

Transparent-Box Business Simulators versus Black-Box Business Simulators: an initial empirical comparative study.

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1. Introduction.

As we stated in a previous study (see Machuca *et al.*, 1993, p. 289), we have been criticizing, since 1988, the use of black-box business simulators (BBBS) and defending the use of transparent-box business simulators (TBBS), in which the structure (for example, in the form of a causal diagram), and even the main equations of the model on which it is based, are at all times accessible to the user, who will therefore find it easier to make decisions based on previous study of the possible causes of the different behaviour of the variables, and not only on observation of the latter, which are simply effects. Our approach was based on the hypothesis that in this way the learning process and acquisition of systems thinking would be clearly improved (Machuca, 1992). Although other authors have subsequently touched on this topic, directly or indirectly, (Eberlein (1989), Isaacs and Senge (1992, p.195), Kemeny and Kreutzer (1992, p.305), Morecroft (1992, p.465), Peterson (1992, p.117), Sy-feng and Young (1992, p.765)), the idea has scarcely been reflected in transferal in practice to game-design. In our view, one of the most valuable tools that System Dynamics offers to the development of systems thinking was being lost (Machuca, 1992, p. 176).

With the above in mind, we decided to move on from ideas to action, and in 1994 began an empirical experiment, the *fundamental objective* of which was to establish whether our hypotheses were correct. Although this experiment is still in progress, we believe that the results obtained during the last two years are relevant enough for us to conclude that our hypotheses were well-founded.

In the experiment our *secondary aims* were to compare TBBS and BBBS with other teaching methods, specifically traditional classroom teaching and the case method.

2. The experiment

Year 1994

We worked with a sample of 54 students from the 4th and 5th years of the Business Management degree course, organized into 18 groups of 3 individuals, since we believed that the synergy produced by the group work would benefit learning. Eight groups played with the BBBS type and the rest with TBBS. The steps taken were as follows:

a) All the students were initiated in Systems Thinking, with emphasis on the differences between this and the analytical approach.

b) All played with a very simple game, with the sole aim of becoming familiar with the software to be used. In this way, when later using a more complex game, they would not be distracted by the form, but concentrate on the essential underlying aspects.

c) In a special session for the BBBS groups, the case which they were going to simulate, a firm manufacturing a single product with a total of six decisions being made connected with the areas of production, personnel and finance, was explained in the traditional manner,

without going into an explanation of the causal structure. They were previously provided with the relevant written documentation.

d) In a special session for the TBBS groups, the causal structure and the main equations were explained to them. They too were previously provided with the relevant written documentation. In both this session and the one mentioned above, the case was discussed and the students claimed to have understood it.

e) The different groups then played with their respective versions (BBBS or TBBS) of a medium-complexity simulator representing the case over several sessions. This was done starting with a simpler version, which in subsequent sessions became more complex in its structure, with an increasing number of decisions having to be taken. This enables new situations to be tested, which substantially increases the number of learning experiences and considerably improves the player's capacity to adapt.

Once a simulation had been carried out, players compared the actual results with those expected, and, in case of discrepancy, analysed the causes of this behaviour. To this end, the groups playing with TBBS had to make use of the causal diagram and, if they considered it necessary, the principal equations of the model, these tools providing a basis for improving subsequent decisions. This possibility was not offered by BBBS, which only allow access to the results observed, that is, the effects or symptoms, but not the causal structure giving rise to them. In this latter case a trial and error procedure is usually followed, based on the mental models each player has of the case being examined.

f) After the end of each session (five in all) each group answered a questionnaire covering numerous points and making it possible to observe:

f1) *objective aspects* (after each session (5 in all), depending on the complexity of the version of the game used):

- * understanding of the case under simulation.
- * understanding of the interactions between variables (that is, the functioning of the system):
 - x questions for which the previous education of the students could be sufficient to give a correct response.
 - x questions previously commented upon in the documentation received or related with variables connected by relatively short chains of interactions and variables.
 - x questions not commented upon in the documentation received, or related with variables connected by longer chains of interactions and variables.

f2) *subjective aspects*, linked to the students' perception of the greater knowledge attained through the game (BBBS or TBBS) in relation with different aspects studied previously by means of traditional teaching.

Year 1995

Working from our 1994 experience, we extended and improved the experiment, both regarding the sample and the aspects studied. The sample consisted of 87 students from the 4th and 5th years of the Business Management degree course, organized into 13 groups for TBBS and 16 for BBBS. The steps taken were:

a) Initiation of all the students in systems thinking, with emphasis on the differences between this and the analytical approach.

b) The use of a very simple game to become familiar with the software.

c) The use of the well-known oscillations model as a classic and elementary case:

- * Explanation of the case to all the groups (having previously received the explanatory documentation (without the causal structure)).

- * The groups dealt with the problems presented as a classic case.
- * Questionnaire to compare the use of cases with traditional teaching.

d) Use of the oscillations model in black box type version of the game by all groups, starting with the simplest structure and gradually increasing the complexity. After each phase, questionnaire on understanding of interactions. After the final phase, general comprehension questions and others to compare BBBS with the case method.

e) Thirteen of the groups were initiated in the elaboration of causal diagrams. They were then asked to produce a diagram for the oscillations case, which they would later compare with the diagram for the representative model. Discussion and explanation of the case.

f) These thirteen groups played with the TBBS version, using at each stage the causal diagram and, where appropriate, the equations.

g) Debriefing for the case considered.

h) Use of a more complex game (the one used the previous year):

- * Procedure as for a classic case (see point c).

- * Procedure (for 13 groups with TBBS and 16 with BBBS) following the sequence indicated for 1994 (points c to f), but increasing the number of questions and aspects of study (now all the students compared their respective games with the case method, considered aspects such as motivation, there were more questions on understanding of the interactions, etc.).

i) After a systemic explanation of the game, eleven BBBS groups switched to the TBBS version, following the same sequence and answering the same questionnaire (playing only once, as opposed to several times with BBBS).

3. Brief summary of the results

The analysis of the questionnaires elaborated during the two years mentioned show results which indicate:

a) the preference of the users for the games (BBBS and TBBS) as compared with traditional teaching.

b) although, in general, BBBS users express a preference over the case method, it is not particularly marked. However, there is a clear preference in the case of TBBS users.

c) the results obtained with TBBS are better than those for BBBS.

d) there is a clear preference for TBBS over BBBS in the case of students who have used both. They claim that with the former there is greater motivation, growth in knowledge and learning.

In our presentation we will show in greater detail the above mentioned results.

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