Learning and Education Experience in System Dynamics of Management Students: Case Studies

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ABSTRACT

Article describes experiences in the teaching of a modelling and simulation course for students at Faculty of Organizational Sciences. The course consists of time-continuous simulation based on System Dynamics (SD) and discrete event simulation (DES). It is held in the 3rd year of studies, at which point students have taken courses in mathematics, statistics, theory of systems, as well as organizational and economic courses. The final grade for the course is derived from the student’s project and written exam. Students took part in an experiment where they had to solve a managerial decision problem supported by a simulation model. Experimental results were then analysed and discussed in the students’ projects. Students’ contributions were part of their final grade. The results show that students, taking the course of Modelling and Simulation, thought that application of the simulation model contributes to a greater understanding of the problem, the faster finding of solutions, and enhanced confidence of the participants. The results are explained and discussed using a learning model.

KEYWORDS

Education, Experiment Design, Group Decision, Learning Model, System Dynamics

INTRODUCTION

The role of simulation methodology in the decision assessment of complex systems is constantly increasing. Human knowledge, the simulation model, and decision methodology combined in an integral information system offer a new standard of quality in management problem solving (Simon, 1997). The simulation model is used as an explanatory tool for a better understanding of the decision process and/or for learning processes in enterprises and in schools. Many successful businesses intensively use simulation as a tool for operational and strategic planning as well as enterprise resource planning (ERP) (Schniederjans & Kim, 2003; Muscatello, Small & Chen, 2003). Experiences described in literature (Forrester, 1969; Homer, 1969), emphasize that real problems in a variety of industries can be solved with computer simulation for different purposes and conditions. At the
same time, potential problems can be avoided, and operative and strategic business plans may also be tested. The combination of simulation models with expert systems was started early in 1970 (Dijk et al., 1969; Hall, 1969). Presently, the most intensive efforts are concentrated on the application of simulation methods and expert systems on a broad field of research (Rozman et al., 2013; Martins et al., 2015; Baier et al., 2015; Diniz et al., 2015). Although there is a considerable amount of work devoted to simulation methodology, the application is lacking in practice; especially in small and medium-sized companies.

One of the objective problems is model validation, which is crucial for any model-based methodology. The validity of the model of a given problem is related to the soundness of the results and its transparency for users. According to Coyle (1969) as well as Keys as Wolfe (1990), a valid model is one that is well-suited to a purpose and soundly constructed. The second problem, the subjective one, is related to the transparency of the methodology and data presentation (Kahneman & Tversky, 1979), preferences of the decision-maker for using a certain decision style and poor communication between the methodologist and the user. The simulation methodology is a paradigm of problem-solving in which the personal experiences of users, as well as their organizational culture, play a major role (e.g., in transition countries: market economy, ownership, etc.).

This paper describes experiences in the teaching of a Modelling and simulation course for students of management sciences at the Faculty of Organizational Sciences, University of Maribor. Our course consists of continuous simulation based on systems dynamics and discrete event simulation DES. The course is in the 3rd year, and students have already taken courses from mathematics, statistics, theory of systems, as well as organizational and economic courses. The final grade for the course is derived from the student’s project and written exam. In this paper, we will discuss methods of teaching SD and its impact on the students’ performance (final grade). The paper is arranged in four sections after introduction. The second section summarizes related work. The third section introduces a brief description of our past research (Škraba, Kljajić & Leskovar, 2003; Škraba, Kljajić & Kljajić Borštnar, 2007; Kljajić Borštnar, Kljajić, Škraba, Kofjač & Rajkovič, 2011). The fourth section presents the learning model depicted as an SD model. The fifth section presents the educational value of a simulation experiment and conclusions.

Literature Review

Many articles devoted to these topics are published each year. Analysing the Tomson Web of Science for the year 2015 one can find over 270,000 articles for the keyword “simulation”, over 900 for “simulation and decision support”, “system dynamics and decision support and management” returns 189, while for “system dynamics and education and management” 59 articles are found. This number has grown exponentially in the past few years, which indicates the relevance of the topic. This makes it a vast research area that cannot be fully explored. An overview of the use of simulation methods in education started in the 1990s (Lant & Mezias, 1990; Keys & Wolfe, 1990). Lant & Mezias (1990) clearly depicted the relevance of experimentation on a simulation model for organizational performance, growth and survival for different strategy while Keys and Wolfe (1990) studied the educational value of management games. Both of them discussed the conditions for the model validity and organization of simulation and education. Hsiao & Richardson (1999) systematically analysed 33 empirical studies on dynamic decision making. From the surveyed texts, they defined five categories of evaluation criteria (dependent variables): task performance, learning, efforts for decision making, quality of the decision-making process, and decision-making architecture; and three categories of predictors (independent variables): decision-making factors, task complexity, and user interface. They identified information feedback as one of the constantly present independent variables used in the studies, although those on the use of feedforward, outcome, or cognitive feedback are not unanimous about their impact on task performance. Thus, they proposed that future research be focused on the components of particular information feedback and their interaction. In the study by Rouwette et al. (2004), 51 articles from SD-based simulators were analysed to identify factors that...
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