Dr. Felix Reed-Tsochas has successfully employed the Modelling4All tool BehaviourComposer in his teaching of the modules ‘Complex Systems’ and ‘Managing Complexity’. The pedagogical affordances of the software have enabled rich and deep learning experiences, resulting in students’ increased understanding of difficult subject specific knowledge and in their development of the methodological awareness required for carrying out contemporary research within mixed-methods paradigms.

Educational Context and Challenge
Having an academic background in physics, Dr. Felix Reed-Tsochas has primarily taught students familiar with advanced maths and computer programming languages. At the Said Business School, cohorts of MBA and MSc students are of multidisciplinary composition, and thus, Dr. Felix Reed-Tsochas had to design his 8 week elective modules ‘Complex Systems’ (MSc students) and ‘Managing Complexity’ (MBA students) in a manner that catered for the diversity of educational and professional backgrounds of this students. Theoretical models of systems are core content components of the two modules, and to facilitate the intended learning outcome of the lectures, Dr. Reed-Tsochas decided to make use of the Modelling4All tool in two separate 2- hour hands-on sessions. The sessions were dedicated to making each student build agent-based models of a society. Members of the OUCS’ Learning Technologies Group assisted Dr. Felix Reed-Tsochas in setting up the software and running the training session.
“Modelling4All allows you to take a bunch of students with no prior experience of programming language, and enables them to build and explore a model in a two hour training session.”

Dr. Felix Reed-Tsochas

Pedagogical gains of using Modelling4All in teaching

There are several reasons why Dr. Felix Reed-Tsochas found it pedagogically rewarding to have his students compose and run agent-based models - some relate to the nature of agent-based models in general, while others are concerned with the usability and flexibility of the Modelling4All tools. A powerful feature of agent-based models is their ability to display complex and changing phenomena visually and temporally; they make evident how emergent properties of local interactions between responsive entities on micro levels influence patterns on macro levels. In doing so, models enable the exploration and investigation of unanticipated outcomes of a given system or social world. Dr. Felix Reed-Tsochas has experienced how students in the hands-on sessions recognize this feature through their interaction with the BehaviourComposer: “They become able to see some of the emergent collective behaviour. For instance wealth distributions which they haven’t explicitly put into the model, but that are unanticipated collective consequences of the micro-rules that they have specified.”

A further pedagogical benefit of using the Modelling4All tool in teaching is, according to Dr. Felix Reed-Tsochas, that it initiates the development of modelling literacy. Modelling literacy is a transferrable skill that can serve to inform MBA students’ decision-making processes in future consultancy contexts. In addition, modelling literacy is a domain specific skill that makes students capable of scrutinizing literature and research involving agent-based modelling for generating or analysing data. As a method, agent-based modelling can be difficult to master in practice, because it relies on a certain degree of tacit knowledge. Therefore a ‘learning by doing’-approach is much more effective as Dr. Felix Reed-Tsochas explains: “Is it possible to describe to an audience what is involved in modelling - what the output of the modelling is. But a much more effective thing is to engage people in doing the modelling themselves, making their own mistakes, correcting their own mistakes, and getting a sense for how this modelling works.”

Learning outcomes and future aspirations

Dr. Felix Reed-Tsochas has observed positive changes in his students’ comprehension of agent-based modelling since he introduced Modelling4All sessions as an alternative to traditional lectures. The quality of assessed essays on the topic has gone up, and it is evident that the interaction with the software constructing models has facilitated deep learning; students are synthesizing knowledge, making connections between abstract concepts and are able to discuss this on an adequate academic level.

As a supporter of mixed-method research paradigms with a strong interest in innovative ways of carrying out research by means of networked technologies, Dr. Felix Reed-Tsochas is currently working towards developing a modelling module for DPhil students across the social science division, forming part of mandatory methods training.
Educational benefits of agent-based modelling

Themes addressed in scholarly literature

Other examples of uses

Modelling4All’s BehaviorComposer has been applied in different contexts across divisions at Oxford University. The tool has been used as a learning technology employed in classroom teaching and as a research instrument for generating data or testing hypotheses. A few examples:

Dr. Robert Belshaw, Department of Zoology, has used Modelling4All in practicals with undergraduate students. Through a BehaviourComposer model, students explored the role of social networks on the spread of diseases.

Professor Harvey Whitehouse, Institute of Social Anthropology, is leading the EC funded research project “Explaining Religion”. As part of the project, agent-based modelling has been employed to display dynamics of religions: A library of modelling components in Modelling4All has been developed to enable the simulation of models investigating various aspects of Professor Whitehouse’s theory of religiosity.

Modelling the unobservable

Agent-based modelling is a powerful way of facilitating learning of phenomena that cannot be observed ‘naturally’, for example, a theory or entire societies (Rieber, 1996). Creating a model by specifying a set of rule-based interactions between agents will allow students to playfully explore the influences of these interactions on the overall system, and analyse structures emerging from them (Janssen et al., 2008). Moreover, agent-based modelling is an effective way of visualising change over time in these complex systems or worlds.

Pedagogical benefits of modelling

One of the main pedagogical benefits of engaging learners in the creation of simulations is that the construction of a model requires of the students to make explicit underlying assumptions (Thompson, 2008). The modelling process itself thus prompts the students to critically reflect on the concepts and connections that the micro-behaviour represents, thereby allowing the opening up of discussions and comparisons of otherwise hidden or overlooked assumptions influencing the system. The outcome of modelling activities could therefore rightly be believed to facilitate deep learning, described as the making of “connections and synthesizing meaning as opposed to surface learning involving memorization of facts or specific elements.” (Butcher, Davies & Highton, 2006:89). One study providing evidence of increased deep learning is provided by Levy et al. (2004), investigating the influence of modelling on students’ understanding of chemical processes. In addition to enhancing the learning outcome, models can also enrich the learning experience as students find them evocative and motivating (Goldstone & Son, 2005).

Testing hypothesis

Agent-based models do not only serve exploratory purposes, but can also be effectively used for testing hypothesis. In instances where the agents forming part of the hypothesis are dynamic – for example, if their actions rely on past experience and they adapt future actions in accordance hereto – mathematical analysis can prove less useful because of its limited “ability to derive the dynamic consequences.” (Axelrod & Tesfatsion, 2006:1649). Enabling the analysis of relational levels is put forward as the main quality of agent-based modelling bridging the gap between micro and macro levels of enquiry (Macy & Willer, 2002). Other proponents of modelling as a learning and research tool even hail it as a novel third way of expressing theory (Gilbert, 2004) and as an alternative to the dichotomy of induction and deduction (Axelrod & Tesfatsion, 2006).
Want to know more?

Getting started with Modelling4All and the BehaviourComposer

- On the Modelling4All project website you will find video tutorials helping you get started: [http://www.modelling4all.org/](http://www.modelling4all.org/)

- OUCS regularly arranges hands-on workshop, in which participants can try out the Modelling4All software under the guidance of members of the Learning Technologies Group. Please get in contact if you are interested in participating in a workshop: [info@modelling4all.org](mailto:info@modelling4all.org)

- Keep up to date with the Modelling4All project online, either on Facebook, via Twitter [@modelling4all](https://twitter.com/modelling4all), by subscribing to our project blog [http://blogs.oucs.ox.ac.uk/modelling4all/](http://blogs.oucs.ox.ac.uk/modelling4all/) or through our YouTube Channel [http://www.youtube.com/user/modelling4all](http://www.youtube.com/user/modelling4all).

References


Gilbert (2004). “Agent-based social simulation: dealing with complexity”, Centre for Research on Social Simulation, University of Surrey


The Learning Technologies Group (LTG) at OUCS is committed to the following objectives:

- Providing and developing a central Virtual Learning Environment (VLE)
- Carrying out and disseminating influential research into the use of C&IT
- Providing training in IT literacy skills and effective use of C&IT
- Promoting the use of C&IT in teaching at Oxford via our user communities, websites, news publications, workshops and events
- Providing well equipped teaching and training spaces
- Promoting and supporting the use of online multimedia for learning and teaching via projects and services
- Developing learning packages and project websites
- Recognizing and celebrating innovation and good practice in use of C&IT in teaching at Oxford;
- Ensuring that our practice is inclusive, up to date and in line with user needs.