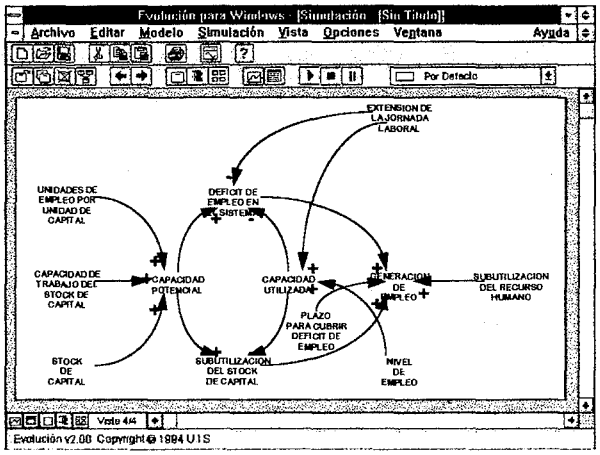

Figure 1. Causal Loops Diagrams Editor

HICEFE has a causal loops diagrams editor (See Figure 1), in which each element and each relation has an associated information, that explains the role of elements and relations in the model. In predefined models, student can find answers about why each element was included, how an element influences another one through a positive or negative relation, and how each element interacts with the others. Causal loops diagrams editor offers a feedback loops identifier, wich can store aditional information about the dynamics of cycles. Economic models built to this project give descriptions about their meaning.

3.2.2. FORMULATION AND EVALUATION

Students without experience in modelling with System Dynamics, can study predefined models and modify their simulation scenarios, to experiment their own policies. Students with the necessary experience have the opportunity to use the resources of EVOLUCION 2.0 to create their own

[4] Software to support mathematical modelling with System Dynamics, developed by Group SIMON.

models. Graphic presentation of results let student determine whether his proposals can point the system to the required state, or whether it's necessary to modify the proposals to get the expected results.

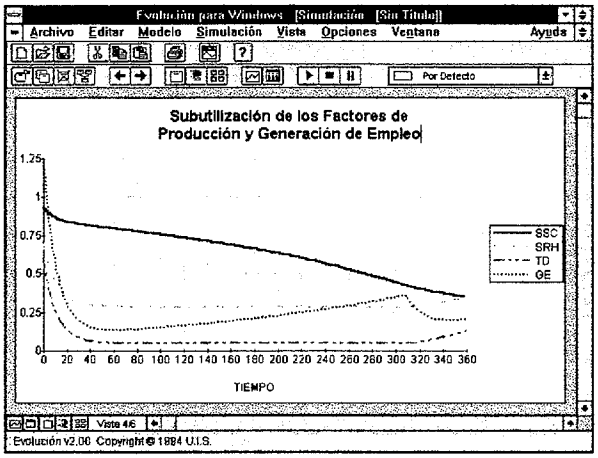

Figure 2. Presentation of simulation results

4. CONCLUSIONS

Graduality in building models makes it easy study economic phenomenon. To the teacher, HICEFE offers a complement to the way of teaching economics, including the possibility to see clearly those relations that are not included in econometric models. To the student, HICEFE gives the opportunity to manipulate models components and to see the effects that this manipulation causes in system behavior, in order to experiment with the student's ideas about how the system has to be directed.

5. REFERENCES

System Dynamics Society. 'SYSTEM DYNAMICS REVIEW : SYSTEMS THINKING IN EDUCATION'. "Introducing System Dynamics in Schools : The Nordic Experience". Wiley & Sons Ltd. Vol. 9 No. 2. Baffins Lane, Chichester, UK. Summer 1.993. pp 165-181

System Dynamics Society. 'SYSTEM DYNAMICS REVIEW : SYSTEMS THINKING IN EDUCATION'. "Bringing experimental Learning to the Social Sciences". Wiley & Sons Ltd. Vol. 9 No. 2. Baffins Lane, Chichester, UK. Summer 1.993. pp 165-181

Roberts, Nancy. 'INTRODUCTION TO COMPUTER SIMULATION. A SYSTEM DYNAMICS MODELLING APPROACH'. Addison-Wesley Publishing Company. 1.983

Group of Reserach SIMON UIS. 'MANUAL TECNICO DE EVOLUCION 2.0'. Bucaramanga, Colombia. 1.995

Mejía Castro, Jaime Daniel y Jaime Vivas, Ricardo Vicente. "HERRAMIENTA INFORMATICA PARA LA COMPRENSION Y EXPERIMENTACION DE FENOMENOS ECONOMICOS". Group of Research SIMON UIS. Systems Engineering thesis. Universidad Industrial de Santander. Bucaramanga, Colombia. 1.996.