Διεθνές Συνέδριο για την Ανοικτή & εξ Αποστάσεως Εκπαίδευση

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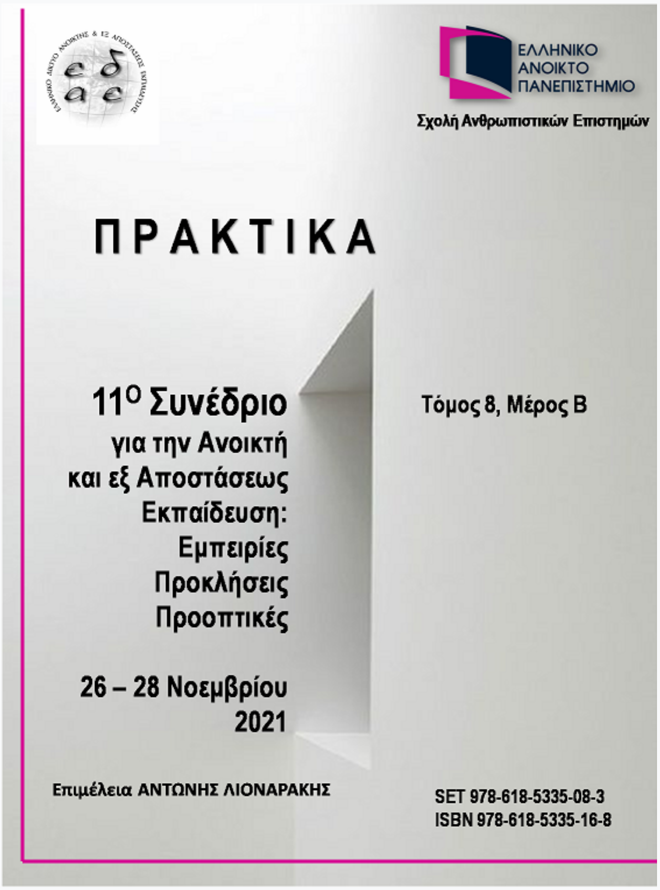

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Designing a learning environment to teach about COVID-19

Σχεδιασμός ενός μαθησιακού περιβάλλοντος διδασκαλίας για τη νόσο COVID-19

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Abstract
Coronavirus disease 2019 (COVID-19) was first described in December 2019 in Wuhan, Hubei province, China. A novel coronavirus was identified as responsible for the disease, known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The spread of the COVID-19 has led to a pandemic with unprecedented consequences; until May 2021, the cumulative cases of laboratory-confirmed diagnosis of COVID-19 had already risen up to 170 million, while the number of deaths exceeded 3.3 million globally. Measures such as good hand hygiene, social distancing, use of face masks and quarantine have been prescribed by entities such as World Health Organization (WHO) to limit the number of new cases. However, the degree of acceptance and adoption of protective measures seem to differ among public in terms of variables such as gender, age, personality traits and knowledge about COVID-19. Considering that (a) adequate knowledge about COVID-19 seems to enhance the acceptance of protective measures, and (b) the fact that young people show low acceptance and adoption of protective measures, we decided to design a learning environment aiming to support students in building understanding on SARS-CoV-2 transmission and prevention. Our design is theoretically driven by the problem-posing approach and integrates NetLogo models, which simulate the transmission and perpetuation of SARS-CoV-2 when strategies such as using a face mask, quarantining and social distancing are adopted or not. In this article we present our learning environment and discuss its characteristics and limitations.

Keywords: *COVID-19, SARS-CoV-2, biology education, learning environment, simulation models*

Περίληψη
Η νόσος COVID-19 περιγράφηκε για πρώτη φορά τον Δεκέμβριο του 2019 στη Γιουχάν, στην επαρχία Χουμπέι της Κίνς. Ένας νέος κορονοϊός αναγνωρίστηκε ως υπεύθυνος για την ασθένεια, γνωστός ως κορονοϊός σοβαρού οξέος αναπνευστικού συνδρόμου τύπου 2 (SARS-CoV-2). Η εξάπλωση της COVID-19 οδήγησε σε πανδημία με πρωτοφανείς συνέπειες: μέχρι τον Μάιο του 2021, οι εργαστηριακά επιβεβαιωμένες διαγνώσεις της COVID-19 ανέρχονταν ήδη σε 170 εκατομμύρια, ενώ ο αριθμός των θανάτων ξεπερνούσε τα 3,3 εκατομμύρια παγκοσμίως. Μέτρα όπως η καλή υγιεινή των χεριών, η κοινωνική αποστασιοποίηση, η χρήση μάσκας και η καραντίνα προτείνονται από φορείς

όπως ο Παγκόσμιος Οργανισμός Υγείας (ΠΟΥ) για τον περιορισμό του αριθμού των νέων κρουσμάτων. Ωστόσο, η αποδοχή και υιοθέτηση προληπτικών μέτρων φαίνεται να εξαρτάται από μεταβλητές όπως το φύλο, η ηλικία, χαρακτηριστικά της προσωπικότητας και οι γνώσεις σχετικά με την COVID-19. Λαμβάνοντας υπόψη ότι (α) η γνώση της COVID-19 φαίνεται να ενισχύει την αποδοχή προληπτικών μέτρων και (β) το γεγονός ότι οι νέοι δείχνουν χαμηλή αποδοχή και υιοθέτηση προληπτικών μέτρων, αποφασίσαμε να σχεδιάσουμε ένα μαθησιακό περιβάλλον με στόχο να υποστηρίξουμε τους μαθητές στην οικοδόμηση κατανόησης
για τη μετάδοση και πρόληψη του SARS-CoV-2. Ο σχεδιασμός μας αντλεί στοιχεία από τη διδακτική στρατηγική της προσέγγισης με βάση ένα κεντρικό ερώτημα και ενσωματώνει μοντέλα NetLogo, τα οποία προσομοιώνουν τη μετάδοση του SARS-CoV-2 όταν υιοθετούνται ή όχι προληπτικά μέτρα όπως η χρήση μάσκας, η καραντίνα και η κοινωνική αποστασιοποίηση. Σε αυτό το άρθρο παρουσιάζουμε το μαθησιακό μας περιβάλλον και συζητάμε για τα χαρακτηριστικά και τους περιορισμούς του.

Λέξεις-κλειδιά: *COVID-19, SARS-CoV-2, διδακτική της βιολογίας, μαθησιακό περιβάλλον, μοντέλα προσομοίωσης*

Introduction

Coronavirus disease 2019 (COVID-19) was first described in December 2019 in Wuhan, Hubei province, China. Chinese scientists isolated a novel coronavirus responsible for the disease, known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The incubation period is between 2 and 14 days and common symptoms of the disease are high body temperature, cough, sore throat, dyspnea, low energy or tiredness and weakness. Clinical manifestations are usually of moderate severity but in immunosuppressed, in those with comorbidities and in the elderly, it advances to pneumonia, acute respiratory distress syndrome (ARDS) and multiple organ failure (Rufaida et al., 2021). The spread of the new COVID-19 virus in early 2020 has led to a pandemic with unprecedented consequences; until May 2021, the cumulative cases of laboratory-confirmed diagnosis of COVID-19 had already risen up to 170 million, while the number of deaths exceeded 3.3 million globally (Rosolanka, Henao-Martinez, Pisney, Franco-Paredes, & Krsak, 2021).
The transmission of the virus is mainly facilitated between humans at close range or through respiratory droplets that are produced by conversation or coughing or via direct contact of the hands and the mucous membranes or mouth. Subsequently, the validity of face masks and plexiglass boxes as protective systems could be affirmed, as they isolate the diffusion of aerosol particles that are dispersed by infected people (De Vito et al., 2021). Quarantine can be imposed from 7 to 14 days in high-risk exposures, accompanied by testing if the interval of 7 days is chosen. Monitoring for the development of symptoms as well as testing is recommended for people who have been in close contact or live/work with vulnerable individuals. Unless they develop new symptoms, quarantine is not required for people who have overcome the disease within the past 3 months and recovered (Rosolanka et al., 2021). As prescribed by World Health Organization (WHO), simple measures to prevent the virus spread are the following: (a) hand hygiene: regular handwashing with soaps or cleaning hands with alcohol-based hand rubs, (b) social

distancing: avoidance of visiting crowded places and maintaining at least 3 feet distance from other people, (c) respiratory hygiene: during sneezing or coughing, use of a tissue or coverage of the mouth and nose with the bent elbow or use of a face mask outdoors, (d) stay home and stay safe: self-isolation in case of symptoms of cough, fever or headache (Daverey & Dutta, 2021).

The measure of acceptance and adoption of protective measures seem to vary among public. It seems that gender and age are important predictors; males and young people show lower acceptance and adoption of protective measures than female and older people respectively. Moreover, high rates of trust in politics and trust in science seem to positively influence the acceptance and use of protective measures against COVID-19 (Dohle, Wingen, & Schreiber, 2020). Furthermore, personality traits seem to predict the degree of adoption of protective behaviors (Paiva, Cruz-Martins, Pasion, Almeida, & Barbosa, 2021) as well as the level of knowledge about COVID-19 and the attention payed to the media (Ning et al., 2020).

Considering (a) the fact that knowledge about COVID-19 seems to enhance the acceptance of protective measures (Ning et al., 2020) and (b) the fact that young people show low acceptance and adoption of protective measures (Bazaid, Aldarhami, Binsaleh, Sherwani, & Althomali, 2020; Dohle, Wingen, & Schreiber, 2020) we decided to design a learning environment aiming to support students in building understanding on SARS-CoV-2 transmission and prevention. Here we present our learning environment and discuss its characteristics and limitations.

Overview of the learning environment

Our design is theoretically driven by the problem-posing approach (Ampatzidis & Ergazaki, 2018; Klaassen, 1995; Knippels, 2002) which suggests that students should (a) know what they do, why they do it and what they will do next, and (b) be provided with a global and a series of local motives. A global motive is a question that should evoke an interest in and motive for a study of the particular topic, while local motives are questions that motivate the main phases of the exploration within the learning environment (Lijnse & Klaassen, 2004). So, our learning environment is driven by (a) the global/overall question 'how SARS-CoV-2 transmits and how its transmission may be prevented?' which is addressed at the very beginning and (b) a series of local/partial questions which aim to highlight the impact of different factors and protective measures involved in the transmission of SARS-CoV-2. Answering the local questions is supported by exploring NetLogo models with the aid of worksheets that require predictions about the presence of SARS-CoV-2 in a human population before using the model and explanations afterwards. Going successfully through these is necessary for answering the local questions, while answering the local questions is necessary for answering the global one. Finally, we note that our learning environment is designed to be implemented in a distance education context – students communicate through chat/video conferencing and run the models online.

The NetLogo models in detail

The three models used within the learning environment are based on the 'virus model' (Wilensky, 1998) and they simulate the transmission and perpetuation of SARS-CoV-2 when strategies such as using a face mask, quarantining and social distancing are adopted or not. The interface of the models include the following: (a) a series of boxes showing the percentage of infected people, the percentage of immune people and the number of years passed in the simulation, (b) a simulation window showing the individuals in different colors (green for the healthy people, grey for the immune people and red for the infected people), and (c) a graph window showing changes regarding the population of healthy, immune and infected people with time. Below we describe the NetLogo models (NM) in detail.

NM1$_{\text{introductory}}$

NM1 starts with a number of people, a percentage of which are infected. People move randomly in one of three states: healthy (green), infected (red), and immune (gray). Healthy people (green) are susceptible to infection and infected people (red) are infectious. People may die of infection or old age. If people don't die of infection, they get immune (gray). When the population gets lower than the environment's 'carrying capacity' (it is set at 500 in this model) healthy people may produce a healthy offspring which is susceptible to infection.

Parameters such as the size of the initial population of people, the percentage of people who are initially infected, the infectiousness of the virus and the degree of immunity may be set by the users in this model. Immunity is secure (i.e. an immune person is not susceptible to infection); moreover, the duration of immunity may be set by the users. Finally, users are able to set the chance that people who get infected have to recover and length of time people may be infected before they either recover (and become immune) or die.

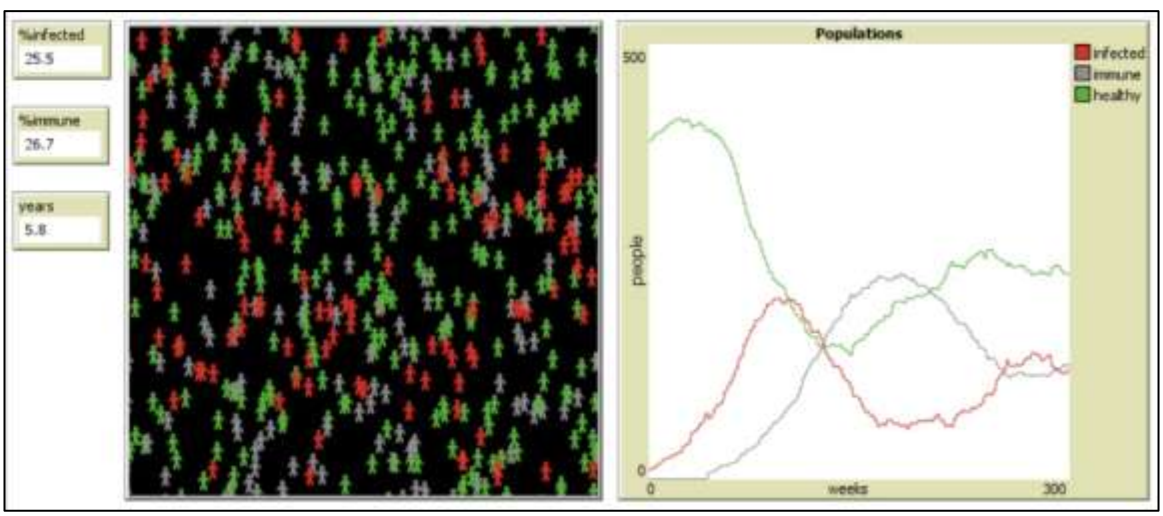

Figure 1. The NM1$_{\text{introductory}}$.

3.2 NM2$_{\text{quarantine of the infected}}$

NM2 starts with a number of people, a percentage of which are infected, the same way as in NM1. People again move randomly in one of the three states: healthy (green), infected (red) and immune (gray). The difference here is that when people get infected, they are put into quarantine (they stop moving). People die and reproduce the same way as in NM1. Finally, users are able to set parameters such as (a) the size of the initial population of people, (b) the percentage of people who are initially infected, (c) the infectiousness of the virus, (d) the degree of immunity, (e) the duration of immunity, (f) the chance that people who get infected have to recover and (g) the length of time people may be infected before they either recover or die in NM2 as well.

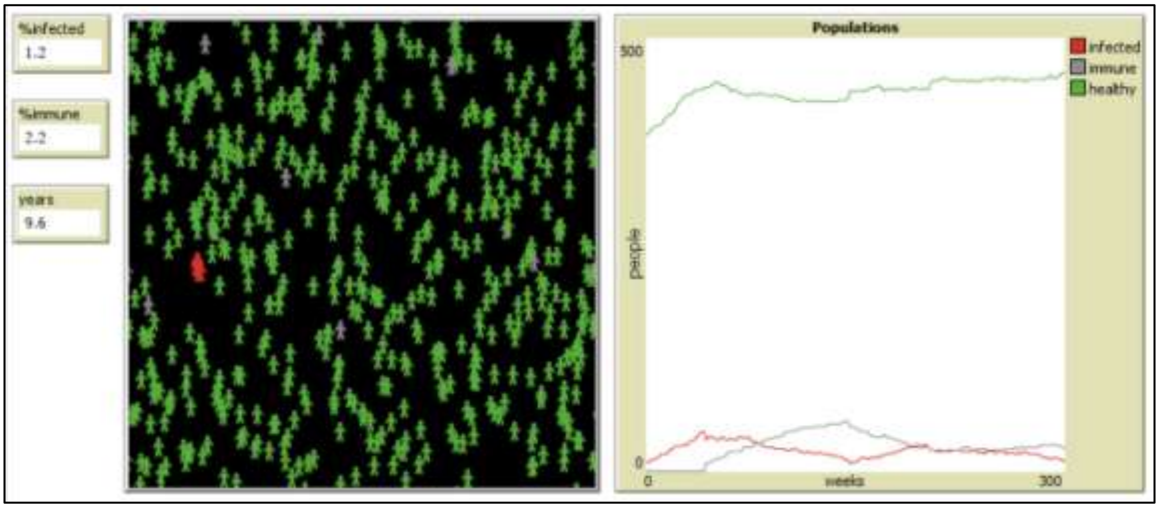

Figure 2. The NM2$_{\text{quarantine of the infected}}$.

NM3$_{\text{social distancing}}$

NM3 starts with a number of people, a percentage of which are infected, the same way as in NM1 and NM2. People again move in one of the three states: healthy (green), infected (red) and immune (gray). The difference here is that their movement is not totally random: people tend to avoid each other, walking away from the closest person each time. People die and reproduce the same way as in NM1 and NM2. Finally, users are able to set parameters such as (a) the size of the initial population of people, (b) the percentage of people who are initially infected, (c) the infectiousness of the virus, (d) the degree of immunity, (e) the duration of immunity, (f) the chance that people who get infected have to recover and (g) the length of time people may be infected before they either recover or die in NM3 as well.

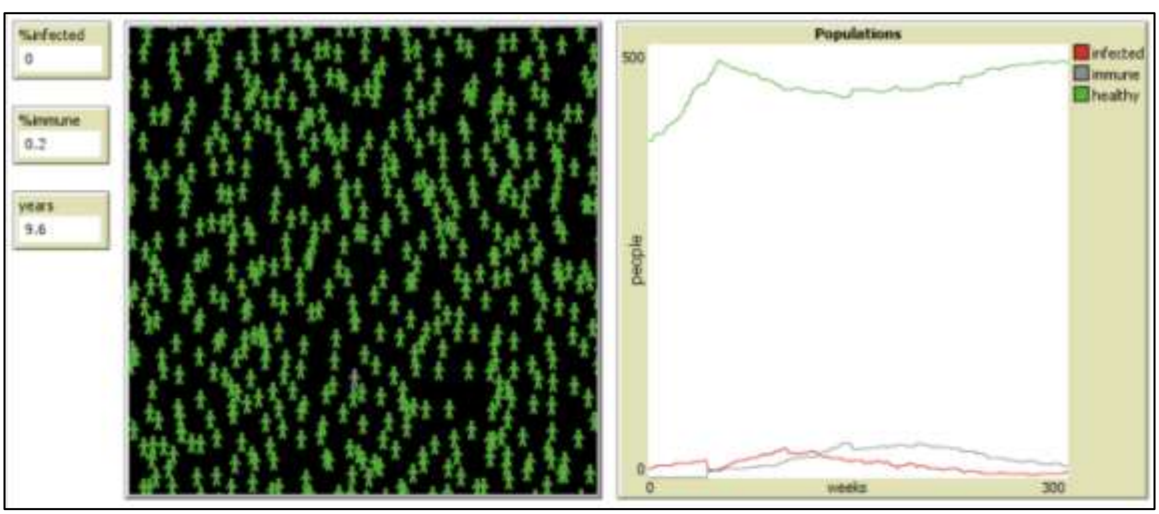

Figure 3. The NM3$_{\text{social distancing}}$.

Final notes

Computer simulations have been widely used in science teaching (Rutten, Van Joolingen, & Van der Veen, 2012) for they are assumed to support learners in visualizing dynamic processes taking place at organization levels or time-scales that cannot be easily accessed otherwise (Ergazaki & Zogza, 2008). Computer simulations may represent important aspects of the natural world that are too complex or abstract to deal with in a more concrete way, and thus function as greatly effective tools for education (Smetana & Bell, 2012). Drawing on the above, we designed a learning environment that aims to support students build understanding on how SARS-CoV-2 transmits and how its transmission may be prevented. Students are engaged with exploring NetLogo models with the aid of worksheets that require predictions about the presence of SARS-CoV-2 in a human population and explanations afterwards. We argue that the three NetLogo models that simulate the transmission and perpetuation of SARS-CoV-2 support students to understand how the virus may transmit and how effective protective measures such as (a) decreasing the virus' infectiousness by, for example, people wearing face masks, (b) quarantine of the infected and (c) social distancing may be. Considering the fact that young people show low acceptance and adoption of protective measures, we argue that learning environments like ours have the potential to raise awareness on protective measures among students and thus support the effort to contain spread of COVID-19.

Limitations

We argue that our learning environment may help students understand how decreasing the virus' infectiousness by wearing face masks or cleaning hands with alcohol-based hand rubs influences the percentage of infected and healthy people over time. However, a comparison of effectiveness between hand hygiene and using face masks is not possible within our learning environment. Moreover, quarantine of high-risk exposures is not simulated by our models. In a next version of our learning environment, we plan to elaborate the NM2 so the quarantine concerns also the people who have had close contact with an infected person. Moreover, we plan to modify how being in quarantine is simulated in our model so instead of stop moving, people in quarantine may prevent others from getting close to them.

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