Emergent by Design Workshop

The Workshop

The goal of the workshop is to teach kids about emergent phenomena and complex system that can be observed in nature, such as the dynamics of the food chain and how the human immune system is mobilized to fight against viruses and diseases. We chose this topic because we were interested in the challenge and the compromises that have to be made when developing a set of fun and entertaining activities to teach kids about something intricate and that is not entirely intuitive to them. The workshop is composed of a set of participatory simulations and computer activities using the StarLogo software. We divided the workshop in parts:

Random Walk

In the first part of the workshop, kids will learn more about random walks, an idea that is behind several different phenomena in nature, such as how a perfume spreads in a room. We first play a game with the kids where they simulate particles randomly diffusing from a central location. In this case, the particles in the game are the kids themselves!

Termites and wood chips

In the second part of the workshop, we will show the kids also using a game how termites collect randomly-spread wood chips and form piles with them. We then jump back to StarLogo and show the kids the effect of thousands of termites doing exactly what they did during the game.

Make your own simulation

After the first two parts of workshop, we hope to have given enough stimuli to the kids so that they are excited to simulate and other kinds of phenomena using StarLogo themselves.

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MAS712. Technology Tools for Learning

ED: Brainstorming about the Workshop

The First Big Brainstorming Session

April 11th 2001 - Thomaz

All right, I did some research today ! I spent about one hour at the co-op looking at all these books full with science experiments for kids. Unfortunately, my ideas are not as complete as I thought they should be, but at least that's progress in the right directions. The plan is to start thinking about things until we shape something that we like and that is feasible.

I couldn't really find anything related to modelling different kinds of phenomena in the books I checked. I think that if we go in that direction, we may really need some help from Mitch, Bakhtiar and Vanessa. We need to look deeper into what we can do with StarLogo and the other kinds of software packages as well.

On the other hand, I read about some really interesting projects, science projects for kids. There are neat things that we could perhaps do. There are two projects that I found very interesting. One of them has to do with submarines. The idea would be to explain to kids how submarines submerge and emerge. The submarines are actually water bottles. It's neat. When I saw that I thought that we could attach some sensors to the water bottle submarine and take measures of diving depth and so on. In addition to that, we could do some kind of modelling using these software packages as well.

Another project that I liked is the natural oven one. Basically, you create a very small greenhouse with a grill inside. You can put all kinds of fruits in there in a sunny day and dry them after a few hours. Again, we could put some sensors inside the little oven to measure the temperature and how fast it is rising. Then we could explain to

kids what is actually going on with the fruits, the water from them that is evaporating and so on. Then, at the end of the workshop, we could eat all the dry fruits. Yummy !

All right, the last idea that I had you guys already know about. It's the one about sports. We could organize a game of some kind, maybe soccer, basketball, whatever and attach a few biosensors to the kids. Then at the end of the game, we could tell and show each kid, one by one, how their heart beat rates changed during the activity and how many calories they lost, approximately. With the kids waiting, we could teach them more about how the human body works in the context of the game that they played and make some interesting analogies that would get them interested such as : "Don't you feel hot after playing basketball ? Well, the amount of heat that your body produced when you were playing basketball is enough to boil three cups of water".

Perhaps tomorrow after class we could go over to the coop to look at some other books that may give us some more ideas.

Well, that's all from me for now.

See'ya in class,

Thomaz

Project ideas

Overheating

The first idea that I have is about introducing children with the ³overheating process of the earth². What we can do is try to come up with different scenarios where they can see several causes of resulting in global warming and a significant increase in the world's snow and ice cover. Increasing amounts of greenhouse gases are likely to accelerate the rate of climate change leading to the raising of global sea levels and the flooding of current coastlines.

Relativity theory

I think that we can create some interesting simulation experiments on the computer and try to figure out if children can actually understand the principles behind them, in order to give them a better understanding of what Einstein's theory is about. Perhaps we can do something to introduce them to the concept of ³black holes².

How toŠ

I was looking at the howstuffworks website and they have different information about

all kind of devices, computers and so forth. There are different options there and I think we can come up with ideas of how to make children understand how a satellite works or how a solar sail works or any other thing that we wantŠ The interesting thing here will be to have them understand a specific concept (either a physics or mathematics concepts) through playing with the model.

cu

Jose

Project Ideas

Big Buildings

As we know big buildings do sway do to strong winds. The wind causes skscrapers to sway back and forth. Swaying can produce nause to people in top floors of buildings. To minimize the sway buildings use steel beems strapped around them. Other method involves hanging a huge weight at the very top that is called a Tuned Mass Damper.

For our workshop we can ask the kids to make their own model of a skycraper (they also can build one with the legos), create some wind, construct a measuring device to measure the sway. Also ask them to create their own tuned mass damper. As well we can have a model in the computer they can also play with it, to experiment with buildings with many many floors. So they can experiment how tall a building can be built, and what would it be needed in order to build a 1000 floors building.

So the learning would be knowing the effects of wind in buildings, effects of swaying in people, and how to minimize the sway.

Tornados

We can try a workshop about tornados, how they are formed. We can create a model in computer and ask the kids to play with it. They can learn about the temperatures of the air in the ground and in the air, learn about the difference in temps... know about speed of tornados, different types according to strong of them. We can also ask them to construct a machine for building a tornado that has a sensor for temperature and one for measuring the wind speed.

Fireworks

I've already talk to you about this idea. Actually, I found a computer model in starlogo for fireworks. It's kind of simple but kids could play with it.

Marco

Project ideas:

After reading some of Vanessa's writings about Participatory Simulations, I really like the idea of incorporating some of those ideas into our workshop. I'm still interested in using simulation software, but perhaps that could be the second part of the workshop, where the kids will apply what they learnt through an organized activity. So we could still use the emergent phenomena or decentralized systems ideas we had talked about before (foodweb in a forest, spread of gossip in a school, etc.) For instance, I'll elaborate on what we could do if we used the spreading of gossip idea.

First, we could tell the kids, "Hey, you know how some kids like to start rumours in the school? How do you think rumours spread? What do you think can happen with it?"

The kids might respond:

Kid #1: "Oh yeah! I know a kid who loves gossip, and will pass it on to everyone she knows!"

Kid #2: "But wait, that's not always true! For example, my friend John is a very serious type. If he hears rumours, he usually does not believe them, and he certainly doesn't spread them further because he believes rumours to be hurtful to people."

Kid #3: "Oh, but I know this guy who not only spreads rumours, but he even makes it worse and adds stuff to it and then tells everyone he knows about it as if it's completely true."

etc. etc.

After this exploration phase, we can tell the kids: "Okay, so you know that there are all kinds of people who do different things with the rumour. So what do you think happens at the end of the day? Does the whole school know the rumour? Or does it end up being completely different from how it started? Or did it stop spreading at some point?"

Kids: "Well... I guess that would depend on how many of each kind of people there are..."

"Or even if there are many gossip-mongers, maybe some of them are sick today or busy studying for a test and have not had as much time to spread the story..."

etc.

After the kids have generated some ideas about how the individual agents in the system might be behaving, and the different kinds of behaviors they might be exhibiting, we tell the kids: "Okay, why don't we try an experiment? Why don't each of you pretend to be on the kids you talked about before, like the studious kid, the gossip-loving kid, the jock, etc. and then act out their roles. Let's see what happens after you guys go about your business for half an hour."

So we give them the Thinking Tags (or some other similar kind of technology that will help track what's going on) and let them interact and depending on what parts the kids choose, we'll see if at the end of half an hour, if all the kids know the rumor or only some of them, or if it's changed a lot, etc.

Then we spend another half-hour first talking about the activity and exploring what happened, again making sure to draw responses and ideas out of the kids. Then we tell them about modelling this on the computer. We explain the basic idea is that there are many, like even hundreds, of agents, just like they were pretending to be. They can specify the behaviour of the agents, or of sets of agents and of their environment. (Well, we explain these in more kid-friendly terms depending on their age.) And then we help them do simulations and see what kinds of outcomes happen depending on the conditions they started with.

All of the above could happen with one group of kids, while another group of kids could be doing a totally different thing like acting out and then simulating the immune system's antibodies fighting disease-causing antigens, or a foodweb with different kinds of animals and their interactions, etc. At the end we could have a half hour session to bring the two groups together and have them explore the similarities between the two activities and discuss what they learnt. This whole thing should be doable in 2 hours, I think.

Okay, see you in class.

Nausheen

4/22/01:

modeling with programmable beads:

boolean algebra/propositional logic/logic gates

a calculator for arithmetic

probability, random walk

The Second Big Brainstorming Session

Big Idea:

In our workshop, we would like to use digital manipulatives such as programmable beads to help children explore concepts in decentralized systems and emergent phenomena. Playing with beads will allow the kids to develop an intuition with how global patterns develop from the simple behaviors of individual beads, which provides a good foundation for thinking about other more complex systems in the future.

Proposed workshop structure:

Part 1: Start off with a game where we provide the kids with a set of preprogrammed beads exhibiting a certain pattern. We tell them that all the beads have been given a simple behavior, and their task is to figure out what that is. In other words, given the global pattern and the fact that all the beads have the same local behavior, they need to figure out what the local behavior is.

Part 2: Introduce the notion of decentralized systems and emergent phenomena after the kids have figured out the challenge presented to them. Hopefully the game will have motivated the ideas already, and we will just help formalize them.

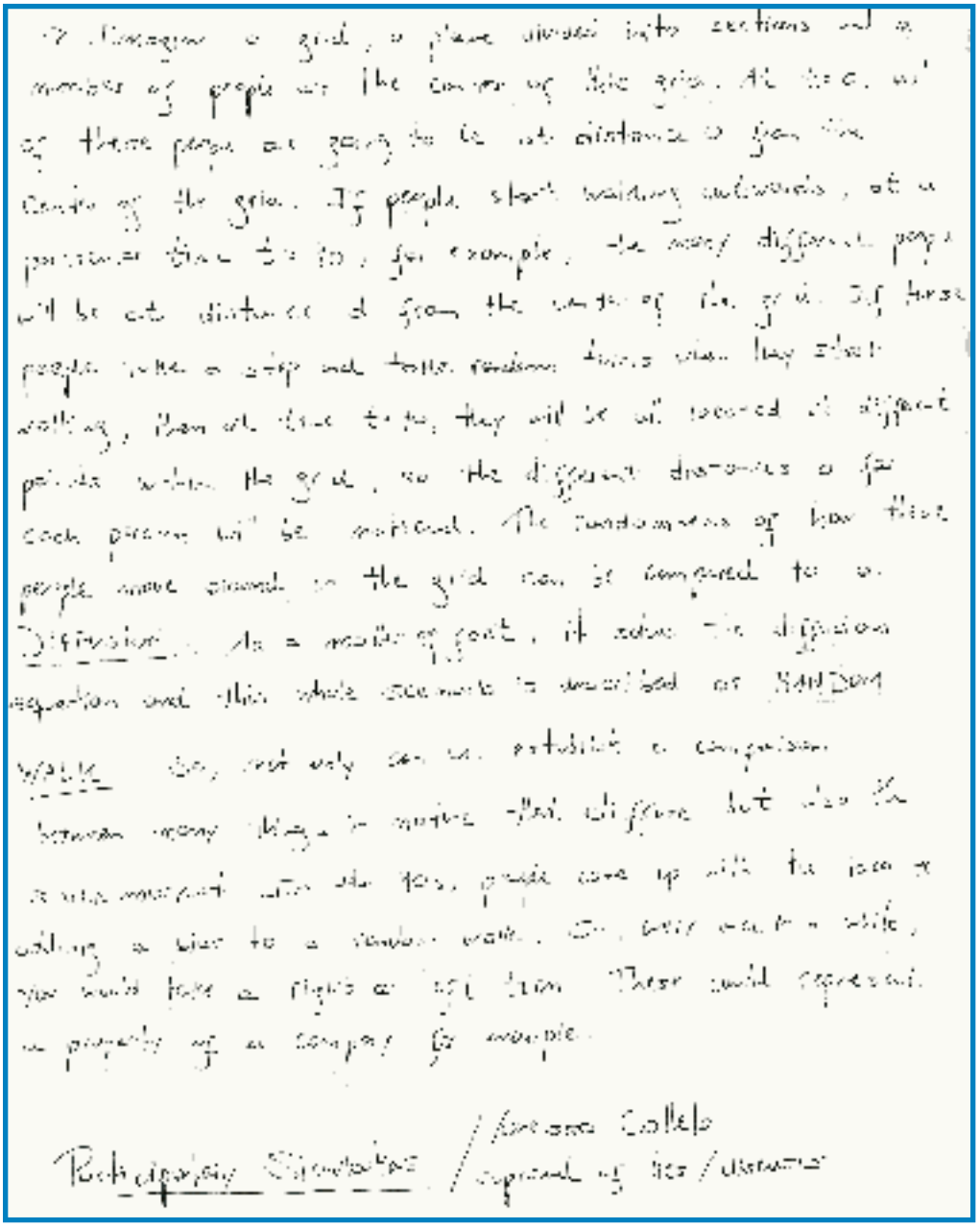
Part 3: Have the kids brainstorm about other ideas they want to model using the beads. Invite them to create more complex behaviors and patterns. Some possible mathematical models are oscillatory motion, probability, boolean algebra, etc.

Part 4: Conclussion session.

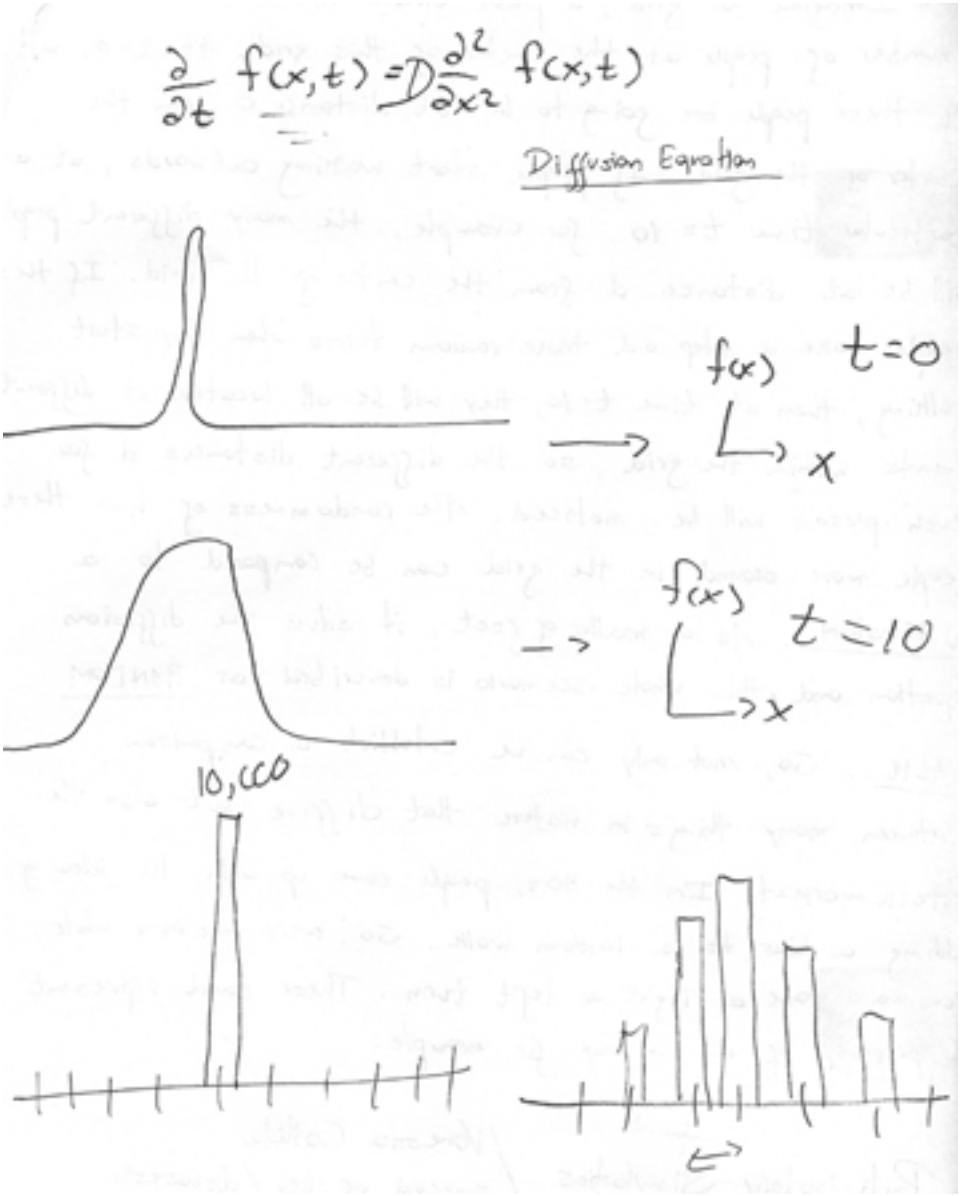
Target Audience: 10-12 year old children

Technology required: Programmable beads

Random Walk Idea



Random Walk and Diffusion



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MAS712. Technology Tools for Learning

ED: Just Add Water

A Workshop Blue-Print

We have spent countless hours organizing and planning this workshop. Resources, tools, space, give-aways and food are just some of the many issues that need to be considered in order for a workshop to be successful. Here, we provide everyone with information about how we put together our workshop so that it can be successfully replicated anywhere! Essentialy, this is a blue-print of our workshop.

What is Needed

* At least 1 computer for every 3 students. We used iMacs.

* The StarLogoT software, installed in the machines.

* The random walk and termite models, for the computer simulations.

* Perfume spray for the diffusion activity.

* A collection of big objects for the termites participatory simulation. We used the big LEGO blocks.

* Crickets, programmed as left/right random decision makers, for the participatory simulations. Basically, this is a randomness generator. If you cannot get your hands on a dozen of Crickets, you can ask the participants to flip a coin and go either left if head or right if tail.

* Posters with inspiring illustrations about the computer models.

* Healthy food and drinks.

* About 3 hours.

Workshop Structure

The workshop is organized in 5 parts. The first part of the workshop is the introduction. The last part of the workshop is a final discussion. The 2 sections after the introduction have 3 subsections each and the section before the final discussion is an exploratory one, where the participants are free to try to create their own models and think about different kinds of phenomena that they might want to model themselves. The subsections of parts 2 and 3 have 3 parts each. The first one is a participatory simulation, the second is a computer simulation, with the random walk and termites models, and the third is a short discussion about the model, where we project the computer model on the wall and then have a conversation with the kids about the model and ask them intriguing questions about it to make them think.

The Environment

Before the introduction, a suitable place for the workshop must be selected. It's usually a good idea to arrive at the workshop location at least one hour before the workshop begins. Remember that it always takes more time than expected to set up the computers, put the posters up and organize everything that is needed. Try to pick a place for the workshop that is quiet and preferably outdoors if possible. It's OK to have some food and drinks for the kids, but please, don't buy them just soft drinks and cookies. Make sure that you have some fresh fruit and juice as well.

Introduction

The introduction is very important because it allows you to get to know the participants of the workshop better, especially because most of the time, the participants of this particular workshop are 9-12 year old kids. We found that it is essential that the participants feel comfortable with us. So, in a practical sense, during the introduction we introduce ourselves, ask them to introduce themselves and then talk a bit about the workshop and the kinds of activities that are part of the workshop. The idea is to have a very informal conversation with the participants, be at their level, so that they feel like they are not even in a school environment. We want them to feel as if they are just playing with a group of friends in their backyard.

Random Walk

The goal of the Random Walk activity is to teach participants about diffusion processes and how random they can be. Initially, we distribute the Cricket decision makers to all the participants and then ask them to be at the center of the room or workshop environment. We then tell them to form a circle at the center of the room with their backs facing each other's backs (they are all looking outwards). The rule of the game is to step forward once, press the Cricket button and then step sideways either to the left or the right according to what the Cricket told them to do, everytime that they hear a clap. After a few claps, the participants will be all located in a random position of the room. Ideally, you should repeat this entire activity a few times and point out that all the participants ended up in a different part of the room at the end of each iteration. A good analogy to make is that of the drop of ink in a glass of water. We never really know exactly how the particles of ink will be spread when it reaches the water. Questions such as "What do you guys think that it is going to happen if we keep playing this game for another hour?" should be asked to make sure that the activity and the underlying principles that you want them to absorb are in alignment.

Once the first participatory simulation is over, ask the participants to form a big circle, as big as possible. Go to the center of the circle and tell them that you are going to spray some perfume. Ask them who they think will smell the perfume first. Spray some perfume. Ask them to raise their hand whenever they smell the perfume. Some participants will smell the perfume before others. Tell them that like with the ink drop in the glass of water, we also cannot predict exactly how gases diffuse in air. Now, tell them to sit in front of the computers, launch the Random Walk model in StarLogoT in each one of them and explain what StarLogo is and what it does, in a way that the participants can understand. Let them play with the models for around 20 minutes.

Gather all the students in front of a computer, connect the projector to it and spend around 10 minutes discussing the Random Walk model with the participants, asking them exploratory questions about it, such as "What is going to happen if we reduce the number of particles that are diffused?" Give the participants a 5 or 10 minute break.

Termites and Wood Chips

The idea behind this activity is to teach the participants that very complex behaviour can emerge out of seemingly trivial actions. Spread the big LEGO blocks or whatever it is that you are using as replacement for the big LEGO blocks in the room. Tell the participants that they are going to be termites and ask them to position themselves kind of randomly in the room or workshop space that you are using. Give each one of the participants a Cricket again and tell them to move around just like before. They should step forward once, press the Cricket button and then step sideways either to the left or the right according to what the Cricket told them to do, everytime that they hear a clap. The only difference here is that if they bump into one of the LEGO blocks on the floor, they should grab it. If they are already holding a LEGO and they bump into another one, they should drop the one that they are carrying. Do not forget to tell the participants that they are not allowed to kick the LEGO blocks on the floor. Start the activity. Clap you hands until it becomes clear that piles of LEGO blocks formed as the participants grabbed and dropped them. Stop the activity and ask the participants if they can see any difference between how the blocks were originally spread out at the start of the game and at the end of the game. They should be able to notice that at the end of the activity, a few block piles were formed. Now, for the big surprise, tell the kids that they behaved liked termites. Tell them that termites move around randomly, and whenever they find a wood chip, they grab it. If they were already carrying a wood chip, they drop the one that they were carrying when they run into another one. The result of many termites following this behaviour over a long period of time is the accumulation of wood chips in the form of piles.

At this point, the participants should be really excited. Ask them to sit down in front of the machines with the termite model in StarLogoT setup and let them play with it for 20 minutes or so.

At the end of the 20 minutes, have a discussion with them about the termite model and ask them questions such as "What happens if we reduce the the number of termites from 10 to 5?", for example. Give them time to think and then answer the questions. Because one of the computers will be connected to the projector, answer the questions by simulating your questions in the computer as opposed to just answering them.

Final Discussion

The final discussion is essential, because it brings all the workshop activities together and puts them in perspective. The fundamental idea to communicate is that nature is apparently very simple, but the truth of the matter is that it is extremely complex, sometimes even more complex than we can understand. Mention that the Random Walk and Termites are only two out of millions of phenomena that we can observe in nature. The idea that we would like them to take home is that nature is beautiful, nature should be appreciated and respected. And these phenomena represent a small percentage of it.