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CAN WE LEARN FROM WRONG MODELS? AN EXPERIMENTAL STUDY ON LEARNING FROM OVERSIMPLIFIED SIMULATION MODELS

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ABSTRACT

Simplifying a model is a necessity in order to create it, but extreme simplification can lead to a wrong - inaccurate or unrepresentative - model. If we end up with such a model, can we still learn from it? This paper investigates possible usefulness and learning outcomes from using wrong models in Simulation. An experiment comparing learning of a model of two different fidelity levels - oversimplified and adequate - is set on a pre/post-test basis utilizing a psychological framework to measure differences within two groups of students. The results suggest that users of the oversimplified version managed to gain a similar level of learning to those using the adequate, while they denoted their model as wrong but still useful for their tasks. Future work will tackle the factors that constitute to creating wrong models and wrong model uses in practice by interviewing simulation experts.

1 INTRODUCTION

The limitations imposed to any modelling process (time, funding, resources, etc.) could result to the creation of a model that will not be an adequate representation of the reality it adapts. Depending on its development, the final model may even be considered as inadequate for use by its users (e.g. due to low validity, numerical outcomes, fidelity issues, etc.). Nevertheless, Hodges (1991) suggests that we can still learn from taking into account such models. Considering the dearth of empirical studies on this topic in the Simulation field, this paper investigates the possible usefulness of models that are considered wrong. To do so, the term is established within literature and an operationalization is provided for wrong models and learning. A set of objectives and corresponding hypotheses is formulated into an experimental design. The results of the experiment are presented alongside discussion on these outcomes and the work that follows.

2 WRONG MODELS AND LEARNING

Wrong models in literature have been characterized as "*unvalidated*" or "*invalidated*" (Hodges 1991), "*fault*" (Phillips 1984) etc. Various reasons for developing wrong models include decisions, model results, validation etc. Despite their plethora, few uses are suggested, since studies prefer successful cases.

A model is a simplification of the reality it interprets with its complexity related to its accuracy (Robinson 2015). Simplification is the process of altering model complexity (with the outcome referred here as the "*fidelity*" of a model). Thus, another reason for developing a wrong model is the improper use of simplification. Indeed, it has been stated that model abstraction is required - with clients preferring simpler models to work with (Robinson 2015) - but it may create inaccuracies to the model (Prieto et al. 2012). For these reasons, we examine the case of extreme simplification, in models that we term "*oversimplified*". The possible learning from these models is compared to their adequate counterparts.

Learning is a long-term process of acquiring or changing current knowledge, behaviors etc. Behavior is related to attitudes - the evaluation of someone's beliefs influencing thought and action (Schacter et al.

2014). The aim of our research is to explore if learning can be achieved by using oversimplified simulation models in order to inform and update the current literature and simulation practices.

3 METHODOLOGY

Considering the research aim, the main research question is: "*can wrong models offer the same learning outcome as adequate models*"? We define a wrong model as one that "*abstracts reality to such an extent, it is not perceived as adequate for the purpose it has been developed*" and we term it "*oversimplified*". Since learning is comprised of attitudes, a change in attitudes would eventually lead to someone's change in learning. To measure this, we adapt the theory of planned behavior (Ajzen 2005) that suggests attitudes are connected to beliefs and can be measured as the sum of likelihood of a belief, and, the rated desirability that the outcome of that belief is true, into an experimental study. A set of objectives and dimensions are created: change of attitude, user confidence, perception of wrongness, and usefulness of model. A model based on an ambulance service is used in two fidelity levels: oversimplified and adequate. Two groups of 32 students each are given a case study with a task and one of two versions to use. The experiment is on a pre/post basis, measuring attitude before and after using the model, with individual evaluation. The responses are measured on a 7-point likert scale (abiding by the above framework) while qualitative data is also collected in order to corroborate the results with the participants' views.

4 RESULTS

The analysis of the results suggests that both groups had a similar change of attitude. In other words, learning deriving from the two models was not statistically different. The self-evaluated users' confidence also didn't show any significant results. On the contrary, users of the oversimplified model suggested that their model was not as representative as those working on the adequate one. This is supported both statistically and by their qualitative answers. Finally, participants having the oversimplified model found it useful enough for the purpose at hand, without differing statistically from those using the adequate one.

5 DISCUSSION AND FUTURE WORK

The results suggest learning is possible from wrong models. Participants managed to find solutions to the tasks using models they didn't consider of equal fidelity, but both were still similarly useful to answer the case study questions. Limitations apply, such as using a larger sample size or more models at in-between fidelity levels. Future work will explore development causes and uses in practice of wrong models.

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