Engaging Climate Change Learners in Public School Settings

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In the ESIP Teacher Workshops this week, a common theme was the difficulty in teaching Climate Change and the Carbon Cycle in public schools. Common themes were a lack of scientifically vetted materials, limited time for instruction due to state standards, (<4 days, for most) and the task of keeping students engaged and interested. While such a need is often addressed using educational software, approximately 20% of the attendees indicated that they had limited access to computers in their classroom. The same issues surrounding the Nitrogen cycle were recently addressed by the creation of 'The N Game', a combination board and card game. It was designed to be educational and fun, and was released under a Creative Commons license, so it can be downloaded and printed, or purchased on game-typical, glossy cardstock. The existence of a scientifically vetted, freely available, physical game solves many of the problems voiced by the teachers. While various carbon and climate games exist, few are truly appropriate for classroom use. Many rely upon numerous pieces and parts, which often stray in classroom environments. Many require a board, and can only accommodate a small numbers of players. Few teachers can purchase (or even print out) 5-10 copies of a game to teach a single unit. There is a need for a quick, educational, scientifically vetted, and entertaining game that can be used to teach about the carbon cycle and climate change in a public school setting. It needs to be simple to learn, fast to play, and open to large numbers of players. These parts exist separately in a number of different games. What's required is the funding to bring them all together, apply polish and scientific review, and disseminate this engaging educational tool to educators. ESiP, in conjunction with its teacher workshops and scientific base seems to be an ideal incubator and test-ground for a project like this.

Putting the Puzzle Pieces Together

First, a confession. I play games. No, not computer games, or Milton-Bradly, Hasboro massproduced games. I play all number of niche games. You may have heard of Settlers of Catan, Last Night on Earth, Flux, or Dominion. These are unique games, with unique rules, goals, and built around unique systems. As such a connoisseur, I also pay close attention to game theory, both from a strategy standpoint, as well as the 'what makes a game fun' standpoint. When I introduce people to games like these, after the initial shock wears off, there is almost always a, 'woah', factor. A 'this is fun, and why didn't anyone introduce me to this before' factor.

I was lucky to be part of one of the beta tests of 'The N Game', and I learned a lot from the experience. Seeing how one biochemical system could be turned into an engaging, fun game was a great deal of the inspiration for this project. While it's undoubtedly a strong educational tool, it has some major flaws, chief among them that it takes far too long (~1 hour, dropping to 45 min with practice) to play in a public school classroom. It was our collective feeling that to truly understand it and be able to strategize for the game, it would take us 3-4 games. Few public schools can afford to spend 3-4 hours on a game for a single subject. A second limitation was that the game requires a large board, and a number of pieces. Both can be a struggle to accommodate in a classroom setting. Further complicating the matter was that we found working in teams of two much more difficult than playing alone. While the game can technically support 6 people – 3 teams of 2, for a class of 24, four games would be required. More realistically, you'd want 8 games. Lastly, the path through the nitrogen cycle was controlled by the players. When a flood was needed, for example, one was played. When a drought was needed, one happened. We remarked that this was inconsistent with the real world – random chance often determines the forcing on biochemical systems.

I was introduced to the Flux games some years ago. These are unique, 'pick up and play' games, that can easily support 8-10 players at a time. The genius in the game is that the only pieces are the cards, and all the rules are on the cards. Thus, if you can read, you can play. While it takes a few games to learn what little strategy there is, everyone can have a satisfying first-game, with no rulebook reading or referee required. In addition, the rules of the games are on the cards, and they don't come into play until the cards are played. For example, the base rule is that you start each round by drawing one card. However, one can play a 'Draw 2' card, which then changes the rules so that everyone starts their turn by drawing two cards. By not requiring a board, rulebook, or pieces, the game plays very quickly. Last but not least, I've been exposed to several games where the players are united in their quest to reach some goal. These can be everything from defeating monsters and zombies to building a rail system across the 1800s midwest. Often, there will be some sort of timer of events, after which the players collectively lose. These sorts of games allow the players to collectively focus on the game, rather than on their own personal offense and defense. It also removes the competitive aspects which can alienate some types of players. At the same time, there are still winners and losers, although it is now the group as a whole rather than a single player.

The Plan

The three types of game I've identified here can be be used as inspiration to make a fast, fun, scientifically accurate way to teach carbon cycles and climate change to public school students. Each has their own limitations, either from a scientific content standpoint, or a feasibility in the classroom standpoint. My goal is to address these issues, and provide a quality learning tool at low cost to educators.

The Game

The game will consist of three different types of cards. One will contain projected atmospheric CO_2 ppm and equivalent ΔT information.

(Doubled CO2 => + 2.1o C, eg.) The second will consist of power sources. Coal will dominate, with the number of each type of power source (solar, wind, geothermal, etc) roughly corresponding to their current percent of global power output. Each will also have an estimated/standardized CO2 ppm source. The third type of card will be random events, feedbacks, carbon sinks, and most importantly, energy requirements such as transportation networks, heating, electricity generation, etc. Four piles/groups of cards will be created as the game progresses. One pile is the atmosphere. As things produce CO2/ ΔT, cards will pile up in the Atmosphere area. Another pile are CO2 sinks. The third group are the power generators – coal plants, nuclear plants, solar installations. These will have power requirement cards under them, to indicate where the power is going. The last will be a discard pile. When something that requires energy is played, the next player will have to supply the energy it requires. They can choose from what they have – it might be coal, it might be solar. The increase in atmospheric CO2 will then be drawn from the ppm pile, and that will turn into atmospheric CO2 / ΔT. The goal will be to then play a CO2 sink to reduce the atmospheric CO2/ ΔT. (ppm cards will be 'buried' under their sink, so as to leave the appropriate amount in the 'atmosphere' pile.) A real-world balance goal is to work the game so that if the 'energy needs' that match our current world are played, they will require energy sources that, if matched to our current energy source distribution, will, when balanced with CO2 sinks, result in an atmospheric CO2 concentration near what we see today. Endgame will be when either the air temperature goes above a set level, or all the energy needs are met. The former represents a loss for the players, the latter represents a win. As in Flux, I plan to have rules that change throughout the game. One card may read, “If the current ΔT is greater than 5 F, the arctic and antarctic ice sheets have melted. The change in albedo continues to warm the earth – add another 2 F to the Atmosphere pile.” Another might be along the lines of, “If the current ΔT is between 1F and 3F, ocean productivity increases, and more carbon is taken up. Reduce the Atmosphere ΔT by 1F. If the current ΔT > 3F, the oceans are becoming more stratified, and can take up less carbon. Remove one Ocean Carbon Sink from the table, and return that CO2 to the atmosphere.”

The Science

The Carbon Cycle is very, very complex. Feedbacks are complex and not well known. Even our units are extensive – ppm, ppmv, Pg, Tg, ΔCo, ηAtm, barrels, GW, α, W/m2 etc, etc. In order to reduce this down to a level that's understandable in 20 minutes in a card game, there will need to be extensive standardizations calculated. My plan is to use three units: GW, and a combination of atmospheric ppm CO2 increase and ΔCo/ ΔFo. This requires some significant assumptions, and will be based on IPCC projected outcomes and a fair bit of other other research. While the entire complexity of feedback cycles can't be captured in a quick card game, at least some of it can. I plan to have cards which have outcomes based on the current atmospheric temperature/CO2 ppm concentration. These will be as varied as glacial and albedo responses to plant CO2 fertilization, ocean acidification, and cloud albedo effects. While it's impossible to teach these complex interactions in a 20 minute game, it is possible to demonstrate the possibilities, and hint at these complexities. Of course, while our current standard of energy use will be incorporated, I also plan to add in 'alternative endings' for the players. Things like moves to electric cars, mass transportation, green roof/white roof technology expanding to sizable percentages of the world, etc. This will show other ways we can use energy, and allow them to modify how the game ends. This might not always be for the better – it's possible that one player could draw the 'we all have cars/switch to mass transportation' card, and choose cars. The benefit is that students can see 'what might have been'. As the game is based on the cards, it will also be possible for an educator to propose different limitations on the game-play. For example, an educator could ask, “What happens if we aren't allowed to use any nuclear power?” That game would be played as normal, but power sources would be limited, and students would have to come up with creative ways to work around that limitation. A teacher could also set some condition like '400ppm max in the Atmosphere', which would change the pace of the game. It could also be '180ppm max', which would keenly show the difficulties in running a modern society without access to fossil fuels.

Creation and Testing

A moderate amount of research will need to be done to capture scientifically accurate details about temperature dependent climate feedbacks, current carbon sink and source details, current power requirements, etc. The standardization on just a handful of variables will also be somewhat tricky, as there is not a direct link between many of the possible variables – they are linked by a complex climate system. However, it should be possible to use the framework of current climate, and future climate projections to create at least a reasonable level of standardization. Artwork will be commissioned for the game, and there will be a number of playtests to examine balance issues as well as playability, replayability, educational value, and overall player-friendliness. Access to a college campus means that the base testing will not lack for players, at the cost of little more than a beer. As a former high school teacher, I also have access to a number of teachers I could ask to play-test this in their classrooms. Last but not least, many copies of the finished game will need to be printed professionally. It is assumed that this will represent a sizable percentage of the investment in the game. It is hoped to give some of these copies to teachers as a means to spread the word about the game.