Informatics in Education, 2014, Vol. 13, No. 2, 197–208

© 2014 *Vilnius University*
DOI: http://dx.doi.org/10.15388/infedu.2014.02

Redesigning Your City – A Constructionist Environment for Urban Planning Education

Arthur HJORTH, Uri WILENSKY
Center for Connected Learning and Computer-Based Modeling
Northwestern University
Annenberg Hall 225
2120 Campus Drive / Evanston, IL 60208 / USA
e-mail: arthur.hjorth@u.northwestern.edu, uri@northwestern.edu

Received: January 2014

Abstract. In spite of decades of use of agent-based modelling in social policy research and in educational contexts, very little work has been done on combining the two. This paper accounts for a proof-of-concept single case-study conducted in a college-level Social Policy course, using agent-based modelling to teach students about the social and human aspects of urban planning and regional development. The study finds that an agent-based model helped a group of students think through a social policy design decision by acting as an object-to-think-with, and helped students better connect social policy outcomes with behaviours at the level of individual citizens. The study also suggests a set of new issues facing the design of Constructionist activities or environments for the social sciences.

Keywords: agent-based modelling, NetLogo, social policy education, constructionism.

1. Theoretical Framing

A cornerstone of democracy is a well-educated citizenry that is able to participate in discussions about how to organize society through the design and implementation of policies (Converse, 2006; Druckman, 2001). However, research shows that citizens struggle with identifying policies that they themselves support, and that they often vote for parties that do not support the same policies as they do (Luskin, 1987, 1990).

Shtulman and Calabi's (Shtulman and Calabi, 2008, 2012) work suggests that part of the explanation to this paradox is that citizens fundamentally do not understand the underlying issues, and that they therefore are unable to reason about policies to address them. Ranney *et al.*'s (2012a, 2012b) work on global warming policies suggests that taking a mechanism-based approach to explaining the underlying issues to citizens may help address this gap; in their studies, the better people understood the mechanistic relationship between infrared light, energy, CO_2, and global climate change, the more likely they were to shift their opinion towards supporting policies that would reduce CO_2 emissions.

However, decades of research in complex systems thinking suggests that 'simply' knowing the individual, mechanistic interactions of a system does not necessarily mean that people are able to reason correctly about the aggregate level behaviour of the system. Rather, it shows that reasoning about complex systems is extremely difficult, and that people often ascribe properties at the individual level to the aggregate, system-level (Wilensky and Resnick, 1999), and that people often apply incorrect intuitions or heuristics when thinking about them (Wilensky and Abrahamson, 2006). This can lead to difficulties with grasping how simultaneous and interdependent interactions can produce 'butterfly effects,' and difficulties with reasoning about critical thresholds or 'tipping points'. Over the last two decades, agent-based modelling has gained increasing use to remedy these failures in complex systems thinking in educational contexts (Jacobson and Wilensky, 2006; Wilensky and Jacobson, 2014). Agent-based models are computer-based simulations in which the modeller specifies behaviours or interactions at the agent-level and then lets the system- or aggregate-level outcomes emerge from these interactions. The focus of agent-based models on individual-to-aggregate-level interactions makes them particularly well-suited for mechanism-based approaches to teaching and thinking about complex systems.

In educational contexts, agent-based models have been deployed in domains as diverse as physics (Sengupta and Wilensky, 2009), evolution (Centola *et al.*, 2000; Wagh and Wilensky, 2012), animal biology (Klopfer *et al*., 2009; Wilensky and Reisman, 2006), chemistry (Levy and Wilensky, 2009; Stieff and Wilensky, 2003), material sciences (Blikstein and Wilensky, 2009), and robotics (Blikstein *et al.*, 2007). This educational research combining agent-based modelling and complex systems thinking has often taken a Constructionist approach. Constructionism is a theory of design and learning developed by Seymour Papert (Harel and Papert, 1991; Papert, 1980). Constructionism extends Piaget's view of knowledge as 'structure' on which we can perform cognitive operations, and argues that building, sharing, and discussing external structure can change our internal, cognitive structure. The function of agent-based models in this work has been to act as this external structure, an *object-to-think-with* that helps learners construct and share their thinking on a particular issue.

2. Research Questions

Taken together, these bodies of research suggests that taking a mechanism-based approach to explaining underlying policy issues combined with an agent-based model as a tool to think with, may be a productive way of teaching social policy. Over the past two decades agent-based modelling has been used in social policy for decades (Epstein and Axtell, 1994; Epstein, 2006, 2008; Gilbert, 2000; Maroulis and Wilensky, 2014; Maroulis *et al.*, 2010) and is increasingly being used in policy *research* [22]–[24], even focusing specifically on urban or regional development, e.g., (Batty, 2007; Lechner *et al.*, 2004; Martinez and Morales, 2012). However, agent-based modelling is still to make its way into social policy and urban planning *education*. This proof-of-concept study sets out to address this gap in the literature and addresses the following questions:

1. How do learners use agent-based-models as an object-to-think-with in a social policy educational context?
2. Do agent-based models help learners better connect behaviour at the individual level to policy outcomes at the aggregate level?

3. Study Design

3.1. *Context & Sample*

The study ran over the span of three days, as part of a unit on regional development in an Introduction to Social Policy-course at a private, mid-sized university in the American Midwest. The whole class of 39 students participated in the modelling curriculum, and out of these, 12 students in four groups of three consented to being video recorded.

3.2. *Activity Design*

On the first day during class, the professor (who was not part of the research team) started class with a 20-minute class-discussion on why people live where they live. Students were asked what they liked about where they grew up, what they didn't like, and why they thought their parents moved there. This section of the activity was designed in order to render salient the behavioural mechanisms at the level of individual citizens that lead to the formation of homogenous neighbourhoods, even in cities with a heterogeneous population. This discussion was supported by a map programmed in NetLogo (Wilensky, 1999) and using the GIS-extension (Russell and Wilensky, 2008), illustrating concentrations of poverty, minorities, and population density in the city in which the university is located (Fig. 1). The professor then discussed with the students how the design

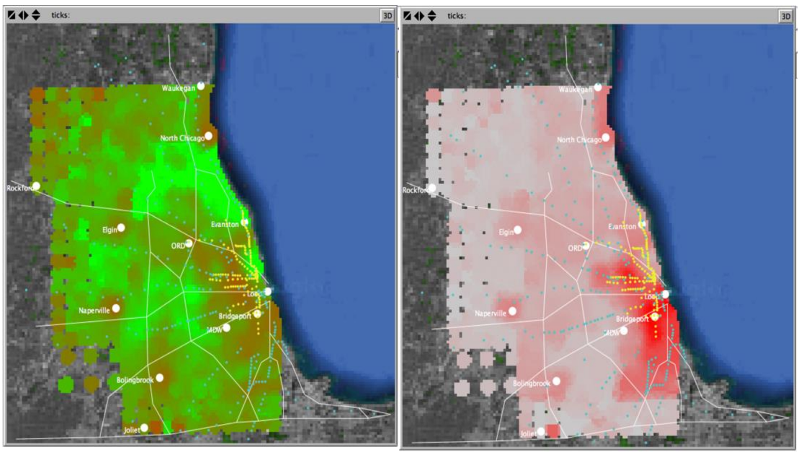

Fig. 1. GIS information about Chicago: Income levels (left), and concentration of minorities (right).

of land-use policies, and decisions about infrastructural design affected the behaviour of citizens, which in turn affected how the city emerged.

Students were then given a model, also written in NetLogo, of the same city. In groups of 2–3, they were asked to redesign the city, focusing on one of three policy outcomes (‘commute times’, ‘access to leisure’, or ‘access to high quality education’). By changing the land-use law (either ‘dense urban’, ‘medium urban’, ‘suburban’ or ‘subsidized housing’), placing industrial zones, and adding or removing railway and highways, students were asked to “re-grow” their city and achieve the policy outcome goals that they set for themselves. Students were asked to spend one hour on this activity after class, and to go through as many iterations of their city design as time allowed.

3.3. *Brief Description of the Model*

When the model is started, students are given a barebones version of the city’s infrastructure in which only the most important railroads and highways are present (Fig. 2). This was done for a number of different reasons: First, to help activate concrete knowledge about the city; second, to give the model an air of realism; and finally, to create some constraints on the possible designs, and nudge student thinking in the direction of ‘improving on their city’ rather than coming up with an entirely new one. Students had to zone enough residential areas and enough industrial zones to provide housing and jobs for 2.7 million people (the actual number of residents in the city). We decided to give students an unlimited budget. Although this breaks with the realism aspect of the simulation, the purpose of the activity is first and foremost to help students connect behavioural mechanism to aggregate policy outcome. We therefore wanted to see how they would do this without the constraints of dealing with balancing a budget.

Once students had zoned enough residential and industrial zones, and they felt their city was ready to be populated, they could press the “Grow!” button, and citizens would start populating the city. Citizens were generated with an income drawn randomly from a distribution similar to the US income distribution. Each citizen would be given a job

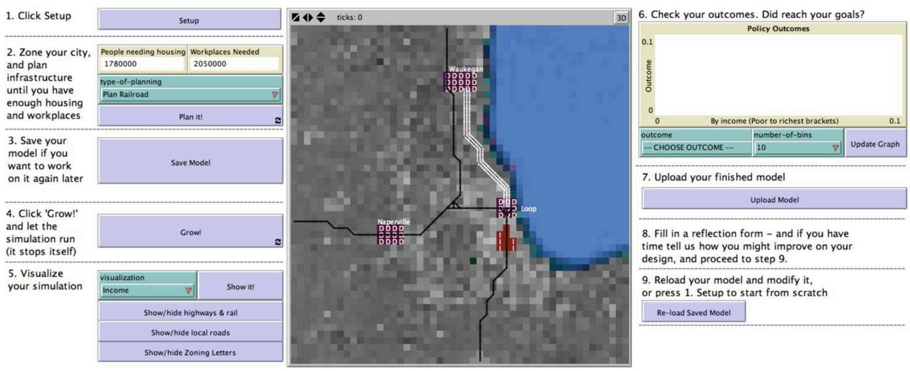

Fig. 2. The interface of the model, and the barebones version of Chicago’s existing infrastructure and land use.

in an industrial zone, and each citizen would then make a decision about where to live based on three principles:

1. It must be affordable.
2. It should be as close to their spending maximum as possible.
3. It should be as close to their workplace as possible.

In plain language, people want to live in a place that they can afford, that is about as ‘nice’ as they can afford, and that is not too far away from their workplace. Whenever a citizen moved into a residential zone, the housing prices would change to reflect the mean income of citizens who live there. The poorest 15% of the population does not have cars, and can therefore not use highways. As people populate the city, roads get congested, slowing down traffic, increasing commute times, and in turn, changing the desirability of surrounding residential areas. Areas with parks or the lake nearby are more attractive, and will therefore tend to attract more wealthy people. Running the model and populating the city takes somewhere between 30 and 90 seconds, depending on how big the city is. This allowed students to quickly and incrementally iterate their different city designs.

3.4. *Data Collection*

Three kinds of data were collected during the study. First, Google forms were used to collect student thinking in writing before and after each design iteration. In these forms, students were first asked which of the policy outcomes they would focus on, what they wanted to accomplish with the outcome, and how they hypothesized they should design their city in order to achieve that; then they were asked whether they achieved the outcomes they hoped for, to reflect on what worked or didn’t work, and whether their city would be a good city if it were a real one; and finally they were asked what they would improve or change next time around. Second, every time a group had finished a design and ran their model, they would submit a screenshot and the entire state of the model of it to a server. Third, Camtasia was installed on student computers, so that we could get recordings of what they did on- and off-screen during the activity, in order to capture the students’ group work process.

4. Findings

We focus on one group consisting of three female freshmen or sophomore students; Laura, Beth, and Kim. In this section we will go over their two iterations of designing their city, and discuss what we see as evidence of changes in their thinking for each of the iterations, and how it relates to our research questions.

1st Iteration

The group first sets as their goal, “[…] to lower the commute times for everyone in the Chicago area. We want to get the commute time for everyone below 35 minutes”.

When asked how they would achieve this goal, they state that they would, "[…] put houses near [industrial zones], highways and public transportation stops. We will put the subsidized housing by the railroads in order to have easier access for those without cars". Their reasoning seems to be that as long as there are transportation options near all residential zones, commute times will be low for everyone, which at least at the surface level is correct. Based on these heuristics, they design their first city (Fig. 3). They start out by first expanding on the three existing residential areas from Fig. 2, and then adding a fourth residential area. When they have zoned all the necessary residential areas, they add some industrial areas near each of their four residential areas. Finally, they connect all four areas with first a circular railroad, and then with an X-shaped highway system. They later in their reflection explain that their reason for creating four "epicentres" is that they want people to be able to live and work in the same local communities. However, when they run the model, they end up with very long commute times [Bar chart, Fig. 3], with the middle-income decile having an average commute of around 80 minutes. They correctly reason that this happened because, "[…] people did not necessarily live in the epicenter where their work was, which we couldn't really control", and that they "[…] underestimated the distance between each epicenter and thought that the connecting railways would easily reduce the commute time".

The part about distance is somewhat banal: The size of their redesigned city is in real terms approximately 45 by 60 miles. By putting so much empty space in the middle of the city with neither residential areas nor workplaces, they increased the distances that citizens must travel, thus increasing commute times. What is more interesting is their realization that creating equality in commute times is about creating equality in both infrastructural design, and in the attractiveness of living in various neighborhoods (or 'epicenters'). Because they only focused on infrastructural decisions, ensuring that all residential areas have access to highways and railroads, they ended up creating neighborhoods that were only attractive (or, conversely, affordable) to particular groups of the population, and thereby created a situation in which people either chose not to live near their work, or could not afford to live near their work. A good example is the part of their

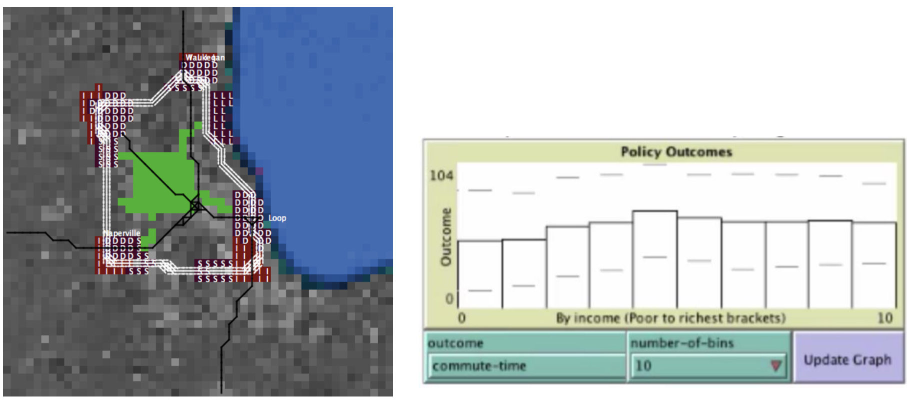

Fig. 3. The group's first design. Four distinct suburbs create long commute times for people who do not work and live in the same place.

city containing just suburban areas (marked with 'L') in the top right along the lake. Although it is not that well connected to infrastructure, it is attractive because it is suburban and because it is right on the lake. In contrast, all their other 'epicenters' consist only of subsidized housing and dense residential areas. This makes them very affordable, but in turn also not particularly attractive to high-income citizens. As a result, many high- and middle-income citizens discounted the benefit of living close to their place of work and chose instead to live in far away, more attractive areas.

2nd Iteration

In their second attempt, the group decides to start from scratch, rather than attempting to modify their previous design. As they begin to re-design their city, Laura says, "We're trying to reduce commute times…" and Kim continues, "so the closer everything is, the better" [00:39:15–00:39:26]. It seems clear that this heuristic was developed from the mistake they made in their last attempt in which their residential areas were too far spread out. It should be noted that while this heuristic is true at the surface level, it is not necessarily always true; the more compact a city is, the shorter the distance people must travel which of course will reduce commute times, but the more people will have to share the same roads which increases commute times. So even with a dense city, it is important to make sure that workplaces are spread out, and that the density of the population is evenly spread out. The group starts discussing how to connect the two suburbs that are part of the pre-existing infrastructure in the model, in order to "not have suburbs". In an interesting contrast to their first attempt in which they first zoned all residential areas, *then* zoned industry, and *then* zoned infrastructure, this time they continuously shift between all three kinds of areas. By doing so, they are able to create rings of industry and residential areas around the city. As a result, they end up with a drastically differently designed city (Fig. 4) than in their first attempt. The city is denser, and all industrial and residential areas are adjacent to each other, i.e. "no suburbs".

This time, while the city is populating, the three students look intently on the screen, offering comments as people move in and the results start emerging. They start out by vi-

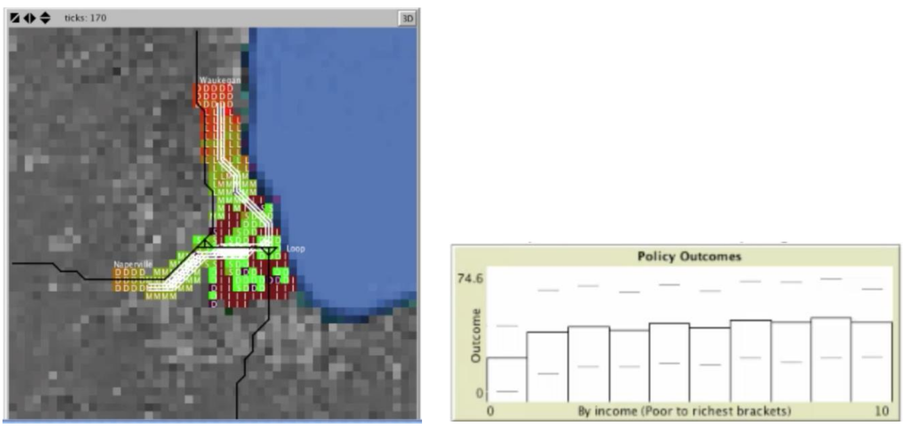

Fig. 4. The group's second design, colour coded by commute times. Because of smaller distances and greater spread of industry, commute times are much lower.

sualizing their model by income, but later change it to show commute times. When they see that the area in the top part of the city is turning red (i.e. that people living there have long commute times), Kim says, “It’s okay, they’re rich. They’re fine.”[00:43:37–00-:43:40] At this point, it is hard to tell how much of this is just a joke, and how much of this comes from a feeling that these people chose to live far away from their workplaces, and that in a sense they don’t deserve a short commute time. Neither of the other two group members responds to the comment, though. As soon as the city is done growing and it is clear that people living in the northernmost part of the city have much longer commute times, Laura says, “Oh, we should have put industry in [the northern part]!” Beth responds, “Yeah, we’ll put that in our reflection”. They then look at their outcomes on the bar chart, and Kim says, “Hey look, the poor people have the shortest commute times!” and Laura continues, “And then everybody else is pretty much equal. That’s cool!” [00:44:05–00:44:13]

At this point, the group decides that they have reached their policy goal, and that they are done with their design. They therefore stop working on the activity. In their reflection, they note that they should have put industrial areas in the northern part of the city. Planning-wise then, their lesson from the 2nd iteration is that they need to put industry all over the map. This is similar to what they learned during their first iteration, but the second time around they knew they had made the mistake before the model had even stopped populating the city. More interestingly, they say that they overall felt they achieved their policy outcome goals of lowering commute times for everyone. This is interesting because while they certainly got closer in their 2nd iteration, they are still some ways off the 30 minutes commute time that they initially set as their goal. In other words, they are now diverging from their initial goal of getting everyone’s commute below 30 minutes, and are instead happy that the poorest citizens have the shortest commute times. Also interesting is the fact that they note that it would not be a good city to live in, “because it is so dense and everyone would be on top of each other and there are no parks.” While this may be true, this is, strictly speaking at least, unrelated to the policy outcome goals that the group had decided to focus on. We think that these two outcomes are expressions of a perspective in which agent-based modelling curricula on social policy-education diverge from the hard hard-sciences topics in which agent-based modelling has previously been used: Decisions about social policy outcomes are inevitably tied in with political or ideological beliefs. The group is not ‘just’ trying to maximize a particular measurement in an emergent, complex system. Rather, they seem to treat the finished model as a social artefact that they assess through the lens of a particular set of values. They seem to agree on these values, and those values seem to make it more acceptable to them that low-income citizens have shorter commute times while everybody else do not – at least relatively. This importance of the social aspects of the modelling activity, at least to this group of students, is further exacerbated by their inclusion of parks and leisure areas in their assessment of the model outcomes, and by their comment that everybody would be living on top of each other: Had we asked students in a hard sciences class to maximize a particular outcome in a model, we would not expect them to bring up other outcomes in their self-assessment. However, we speculate that social issues may be more difficult to cognitively disentangle and think about in an isolated manner.

5. Discussion & Design Implications

The case-study data presented in this paper suggest that agent-based modelling activities may be productively deployed in social policy education – particularly on topics that lend themselves well to being represented as complex systems, such as the emergence of cities and neighbourhoods within cities, e.g. (Epstein and Axtell, 1994; Lechner *et al.,* 2004). In many ways, the findings from our case-study echo those found in existing Constructionist literature in which agent-based models are used as educational tools: students were able to articulate productive intuitions about the topic that helped them come up with meaningful heuristics for designing their cities. Using the model , they were able to apply these heuristics in a series of iterative model constructions, experiencing the strengths and shortcomings of their intuitions, and over time building up a richer understanding of the social aspects of urban planning. This suggests that students were able to use the model as an object-to-think-with about their city as a complex system: Through their iterative experiments, they increasingly connected the behaviours of individual citizens through their choice – or lack of choice – about where to live, through the formation of economically heterogeneous neighbourhoods, to the policy-level outcomes and commute times of the city as a system.

Existing Constructionist educational literature has focused primarily on natural sciences subjects. By taking the leap into social sciences, and in particular social policy, we face a new set of problems relating to the design, and assessment, and analysis of modelling curricula. Political theorist Michael Freeden argues that policy issues are essentially contestable, meaning there are many equally valid but mutually excusive ways to think about them (Freeden, 2005, 2008). Taking a Constructionist approach means designing an object-to-think-with, and this necessitates that students are able to connect and express their thinking with that object. For the design of social policy educational activities, this means that the tools we design must be able to express all, or most, reasonable interpretations of a particular social issue and the ways in which it can be addressed. By 'reasonable', we mean here any coherent interpretation of the policy that is articulated elsewhere in public discourse on that policy, and which makes normative statements about the policy intervention, its underlying mechanisms, or how to measure the failure or success of the policy. For instance, in our case, on the outcomes-side, we only provided three policy outcomes, but we may as well have included pollution or traffic safety issues. We further assumed on the policy intervention-side that the solution would be a central planning approach, rather than a free-market approach in which the construction of infrastructure is left to private companies looking for profit, or left to local municipalities looking to maximize a set of local outcomes. If, for instance, a student with a libertarian outlook used our model, they might disagree so fundamentally with these assumptions that they would be unable to think-with the model because they are unable to express their thinking with it. Finally, we made assumptions about the behavioural mechanisms and parameters that underpin decisions about where to live. No one in the study or in the rest of the class challenged these assumptions, which might indicate that they were benign enough to not be noticeable. But in the future, it would be not only interesting, but also prudent for the development of Constructionist social policy educational design to encourage students to engage with these assumptions. Second, for the design of activities, we chose to ask students to focus on just one outcome. However, our group seemed to, consciously or not, read things into their outcomes that weren't actually in the computer model – like assuming a lower quality of life for citizens because of the density of the city, or due to lack of parks. This may suggest that social issues should not be disentangled or isolated, but may better lend themselves to a more holistic approach, and that the design of activities shouldn't artificially attempt to separate them.

6. Conclusion

In this paper, we first argued that the use of Constructionist learning in the social sciences, particularly in social policy, is understudied. We then presented a case study on students' use of a computer modelling-based curriculum unit on urban planning and social policy. The unit was designed to take a social, behavioural mechanistic approach to explaining and thinking about urban and regional development, forefronting human behaviour as a key influence on policy outcomes. Our data showed that students increasingly connected micro-level interactions with macro-level outcomes, and that they activated and productively used their intuitions when reasoning about how to better design their city. Throughout their experiments, the NetLogo model helped them redirect their intuitions in those cases where their intuitions turned out to not be entirely appropriate. We finally discussed some of the issues relating to designing Constructionist environments for policy issues.

The present study is limited to a single group of three students. We are therefore not making any grand claims about learning effects or generalizability. However, we believe that there are exciting new opportunities and challenges in taking Constructionism to the social policy education, and we hope that this study can help inform this move.

References

Blikstein, P., Wilensky, U. (2008). Implementing multi-agent modeling in the classroom: lessons from empirical studies in undergraduate engineering education. In: *Proceedings of the International Conference of the Learning Sciences*. Utrecht, The Netherlands, 2008.

Centola, D, McKenzie, E., Wilensky, U. (2000). Survival of the groupiest: facilitating students' understanding of multi-level evolution through multi-agent modeling – the EACH Project. In: *Proceedings of The Fourth International Conference on Complex Systems*. NH: New England Complex Systems Institute, 2000.

Converse, P.E. (2006). The nature of belief systems in mass publics (1964). *Critical Review*, 18(1–3), 1–74

Druckman, J. (2001). The implications of framing effects for citizen competence. *Political Behavior*, 23(3), 225–256.

Epstein, J. M. (2006). *Generative Social Science: Studies in Agent-Based Computational Modeling*. Princeton University Press, Princeton, NJ.

Epstein, J.M. (2008). Why model? *Journal of Artificial Societies and Social Simulation*, 11(4), 12.
Epstein, J.M., Axtell, R.L. (1994). *Growing Artificial Societies: Social Science From the Bottom Up*. MIT Press, Cambridge, MA.
Freeden, M. (2005). What should the "political" in political theory explore? *Journal of Political Philosophy*, 13(2), 113–134.
Freeden, M. (2008). Thinking politically and thinking about politics : language, interpretation, and ideology. In: *Political Theory: Methods and Approaches*. Oxford University Press, Oxford, UK.
Harel, I., Papert, S. (1991). *Constructionism*. Ablex Publishing, New York, NY.
Jacobson, M.J., Wilensky, U. (2006). Complex systems in education: scientific and educational importance and implications for the learning sciences. *Journal of the Learning Sciences*, 15(1), 11.
Lechner, T., Watson, B., Ren, P., Wilensky, U., Tisue, S., Felsen, M. (2004). Procedural modeling of land use in cities. In: *SIGGRAPH '06: ACM SIGGRAPH 2006 Research posters*. ACM, New York, NY, 135.
Levy, S.T., Wilensky, U. (2009). Crossing levels and representations: the Connected Chemistry (CC1) Curriculum. *Journal of Science Education and Technology*, 18(3), 224–242.
Lievano Martinez, F., Olaya Morales, Y. (2012). Agent-based simulation approach to Urban dynamics modeling. *Dyna*, 79(173), 34–42.
Luskin, R. C. (1987). Measuring political sophistication. *American Journal of Political Science*, 31(4), 856–899.
Luskin, R.C. (1990). Explaining political sophistication. *Political Behavior*, 12(4), 331–361.
Maroulis, S., Guimerà, R., Petry, H., Stringer, M.J., Gomez, L.M., Amaral, L.A.N., Wilensky, U. (2010). Complex systems view of educational policy research. *Science*, 330(6000), 38–39.
Maroulis, S., Wilensky, U. (2014). Social and task interdependencies in the street-level implementation of innovation. *Journal of Public Administration Research and Theory*.
Papert, S. (1980). *Mindstorms: Children, Computers, And Powerful Ideas*. Basic Books, New York, NY.
Ranney, M.A., Clark, D., Reinholz, D.L., Cohen, S. (2012a). Changing global warming beliefs with scientific information: knowledge, attitudes, and RTMD (Reinforced Theistic Manifest Destiny Theory). In: *Proceedings of the 34th Annual Conference of the Cognitive Science Society*. Cognitive Science Society 2012, Austin, TX.
Ranney, M.A., Clark, D., Reinholz, D.L., Cohen, S. (2012b). Improving americans' modest global warming knowledge in the light of RTMD (Reinforced Theistic Manifest Destiny) theory. In: *Proceedings of the The International Conference of the Learning Sciences 2012*. Sydney, Australia.
Russell, E., Wilensky, U. (2008). *Consuming Spatial Data in NetLogo using the GIS Extension*. Presented at the Swarmfest 2008, Chicago, IL.
Sengupta, P., Wilensky, U. (2009). Learning electricity with NIELS: thinking with electrons and thinking in levels. *International Journal of Computers for Mathematical Learning*, 14(1), 21–50.
Shtulman, A., Calabi, P. (2008). Learning, understanding, and acceptance: the case of evolution. In: *Proceedings of the 30th Annual Conference of the Cognitive Science Society*. 235–240.
Shtulman, A., Calabi, P. (2012). Cognitive constraints on the understanding and acceptance of evolution. In: Rosengren, K.S., Brem, S.K., Evans, E.M. Sinatra, G.M. (Eds.), *Evolution Challenges: Integrating Research and Practice in Teaching and Learning about Evolution*. Oxford University Press, New York, NY, 47–65.
Stieff, M., Wilensky, U. (2003). Connected chemistry – incorporating interactive simulations into the chemistry classroom. *Journal of Science Education and Technology*, 12(3), 285–302.
Wagh, A., Wilensky, U. (2012). Evolution in blocks: building models of evolution using blocks. In: *Proceedings of Constructionism 2012*, Athens, Greece.
Wilensky, U. (1999). *NetLogo*. Center for connected learning and computer-based modeling. Northwestern University, Evanston, IL, 49–52.
Wilensky, U., Abrahamson, D. (2006). Is a disease like a lottery?: Classroom networked technology that enables student reasoning about complexity. Paper presented at the American Educational Research Association. San Francisco, CA.
Wilensky, U., Jacobson, M. (2014). Complex Systems in the Learning Sciences. In: R.K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences* (2nd Edition). Cambridge, Cambridge University Press, UK.
Wilensky, U., Reisman, K. (2006). Thinking like a wolf, a sheep, or a firefly: learning biology through constructing and testing computational theories – an embodied modeling approach. *Cognition and Instruction*, 24(2), 171–209.
Wilensky, U., Resnick, M. (1999). Thinking in levels: a dynamic systems approach to making sense of the world. *Journal of Science Education and Technology*, 8(1), 3–19.

A. Hjorth is a PhD student at Northwestern University's School of Education and Social Policy. His research focuses on studying students' sense making of society, and in particular on how they reason about social policies. He uses computer simulations and agent-based modelling as means of eliciting student thinking and as teaching tools. Prior to coming to Northwestern University, Arthur completed a MSc in Educational Research at the University of Oxford, and a MSc in Video Games Analysis at the IT-University in Copenhagen, Denmark.

U. Wilensky is a professor of Learning Sciences and Computer Science at Northwestern University. He also holds appointments in cognitive science, the program in Technology and Social Behavior and the Segal Design Center research council. He is the founder and current director of the Center for Connected Learning and Computer-Based Modeling and a co-founder of the Northwestern Institute on Complex Systems (NICO). Dr. Wilensky received his PH.D from the MIT Media Lab. His interests include design of learning technologies, agent-based modeling environments, STEM education, complex systems, and design and analysis of agent-based models. His NetLogo agent-based modeling software has hundreds of thousands of users worldwide, including scientists from a wide range of disciplines and students from middle school through graduate school. He has an abiding interest in the changing content of knowledge in the context of ubiquitous computation, and its implications for making sense of complexity. He has published more than 200 papers, and received numerous grants including the NSF Career Award. He is also a co-founder of the journal Technology, Knowledge and Learning.

Tavo miesto perprojektavimas: konstrukcionistinė aplinka miesto planavimui mokyti

Arthur HJORTH, Uri WILENSKY

Nepaisant dešimtmečių, kuomet agentais grįstas modeliavimas buvo naudojamas socialinės politikos ir švietimo tyrimuose, vis dėlto pastarosios dvi sritys niekada nebuvo integruojamos. Straipsnyje pristatomas vieno atvejo tyrimas, atliktas kolegijoje dėstomo socialinės politikos kurso metu. Siekiant išmokyti studentus socialinių ir žmogiškųjų miesto planavimo ir regioninės plėtros aspektų, tyrimo metu buvo pritaikytas agentais grįstas modeliavimas. Tyrimas atskleidė, kad agentais grįstas modeliavimas padėjo studentams priimti socialinės politikos sprendimus veikiant su tiksliniais objektais. Taip pat studentams buvo lengviau susieti socialinės politikos išvadas su individualaus piliečio elgesiu. Tyrimas parodė ir keletą naujų krypčių konstrukcionistinei veiklai ar aplinkai projektuoti socialinių mokslų srityje.