Interdisciplinarity at the service of society: Interpreting the evolution of COVID-19

Enlightening Interdisciplinarity in STEM for Teaching

3rd interdisciplinary line of inquiry

Simulate scenarios to make decisions on social restrictions

INTRODUCTION

The emergence of the COVID-19 pandemic has put the scientific community in the spotlight of society as a whole. Their studies have been one of the main tools for establishing measures to address the situation and have had a direct impact on daily life. Good examples are *statistical analyses* to extract relevant information from data, the development of *mathematical models* to make predictions, and *computational simulations* to understand virus diffusion.

In the second section we are going to address the third topic: the use of computational simulations to **model** COVID spreading, to **elaborate and compare scenarios** of restrictions and, on that basis, to **support decision-making processes**. In this submodule you will be guided to understand the basic aspects of agent-based modelling and simulations, then to explore some NetLogo simulations that have been designed by scientists during the pandemic. The goal will not be to elaborate a novel and functioning agent-based simulation (which will require extensive training) but rather to develop competencies to analyse existing materials, compare them and experiment on them.

The generative question of the module that will guide your investigation as students in this interdisciplinary line is the following:

How can computational simulations support decision-making processes about future actions in the context of the pandemic (from political, economic, medical, etc. perspectives)? What is their validity and function?

PART 1: Presentation of the interdisciplinary line of inquiry

To get started, we suggest you watch an explanatory video that introduces the basic features of agent-based modelling and of the NetLogo program. Please, also download NetLogo on your device.

Link to the introductory video: https://youtu.be/lel8WtCRAZM

Link to download NetLogo: https://ccl.northwestern.edu/netlogo/download.shtml

After watching the video, we ask you to discuss and answer the following questions in groups:

How can we model the spread of a virus in a population using an agent-based approach? What kind of agents would you suggest? What features would these agents have? How would they behave?

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PART 2: Development of the inquiry

Now, let's start by analyzing, comparing, and experimenting with different simulation tools to model the spread of a virus like COVID-19 in a population. All the NetLogo simulations proposed correspond to models that simulate an outbreak of an infectious disease in a population and its spread, although each of them includes certain characteristics that differentiate it from the rest. It may be helpful for you to take a first look at the simulation, then check the relative information, go back to the simulation again, and eventually inspect the code section.

Example 1: Basic phenomena of an outbreak of an infectious disease in a population. Click here to run the simulation in NetLogoweb or here to download:

> **Questions**: In this simulation, is modelled the basic phenomenon for the outbreak of an infectious disease. Comparing the model embedded in this simulation and the model you previously formulated, is there everything you had thought before? Is it poorer or richer in terms of details? Look at the implementation (code section): where do you recognise the interaction dynamics among agents and the corresponding changes in their epidemiological status?

Example 2: Impact of social distancing. Click here to run the simulation in NetLogoweb or here to download:

> **Questions**: In this simulation is implemented a model for social distancing is. How is social distancing is embedded in the simulation? How do different degrees of social distancing impact the results?

Example 3: Comparison between two adjacent communities. Click here to run the simulation in NetLogoweb or here to download:

> **Questions:** In this simulation, a model is implemented for two different neighbour communities. What happens when borders between neighbourhoods are maintained versus when borders are removed? How different communities are "coded" in the simulation?

More refined simulations have been designed and used during the pandemic. For example, some simulations have modelled different non-pharmaceutical interventions (social distancing, mask-wearing, hand washing, zonal or total lockdowns) and have produced results in terms of cumulative distribution or day-by-day incidence of infected/recovered/dead people. We propose two different complex simulations that address these issues.

Example 4: Changes in personal habits and intermittent perimeter closures. Click here to download the simulation and the user manual.

Example 5: Population separated by age groups and geographically set. Click here to download.

Choose one of the simulations above (example 4 or example 5) and try to answer the following question, which arises from the generative question of the line of research and which, once you know the agent-based models, you can begin to address.

How can this simulation help us make political decisions?

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Experiment as much as you want with the chosen simulation, observing its features and potential while trying to answer the previous question. We ask that, throughout the research, you write down the entire procedure followed, indicating what questions you generate, the answer you give and the new questions that arise, again with their answers and derived questions. In this way, you will generate a map of questions and answers during the process that starts from the generative question and that will have to be delivered at the end of the task.

PART 3: Prepare the presentation of the results

For the group discussion, prepare four slides to show the rest of the groups the work you have done, explaining on each slide the answer you have given to each of the questions.

1. What were the main questions you investigated about?
2. What are the main elements of each simulation you have analysed? What interaction models do they incorporate? What experiments have they allowed you to do?
3. What results do we get from the simulations? Are the results consistent in changing the simulations?
4. If you were decision-makers, would you use these tools as a basis for policy making? If so, how?

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