5.4 Examining the Relationships Between Education, Social Networks and Democratic Support With ABM

Examining the Relationships Between Education, Social Networks and Democratic Support With ABM

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Abstract: This paper introduces an agent-based model that explores the relationships between education, social networks, and support for democratic ideals. This study examines two factors that affect democratic support, education, and social networks. Current theory concerning these two variables suggests that positive relationships exist between education and democratic support and between social networks and the spread of ideas. The model contains multiple variables of democratic support, two of which are evaluated through experimentation. The model allows individual entities within the system to make "decisions" about their democratic support independent of one another. The agent-based approach also allows entities to utilize their social networks to spread ideas. Current theory supports experimentation results. In addition, these results show the model is capable of reproducing real world outcomes. This paper addresses the model creation process and the experimentation procedure, as well as future research avenues and potential shortcomings of the model.

1. Introduction

How do Democracies arise? It is not possible to answer this question in a simple or quick manner. Democracies tend to take decades to fully form, so studying the variables that lead to their rise is not a task one can achieve in a week. The process requires extensive examination of literature and history. However, the study of the relationships between variables that affect democracy can occur in a much shorter period using Agent Based Modeling (ABM). In order to conduct initial experimentation with this new method, this study only examines the effects of a few variables on the rise of democracy; the main variable we examined being democracy, with social networks serving as a medium for ideas to spread, allowing us to examine the effects of social networks on idea transference. Based on a study of the relevant literature, the hypothesis for this experiment is: increases in the education transfer variable will lead to an increased number of democratic supporters, over a 100 step (year) cycle.

2. Literature Review

A review of the current literature on democracy revealed that democratic ideals influenced by education positively affect support of democracy [13], [15], [8], [5], [4]. Democratic states and states transitioning to democracy often have strong liberal education systems. These systems help pass on the basis of democratic ideals to every generation, resulting in a population that approves of and supports democracy [7], [4]. Where these strong liberal education systems are lacking, states often experience lower levels of support for democracy [6].

Much of the literature focuses on the fact that creating a culture of democracy is important to improving democratic support. This tie is into the concept of democratic ideals, or a system of beliefs, which match with a democratic form of government [5], [8]. Consequently, where these ideals are less or completely absent, one would expect democracy to be non-existent, or the

system severely flawed. Therefore, the current theory concludes that support for democracy, on a national level, is contingent on a system of democratic ideals, which the populace receives during the education process.

In addition to education, the literature highlights the relationships between democracy and other cultural and economic influences; with economic variables being a common theme in most of the literature. While this variable appears to influence democratic ideals, in conjuncture with education, there is no clear connection for how the two relate to each other. While it would seem safe to assume that economically secure individuals would receive better educations, none of the literature clearly states this. As a result, for the purpose of this study, economic factors will remain locked, and consist only of a random distribution of wealth among agents.

An additional variable, which the literature identifies as important to the spread of ideas, is social networks. Current literature highlights several ways that an individual's social network can influence them. Many individuals find themselves in situations surrounded by others that share the same democratic ideals as they do; but they also find themselves surrounded by individuals that have different democratic ideals [18]. The likelihood that an individual will accept another's democratic beliefs is based on how strong their current beliefs are, as well as the amount of effort the other person expends trying to instill their democratic ideals. For these reasons, the literature clams there is no more than a fifty percent chance that an individual will accept influence from either side [18].

As opposed to the immediate influence that individuals receive from others within a particular propinquity, current literature also discusses how individuals accept influence from their friends and family. Unlike influences applied by individuals in a person's proximity, a person can choose the friends and family from whom they are willing to accept influence. Recent literature argues that during the current era people are not limited to only accepting influence from friends and family that hold the same beliefs. In fact, since democratic ideals can change at a rapid rate, individuals are willing to accept influence from those with the same ideals, as well as those with differing views [16], [17].

Because of the above-mentioned literature, this study not only looked at individuals within a person's immediate proximity, but also the individuals that are involved within a person's far-reaching network. Additionally, this study did not limit individuals to accepting influence from those who share the same democratic ideals, but allowed for individuals with differing democratic ideals to influence a person.

3. METHODOLOGY

To create the model for this study we followed a two-step process: create a metacode, and then input the true code into NetLogo. NetLogo is an agent based modeling environment developed on the Java platform. The software allows users to create and program agents, giving them sets of instructions for interactions and behaviors. The user can then create interactions amongst agents, and experiment with the interactions to determine how changes in individual behavior affect the overall behavior of the model. Metacode is a rough outline of the intended process for a program, in this case an agent-based model, and represents a high-level view of how the model will function.

After we created the metacode, we began to write the program in NetLogo. While transferring the metacode into true code we often found problems that required us to add modules to the main program and in some cases change some of the basic processes. Figure 1 shows the final model format, in NetLogo, with the added variables and the final variable control formats.

Agents within the model follow a set of procedures to perform the following actions during each "step": they decide whether to

educate or not; they receive education (if they are at a location); they interact with their social network and local community; they decide whether to become a supporter, detractor or remain neutral; they perform actions to possibly give birth or die; and they move. To examine the main variable, education, agents within the system perform an initial check to determine two things: are they close enough to an education location to attend and are they the right age to attend. The radius in which agents must be to attend a location is determined using a slider (education-influence-radius), which we did not adjust for this experiment due to computer processing constraints. Along with the number of locations available for agents to receive education, we felt that increasing or decreasing these variables would result in predictable outcomes (agents would be more likely to support democracy where radius and education locations were high and vice versa). The important variable we did allow to change in order to examine the effects of education was the level of education agents received at the education locations. Agents who attended a location receive X amount of "education" each year until they reach the age of 18. Agents in the model do not have to go to an education center unless they are within the variable range determined by the education-influence-radius. Therefore, agents who "live" away from education centers (those further away from a center than the value of the education-influence-range variable) would not receive education, while those close by would. In addition, agents could receive education anytime after the age of five, until they were 18. Therefore, agents not encountering a location when their age reached the minimum could still enter a location later.

At the beginning of each run of the model, agents look within a certain radius, as well as looking to a certain number of other agents in their extended social network, to receive influence (support or detract). The model contains a multitude of options for adjusting agent's social networks. The model allows for the selection of the immediate radius from which each agent will look to for support influence. As the range of the social network increases, the agents will have more companions from which they can draw either positive or negative democratic support. Within this process, we built in a measure of randomness by ensuring the distribution of agents would result in different numbers of neighbors in each individual's range. After each step in the model, the agents move a couple of spaces in different directions; this allows agents to move in and out of the influence radius of others.

As for the extended social networks of the agents, or more simply a network that is not limited to a certain radius, there are also options that allow the user to manipulate the model. First, the user has the option to choose in which type of extended network the agents will participate. The three options are normal, uniform, or constant distributions. The normal distributions assign each individual a number of agents to participate in their extended network using the normal distribution to determine the exact number. The uniform option uses a simple random procedure to determine the number of agents within a certain individuals extended network. The uniform distribution does not follow the bell curve but allows every number in the random number range to have an equal opportunity of being selected, resulting in random numbers of agents in each network. Lastly, the constant distribution gives all agents the same number of individuals within their extended network.

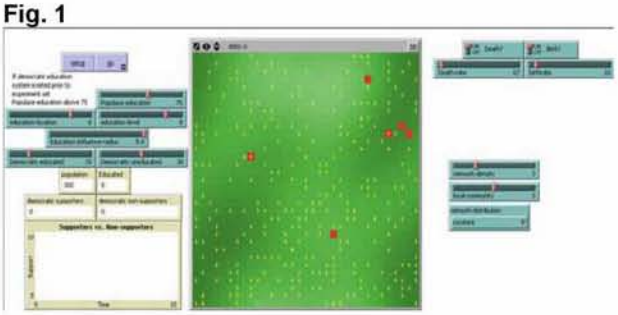
During every time step of the model, agents look within their social network, which includes their immediate radius and extended social network, and determine agents from which they will accept either democratic support or non-democratic support. In order to do this, the model is designed to follow the assumptions described in the literature, and a coin-flip procedure determines whether the agents accept influence (i.e. agents have a 50/50 chance of accepting or rejecting influence). This works the same for both democratic

influence and non-democratic influence. If an agent accepts influence the amount they accept, which remains constant, is either added or subtracted from the democratic support variable. Agents receive greater influence from their non-immediate network (representative of their family and friends) than from their neighborhood. We made this decision because influences an individual receives from family and friends tend to be stronger than influences they accept from strangers. If agents accept democratic influence, the support variable increases, but if they accept non-democratic influence, the support variable decreases.

In addition to the two main variables we examined, agents also performed checks to gain or lose wealth and to decide whether to support democracy or not. Because economics was not a focus of our experiment or our hypothesis, but is an important variable in democratic support, we included a procedure to allow agents to gain or lose wealth. For simplicity sake we used very basic procedures to allow agents to gain or lose wealth; if an agent is in the upper 15% of the population in wealth they have a greater chance to gain more wealth, while those below the 50% median have an equal chance to loose or gain wealth. We felt this procedure was necessary to represent the fact that individuals with large amounts of wealth are better able to protect their wealth and may be able to continue to gain it, while those with less wealth have a harder time protecting and gaining wealth.

Agents follow a procedure of checking their wealth, education and support levels to determine if they will became a supporter or detractor. We set thresholds for these variables (for support and wealth they did not change) and agents check all three, deciding to be a detractor if they fell below all three-threshold levels, and deciding to be a supporter if they were above. As explained previously, agents accept support or non-support from their neighbors and social network. We included this variable and allowed it to shift in order to provide a way to examine the effects of social networks, and to allow agents to decide whether to support democracy based on variables other than just wealth or education. Because it is not realistic to assume that all educated and wealthy people will automatically support democracy, we included the democratic support variable to allow agents to decide not to become supporters, even if they were wealthy and educated.

Fig. 1



4. RESULTS

In order to experiment with this model we ran 12,961 trials using a variety of variable settings. Utilizing the behavior space feature within NetLogo, we were able to sample six variables across multiple settings. For several variables (Populace-education, Democratic-educated, and Democratic-uneducated) we did not sample the entire variable range due to time constraints. In addition, we did not include the remaining sliders and switches (education-location, death rate, birth rate, and network distribution) in this experiment because we did not wish to test their direct effects on democracy.

Results of our experiment showed that overwhelmingly democratic supporters outnumbered democratic detractors (91% of the time).

	Supporters outnumber Detractors	Detractors outnumber Supporters	Total number of runs
Runs	11,795	1,166	12,961

Table 1: Total times each group outnumbered the other

In addition, the average percent of agents in the system that were supporters was 33%, while only 5% of the agents were detractors.

Average number of Supporters	Average number of Detractors	Total number of agents
90	15	300

Table 2: Average results of a run

Across multiple runs, this demonstrates that in almost all instances democratic support arose within the model, across multiple variable settings. However, the 9% of runs, which resulted in democratic detractors being the majority, demonstrated that variable settings did affect the outcome.

In order to gain a better understanding of what our results showed, we constructed a linear regression model of the results, finding that all variables except network density had a significant effect on democratic supporters (results appear in appendix 1). Our regression model included all variables from the model that changed (Populace-education, Democratic-educated, and Democratic-uneducated, Network-density, and local-community). The resultant adjusted R-square value of 0.544 shows that this model was robust and captured a large portion of the variability within the model. In addition, the high F value (2581.219) shows that the model was significant.

The regression coefficients from this model showed that almost all variables had the expected relationships with our dependent variable (based on the literature review). One variable which did not demonstrate an expected relationship with democratic support was the detractor threshold variable. The regression model showed that as the threshold to become a detractor rose, democratic supporters in the model fell. While this result appears counterintuitive, the regression analysis does not take into account the overall number of decorators and supporters in the model (i.e. even as decorators within the system fall due to a higher threshold, democratic supporters in the system do not necessarily rise). This result demonstrates that the two groups, detractors and supporters, do not vary based on each other's numbers. This finding supports our belief that the model adequately captures real world behaviors. Had the regression analysis shown that these variables had opposite relationships with the dependent variable, it would suggest that they might have an effect on each other as well. For this model to be accurate, the number of democratic supporters or detractors should not influence the other beyond moderately affecting the size of the influential population pool. This result is in no way conclusive that the two variables are not connected, but it does indicate their limited connectivity, which implies the number of supporters and detractors within the model is mostly able to vary independent of one another.

The other variables within our model-demonstrated relationships that the literature suggests should exist. All three remaining variables that were significant had positive relationships with democratic supporter numbers. While one of the variables we focused on (education) had a positive significant relationship with democratic supporters, the variables relating to social networks were not both significant. The variable representing the agent's social network external to their location (i.e. those they agents not in direct or near direct contact with) was not significant. However, because agents were able to move within the system, this is likely the cause for the local community (agents in direct or near direct contact with each other) having an effect on the outcome. The limit of social networks in this model is that they do not expand as agents encounter each other; since the social network is not able to expand throughout the agents "life", it has a fixed effect on the outcomes, which appears to be insignificant. In order to verify this finding we would need to re-run this experiment and allow the agents network density to vary across several distributions to determine if the effect is fixed or not.

5. Conclusion

The results of this model, across multiple variable settings, indicate that the model agrees with current theory. The fact that democratic supporters did not always outnumber detractors also indicates that the outcomes are not hard-coded into the model. While the sensitivity does appear somewhat low (as demonstrated by the fact that democratic supporters outnumbered detractors 91% of the time), the model did not produce an overwhelming majority of one outcome or the other. If we had added other variables or added additional variable settings in the experiment, it is likely that the results would likewise have varied. This is especially true for the number of education locations. In order to further test the effect of education on democratic support we would allow the number of locations to vary, and examine how this affects the model's results.

The model also captured the relationship between the spread of democratic ideals and social networks. In addition to the effects education had on democratic support, the relationship between individual agents and their immediate community reveal that external influences also play a large role in determining an individual's views of democracy. However, the model does seem to represent a very small majority of real world situations. The inclusion of social networks, which reach across distances greater than an immediate "neighborhood", is more representative of a country with advanced telecommunication networks. Because countries do not all possess advanced communication networks allowing all their citizens to communicate with friends and family over vast distances instantaneously, the model is not representative of all possible states. However, we could replicate countries without these advanced communications networks by removing the network density variable from experimentation.

While this model is not representative of all countries, which will take further experimentation and testing to correct, it does match well with the current state of the world. In countries with advanced communication networks and good education systems, the predominant form of government is democracy. Our model adequately reflects this, demonstrating that the model is relatively accurate, in terms of recreating real world situations. We expect that removing social networks and running the experiment again would likewise affect the model and produce results more representative of countries without advanced telecommunication networks.

Another possibly inaccurate aspect of the model is the number of education locations we allowed to exist. For the purpose of this experiment, we decided to vary the level of education agents received and not the number of sources where they could receive their education. We expect that lowering or raising the number of locations will have the same impact on the number of democratic supporters. Based on the construction of the model, a high number of locations will inherently affect more agents and introduce more education into the model. We therefore decided to remove this variable from this experiment as we expected its impact would be too great on the outcomes of our experiment. In future tests, we would include this variable and examine how it affects the models results. Should it produce results differing from what we expect, it would provide interesting insight into how the number of education locations available to individuals may positively or adversely affect their education.

In terms of validation, this model appears to be a valid representation of the real world. However, we could not identify a real world case to compare our results too, in furtherance of this conclusion. In future validation procedures we plan to empirically test this model against real world cases of countries where democratic support is the majority opinion of the people, and somewhere it is not. If through further validation our model proves to be an accurate representation of real world situations then our results would further reinforce current theory concerning

education and democracy. The results would also support the notion that social influences are an important factor in determining an individual's support of democracy. Our results from this experiment support this notion and suggest that individuals are heavily influenced both by the people they encounter in contact with, and by the education they receive.

6. APPENDIX

6.1 Regression Tables

Democratic Supporters Regression Model Tables

Democratic Support Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.738*	.545	.544	83.483

a. Predictors: (Constant), local-community, network-density, education-level, Popeducbegin, detracthreshold, demthreshold

Democratic Support Regression ANOVA*

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.079E8	6	1.799E7	2581.219	.000*
	Residual	9.028E7	12953	6969.465		
	Total	1.982E8	12959			

a. Predictors: (Constant), local-community, network-density, education-level, Popeducbegin, detracthreshold, demthreshold

b. Dependent Variable: supporters

Democratic Support Regression Coefficients*

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	172.613	4.549		37.946	.000
	demthreshold	-2.651	.045	-.350	-59.028	.000
	detracthreshold	-.314	.045	-.042	-7.002	.000
	Popeducbegin	1.625	.033	.294	49.537	.000
	education-level	16.280	.216	.446	75.284	.000
	network-density	-.052	.357	.000	-.144	.885
	local-community	27.800	.449	.357	61.906	.000

a. Dependent Variable: supporters

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Education, Social Networks and Democratic Support

Nick Drucker
Kenyth Campbell
MODSIM WORLD 2010

Purpose

- Examining how we can leverage modeling and simulation techniques in the International Relations field
- We were interested in the emergence of democracy supporters and detractors from a neutral population

Research Question

What are the effects of education on the emergence of democratic supporters in a socially connected country?

Agent Based Modeling

- Agents make decisions based on a set of rules
- In the Democracy Emergence model, agents were:
  - Supporters
  - Detractors
  - Neutral
- Supporters and Detractors influence the neutral population, who are eligible to receive education under certain circumstances

Model Logic

- Agents make decisions based on three variables
  - Education is determined by the independent variables in the model
  - Social network provides direction for idea transference
  - Wealth is uniformly distributed and changes in a fixed manner
- Education was the influential variable and was determined by:
  - Radius of education centers influence
  - Amount of education transferred from a center to an agent
  - Agents initial education

Model Logic

- Thresholds for all three variables must be met to support or detract
- Supporters and detractors influence their social networks
- 100 step process with agents dying and being born continuously

Social Network

- Consists of two parts
  - Local radius variable (local-community)
  - Extended network variable (network-density)
- Each of these variables has agents look to other agents for potential influence.
  - Local radius variable has agents look to neighbors within a certain radius.
  - Extended network variable has agents look to friends/family within a social network.

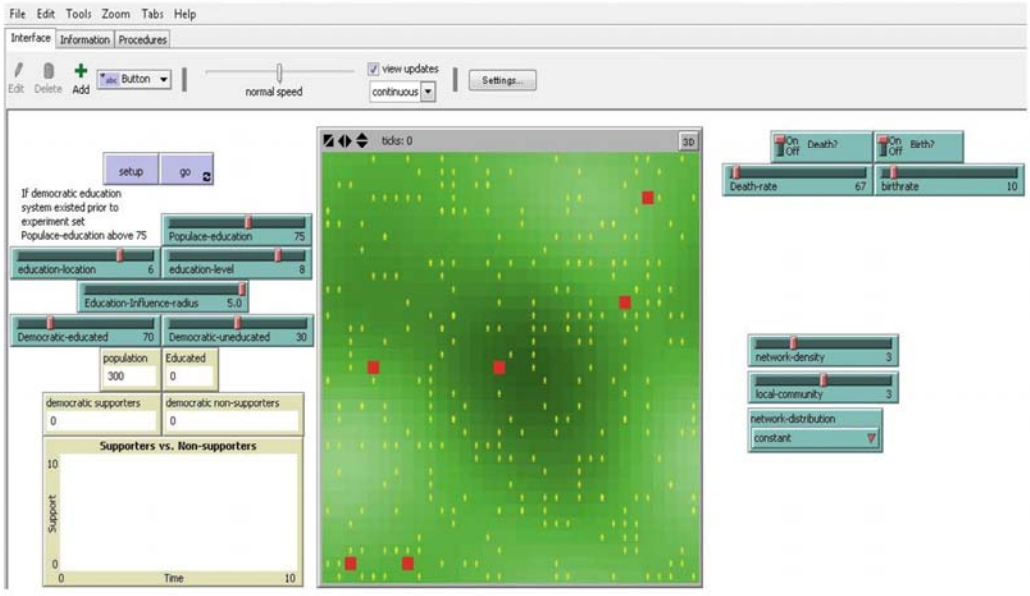
Social Network

- Potential influence is accepted via a coin-flip scenario.
- Influence received from other agents can either be positive or negative.
- Influence is transformed into a support variable that is part of determining whether agents become supporters or dissidents.

Assumptions and Expectations

- Agents exist in a electronically connected environment (e.g. They are able to communicate instantaneously with their distributed network)
- Once an agent is a supporter or detractor they can no longer be influenced
- There is a positive relationship between education and democracy; this assumption is based on current theory

Democracy Emergence Model



Experimentation

- Set parameters for independent variables (upper and lower limits)
  - Ex. Education influence radius (0-10)
- Established points within the parameters to sample
  - Ex. Education transference variable (2, 4, 6, 8, 10)
- Ran 12,961 trials with different combinations

Results

- 91% of runs resulted in a higher level of support for democracy than initial conditions
- On average 35% of agents in the system were democratic supporters; 5% were detractors
- Linear regression analysis revealed relationships that support the literature
  - Higher education transfer, lower education support threshold, and higher initial education resulted in more supporters
  - Lower threshold to become a detractor did not result in less democratic support (unexpected)

Conclusions

- We were successfully able to apply ABM principles to an International Relations topic
- The model aligns closely with literature
  - Appears to capture real world situations
- Democratic support was not the only end state outcome, non-democratic support was also observed

Future Research

- Apply to other Socio-Cultural issues
- Applying it to additional variables that impact Democracy and its emergence

Questions?