Active modelling and simulation in learning environments concerning business subject matters

A systematic reflection on related approaches and concepts.

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I Active modelling in business subject matters

Results of an empirical study have shown that in classes of 'industrial office clerks' - in the German *Dual System* of vocational training - active modelling can have a positive impact for a better comprehension of interrelations in business subject matters. Students state that they are able to see more chances of learning business coherence and/or complexity using active modelling as compared to exploratory glass-box-microworlds.

In spite of numerous applications of SD-based modelling in various teaching approaches (STERMAN 2000) no theory which reflects these learning processes has yet been well developed or can be seen as related. This does not mean however, that there are no instructional principles to support this way of learning. The k-12 group, CLE[1] and other authors in this domain are very much involved in examining and constructing such platforms. Different approaches exist some of which are well documented e.g. 'critical thinking' (CLE), RICHMOND's paper (1993) or by FORRESTER's 'roadmaps' in the internet which is always connected with instructional ideas e.g. of learner centred learning. An additional approach is to define 'standards' for system dynamic projects.[2] These standards should give guidance and goals for the process as well as to evaluate the final product. To summarize is that this work focuses primarily on content analysis aspects. Additional issues are to look for the best techniques or teaching methods such as collaborative learning etc. to teach SD.

[1] The Creative Learning Exchange encourages a view of education for primary and secondary schools based on discovery as the essence of the learning process and advocates systems education implemented through learner-centred learning.
[2] Rubrics For Understanding: Using System Dynamics Tools prepared by the Dynami*QUEST* 2000 Committee

One open question is however, how can the quality of learning process be evaluated? Without reference to a scientific (learning) theory it is not possible to develop an appropriate diagnostic approach.

II A synopsis of approaches to complexity

The proposal is that the synopsis of similar concepts could foster the development of a platform for a (learning-) theory based construction for sd-based learning environments and their evaluation.

Multiple concepts exist in Europe, the US and GB, belonging to different research fields each of which cope with the phenomenon of 'complexity'.

Theoretical concept / Essentials	**Mental Model** (JOHNSON-LAIRD, GENTNER)	**"Coherent Thinking"** (VESTER, GOMEZ/PROBST)	**Complex Problem Solving** (DÖRNER, FUNKE)	**System Thinking/ System Dynamics** (FORRESTER, STERMAN SENGE)
Concept description				
Statements (empirical)	functionality of Mental Models	8 principles of nature which guaranties the survival	'the logic of failure'	The Laws of the Fifth Disciplines
Integration of other concepts	Problem Solving	Problem Solving	System Thinking	Mental Model
Educational focus	none	• causal-loop	• micro worlds • causal-loop	•causal-loop •level-rate
Diagnostics	verbal protocol		performance of control; system states	Interdisciplinary assessment[3]

Fig.1: Overview 'management of complexity' in different research fields

It should be kept in mind that some research fields such as problem solving, have different scientific goals or traditions in Europe, the US and GB. There is empirical evidence that Mental Models serve as a prerequisite f ies and actions in complex dynamic situations. It would seem as a consequence that, a concept like Mental Models should be included into these considerations.

[3] Tad T. Sudnick(1992). Interdisciplinary Evaluation Techniques Using System Dynamics (D-4320-1).

The mutual integration of these different concepts and the transfer or loan of various aspects, some are used eclectically, is apparent. If this is not considered properly it can lead to misconceptions due to the different underlying theoretical concepts of the research fields.

III Perspective

The process of synopsis can lead to systematic procedures for

- identifying misconceptions between the different research fields
- providing an overview of concepts which help to cope with complexity
- elaborating possible support by educational means
- grounding approaches to synergetic effects
- prevent neglect of alternative perspectives
- help-develop appropriate diagnostic instruments based on theoretical background

This final item should prevent the eclectic selection of measurement tools for active modelling in business subject matters, depending alternatively on the 'best fit' for the designed experiment. It could then be demonstrated which criteria support this type of measurement.

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