MIT GAMES-TO-TEACH PROJECT

Design Document for:

A PLATFORM FOR AUGMENTED REALITY GAMING

Environmental Detectives

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Version # 1.00

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DESIGN HISTORY

Version 1.0

Version 1. 0 includes Eric's material from the walk through of Environmental Detectives, and our previous work on the game.

AUGMENTED REALITY GAMING

At 12:35, the last students in MIT Course: 1.725J (Chemicals in the Environment: Fate and Transport) enter the classroom. They're each handed a PDA running *Environmental Detectives*, equipped with GPS and BlueTooth. Students have been divided into 5 groups that represent the following interests:

a) The EPA
b) An environmental health unit at a hospital
c) a manufacturing facility
d) a high tech firm
e) an environmental organization.

As groups launch their PDAs, they are presented with a unique cover story, customized to their roles. The story begins with a group of citizens concerned about the recent rise in health problems in their community. Their cause is then championed by environmentalists who begin to begin to publicize the rash of illnesses. A hostile press learns of this catastrophe, and immediately implicates a manufacturing plant near the watershed. Scientists hired by the industry deal with angry Emails and Instant messages from and concerned citizenry.

Each briefing contains some unique information and a few common facts. There are scattered reports of unexplained illnesses in nearby Cambridge. Through gathering field data, processing data, and interviewing virtual witnesses, players learn that this calamity has been caused by illegal dumping of trichloroethene, a hazardous material that is used to clean machinery. Trichloroethene is extremely harmful, leading to cancer and liver disease. Time is ticking, and players need contain the spread of this harmful chemical throughout the Boston area.

Each player has a specific goal. EPA workers need to contain the disaster, and prevent further human injury and hopefully identify the perpetrators. The environmentalists want to see one of the corporations tried, and public support for more regulations increase. The corporations each want to defend their own interests.

Each team must choose how to use its limited time and funds. Where should they collect data to identify the source of the pollution? Should they set up probes up and down the Charles River? Where should they drill wells to probe the groundwater and how many should they create given their resources? Should they pay to have informants taken to the doctor? Which symptoms should they pay attention to, and which ones should they ignore? Which communities seem to have statistically significant increases in disease? Red herrings in the form of other environmental contaminants, and people sick with other diseases will obscure their efforts.

Environmental Detectives combines the dramatic appeal of Erin Brokovich with the pedagogical value of inquiry-based learning exercises. Further, *Environmental Detectives* allows players to experiment with dangerous toxic, radioactive, or volatile which would be dangerous to do in most classrooms.

At the end of the game, players must try to remediate what they think are the causes of the pollution. After they put their efforts into place, they are given several forms of feedback. They learn how many people continue to get sick, what the pollution levels are, and what public opinion toward them is. The winner of *Environmental Detectives* may be chosen by a classroom vote, a mock simulated vote of public opinion, or other measures of success. Players themselves will need to decide what they think caused the increased levels of tricholoethene and where it started.

Through playing this game, players will learn more about the specifics of tricholoethene, one of the most dangerous and prevalent forms of pollution in the United States. Players will learn about the chemical properties of tricholoethene, and how it moves through the environment in different forms. As such, players learn about global geo-chemical processes, which are core ideas in environmental science.

Environmental Detectives is designed to be used in an environmental education context. Students learn basic investigative skills (observation, hypothesis testing, data gathering, data analysis, and data reporting) that are a part of any environmental education curriculum. In addition, there are opportunities for students to learn how chemicals are transported through the environment, how global chemical systems work, and how environmental toxins are neutralized. The solutions that they must put into place also require them to learn about designing engineering solutions.

Unlike traditional handheld models our augmented reality simulations use the power of the handheld to not only gather data, but to process information, visualize data, and engage the user through narrative and drama. Players search databases of information and design their own experiments to test what may be causing health problems in their communities and design appropriate solutions to fix these problems. In addition to the scientific simulation of tricholoethene transport, is the game of public opinion, and players must carefully consider how they conduct their investigations, what tests they run, how they interact with the media, and how they interact with each other. In addition, the real world context of the game that the players must move around in fosters spatial data visualization, mapping, and social constructed knowledge.

We think that *Environmental Detectives* will be a fun, engaging, and educationally powerful game. However, its greatest value may come not through playing this particular augmented reality simulation, but in the scenario editing tools that are shipped with the game. Players will have the ability to create their own simulations of environmental disasters, setting the type of contaminant, the effects of the contaminant, the rate of spread of the contaminant, and the potential effects of its interaction with the public.

GAME OVERVIEW

Backstory

It's the current day and age, and you're a constituent in your town. The class has been divided into 5 groups that represent the following interests:

1) The EPA
2) An environmental health unit at a hospital
3) a manufacturing facility
4) a high tech firm
5) an environmental organization.

There is a rash of health problems in the community, tied to the presence of tricholoroethe in the environment. Players are each given a unique briefing.

EPA workers. There has been an increase in reports of dead fish found along the shores of the tributaries leading into the Charles. EPA workers are given a backlog of data recorded from local rivers, including ph, and the presence of microbes, toxins, and chemical levels (Nitrates, etc.). EPA Players are also given a database of EPA resources they can look through in trying to identify the toxin.*** THIS REQUIRES SOME RETHINKING Perhaps they have some historical records of levels of tricholoroethene in drinking water. OR they have been alerted to health problems of people working on or near the river.

Environmental Activists. Environmental activists learn of this problem through some outraged citizens who have noticed that many of their friends and family have fallen ill.

High Tech firm. The high-tech firm workers learn of the problem through a corporate memo. The memo highlights the firm's innocence, as well as the importance of preserving trade secrets.

Traditional manufacturing facility. The traditional manufacturing firm (textiles, perhaps) sends a memo to a team of environmental engineering consultants whom they have worked with to streamline their production processes and minimize the amount of contaminants they produce. The players learn that the company has a history of producing toxic chemicals, but has been committed to "cleaning up their act" recently.

Hospital workers. The hospital workers are initially brought in as consultants to help a team of concerned doctors investigate the epidemiology of recent illnesses seen in their patients and family members, as well as examine to examine how the hospital is dealing with its hazardous wastes.

PHILOSOPHY / DESIGN GOALS

Augmented Reality Simulations: Leveraging the affordances of handheld devices

The use of computer simulations is changing the very nature of scientific investigation , and providing us unique insights into the way the world works. Scientists can now experiment in a virtual world of complex, dynamic systems in a way that was impossible just years ago. These tools have led to discoveries on topics ranging from the origins of planets to the spread of diseases through human populations. Simulations have also changed the way that science is taught. Many teachers use simulated systems on desktop computers to allow their students to conduct explorations that otherwise would be too time-intensive and costly.

To date most computer simulations have been tethered to the desktop, as they have relied on the processing power of that form factor. As we move simulations from the desktop to more ubiquitous and increasingly powerful portable devices, we could simply port existing tools to this new platform. This change in form factor alone would provide advantages in price and accessibility to students. But, the move from the desktop to the handheld computer provides other advantages, which make this an especially attractive platform for studying simulations. In order to fully capitalize on the handheld form factor, we should harness other features of handhelds including:

- *portability* –can take the computer to different sites and move around within a site
- *social interactivity* – can exchange data and collaborate with other people face to face
- *context sensitivity*– can gather data unique to the current location, environment, and time, including both real and simulated data
- *connectivity* – can connect handhelds to data collection devices, other handhelds, and to a common network that creates a true shared environment
- *individuality* – can provide unique scaffolding that is customized to the individual's path of investigation.

The purpose of this research project is to develop and examine a new simulation platform that is designed from the ground up for handheld computers and draws on the unique affordances of handheld technologies. Implicit to our research is the belief that a powerful handheld learning environment might capitalize on the portability, social interactivity, context sensitivity, connectivity, and individuality of ubiquitous devices to bridge real and virtual worlds. This platform will enable the development of "augmented reality" simulations, that is simulations that provide a virtual context layered on top of a real-world context. The handheld computer then provides a window into the virtual context that is sensitive to information being supplied to it by the real world.

Providing teachers and students robust authoring tools

As a part of this work, we will create authoring tools for students and teachers to create their own simulations. Research has shown that the process of creating models—as opposed to simply using models built by someone else—not only fosters model-building skills but also helps develop a greater understanding of the concepts embedded in the model. When people build their own models, they can decide what topic they want to study and how they want to study it. As the investigations proceed, they can determine which aspects of the system they want to focus

on, and refine their models as their understanding of the system grows. Perhaps most importantly, building models helps learners develop a sound understanding of both how a system works and why it works that way.

Further, research from the adoption and diffusion of curriculum materials suggests that in successful educational implementations, teachers reinvent curricular materials to meet the demands of local constraints. Ultimately, the success of a program like Environmental Detectives may hinge on providing teachers tools to design scenarios that take advantage of their own unique local affordances and meet particular local curricular constraints.

As we develop and test the Environmental Detectives scenario we will be considering the necessary elements that would enable others to develop a variety of augmented reality simulations. This particular simulation is just a stepping stone towards that goal. Our next steps are to create a suite of tools that facilitates the development and testing of additional augmented reality simulations. Ultimately we hope that our tools are flexible and supportive enough to empower students and educators to create augmented reality simulations that we have never dreamed of.

Fantasy and Narrative

The causes and consequences of toxic spills provide endless narrative possibilities. Toxic spills suggest the possibility of backroom corporate scheming and covert cover-ups. The opportunities for developing plotlines around secret corporate / government projects, environmental degradation, and silent conspiracies to keep this information from the public are limitless. The environmental health implications of these toxins are rife with melodramatic potential. Environmental Detectives combines bona fide scientific inquiry with mystery, intrigue and melodrama to create a gaming experience enjoyable to a diverse range of players.

Simulation with Dangerous Chemicals…

No doubt that students can learn a great deal about toxicology and the transport of toxins by examining real environmental disasters, or by dumping a barrel of oil into the Charles River and examining its impact on the environment and human health. However, not every community is situated near an ecological disaster (or wants to create a new one). Further, having students take readings of acids or titrates in the environment can introduce serious liabilities and costs. Such procedures involve handling dangerous, volatile, and costly chemicals. Finally, the Environmental Detectives platform allows educators to investigate a wide range of nvironmental issues, ranging from airborne particles to radioactive spills to toxic chemicals transported through water. With Environmental Detectives, we specially design scenarios to leverage their pedagogical and entertainment potential. In short, Environmental Detectives does not strive to replace inquiry-based learning or environmental investigations, but rather, to make a whole new range of scenarios open to educators.

Common Questions

What is the game?

Environmental Detectives is an augmented reality simulation game. The handheld device is a conduit for players in embedded in a real world context to interact with a virtual world. Players

cooperate with and compete against one another in identifying the cause of widespread illnesses, predicting how the toxins are spreading throughout the environment, minimizing their effects on human health, and vying for votes of public opinion.

Why create this game?

We believe that handhelds are one of the largest untapped educational and entertainment markets out there. Handhelds are affordable, easy to store and manage in a classroom, and portable, allowing teachers to use them in a variety of environments., How to leverage creatively the individuality, context-sensitivity, communcativity, and simulation power of these devices is an interesting challenge that hasn't been solved. We believe that it would make a viable platform for location-based education, entertainment, workshops, orientations, and special units, as well.

Where does the game take place?

Environmental Detectives is designed for use in any outdoor environment. Teachers or coordinators can set the initial location of the contaminant, the size of its plume, and it's trajectory through the environment.

The coordinator has the ability to determine the initial location of the contaminant, the size of its plume, and it's trajectory through the environment. Several *Environmental Detectives* scenarios are also designed for more constrained, indoor environments. Drawing off of actual cases, players in schools can investigate the consequences of a mercury spill in their school, including predicting and determining how the mercury will spread through air flows. Another scenario would be to investigate the flow of synthetic toxins through a school water supply.

The goal behind *Environmental Detectives* it to provide a handful of compelling game scenarios across a variety of contexts that teachers can then adapt, using the editing tools, to match their own setting. Robust editing tools allow teachers and students to take advantage of features in their environment that might make compelling game play. Teachers and students in the Boston area might use the Charles River, while students in the Midwest might track toxic flows through the Great Lakes. Environmental Detectives can be made even more compelling by applying it to problems associated with current or local events. The airborne toxin and drinking water scenarios have been included specifically because they can be applied most generically.

Between the diverse set of stock scenarios and editing tools for teachers, *Environmental Detectives* allows people to turn any ordinary location into a compelling gaming environment.

Describe the Controls

The interface will aspire to actual scientific instruments and modeling tools when possible. The conversations will take place largely through a clickable tree-structure, where players click through dialogs. NEEDS MORE

What is the main focus?

The main focus of the game is a mystery – students are trying to find out what's going on behind these grave illnesses. What makes this project interesting is that the goal is a moving target. By using time compression, players must pursue the toxin as it spreads throughout the environment, and players share information.

What's different?
Environmental Detectives tries to capitalize on the affordances of handhelds along with the allure of mystery / conspiracy plots to engage learners in an exciting educational experience. This is just one example of how we will use location aware handheld computers to provide augmented reality simulations. The other applications could include role-playing historical simulations, simulations of interstellar travel, or investigations that take students inside the human body. The handheld computers provide a window into that augmented reality and create situations where players are deeply engaged in studies of complex problems.

Who is the target audience?
College / AP Environmental Education classes. The scenarios could also be used in toxicology and transport courses. Students will have access to databases of resources on chemicals and transport rates.

What will people learn through playing this game?
Environmental Education curriculum, particularly investigative skills, which comprise approximately 15% of the AP curriculum. Players will also learn the properties of specific chemicals, how chemicals move through the environment (transport) and about global chemical cycles. The level of complexity is adjusted according to students ages, ability levels, and the duration of the unit. Players might receive very specific chemical reports of what is in the enviornment that they must sort through or heavily digested reports explain what toxins are present, what normal levels should be, and what the anticipated health effects could be.

What are the core game mechanics?
Students manage time and resources in investigating information. Each serves as a limitation for gaining more knowledge that they can use to make a compelling case for the location of the toxins in the environment.

Give 3-5 verbs that describe the gameplay.
Plotting, scheming, planning, collecting, researching, reacting, proposing.

What platform are you aiming for?
PocketPC devices.

Describe the look and feel.
The look and feel is as realistic as possible – students should feel as if the handheld is acting as actual scientific instruments. The game draws inspiration from conspiracy plots and mysteries, so the text should have a twisted and dark hue.

Why is the game fun?
The novelty of experiencing an augmented reality – the idea that there is a whole different world going on beneath the surface, only detectable through the device. We hope to use conspiracy, intrigue, and melodrama to suck the user into this world. We believe that not giving 1 right answer – but giving players the control to determine the outcome will also be popular with students tired of contrived gaming scenarios.

USER SCENARIOS

Overview

We expect that Environmental Detectives will be adapted for a number of classroom scenarios depending on age level, class size, and technological resources available.

General Outline

Time	Event	Decisions / Experiences
1 minute	Cover Story	Learn role, become familiar with the context for the activity. Curiosity should be aroused.
10 mins.	Explore interface, problem space, and meet other characters	Players click through some windows, becoming more familiar with the CE interface and the Environmental Detectives platform. They get a deeper appreciation for the problem at hand.
15 mins.	Formulate plan and begin collecting data.	Players make initial read on problem, begin formulating plan for getting data, and begin collecting data. Players decide who should go where and what tests to run
1 hour	Players are on site and have begun collecting data.	Players meet some extra characters. They learn more about the impact of the environmental disaster on other players. They learn about the other groups and begin interacting with other groups.
1 session	Players run 1 test and start evaluating the usefulness of their research plan. They re-evaluate and change their plans.	Players leave with a good feel for the problem, and some idea about what they will need to do to create a compelling case to meet their goals.

User Scenario 1

A team of environmental scientists has been called in to investigate the recent rash of illnesses occurring in the inhabitants of Riverview, a small community divided by the Rolling River. The scientists meet on site in the Riverview watershed. They are briefed by the mayor, who explains that certain parts of the town have been heavily affected by the illness. She also provides some background on the community and the surroundings.

The team divides up to take some initial, air, water and soil quality readings. Each member of the team is designated a sector to which they must go to take their readings. They specify rendezvous coordinates at which they will meet in one hour. The team goes out, collects their data, and meets up at the scheduled time. When they arrive they share their data electronically

and are provided with instant visualizations of a wealth of air, water and soil quality measurements.

As the students move around they can see where they are on a map. As they collect data using simulated instruments they store that information in their computers. As they mull over what data to collect or what questions to ask, the computer scaffolds their learning by providing context relevant information based on the data that they have collected and their current locations. When they go to interview people, they are given videos from which they must extract the pertinent points. And when they see someone sneaking out the back door they must track them on their devices and follow them to their destination. All of this is supported by real world experiences that include collecting geographical information, and taking digital pictures to support their findings.

One of the members of the team spots a trend in the tricholorethene readings that they have retrieved from wells. The trends indicate some source of pollution coming from the Northeast section of town. There are many industrial plants in that part of town, so again the team divides up to interview workers and managers of the plants in that area. During one of the first interviews, one of the scientists notices a worker sneaking out the back door as he approaches the factory. He races the factory worker to a nearby office building where he finds some incriminating evidence- documents that detail some of the byproducts that the company's manufacturing process produces. After collecting the documents he meets up again with the other team members.

There are still some questions left unanswered. Where is the pollution entering the ground water? Is there possibly more than one source? How can the effects be mitigated? These questions will have to be answered through additional investigations.

User Scenario 3

Wally lets out a deep sigh as he clicks his pen on his iPaq. *Another ride on the "T." Great.* Up pops a text window. *Greetings, Wally. I see that you are on your way to work. Good*. A smirk works its way across Wally's face. *I never get tired of that bit*, he thinks to himself as he scrolls through today's update.

GAMEPLAY

Environmental Detectives Gameplay

RESOURCES
This is the "currency" of the game that allows agents to perform important actions. When an agent runs out, they must go back to HQ to replenish his/her supply.

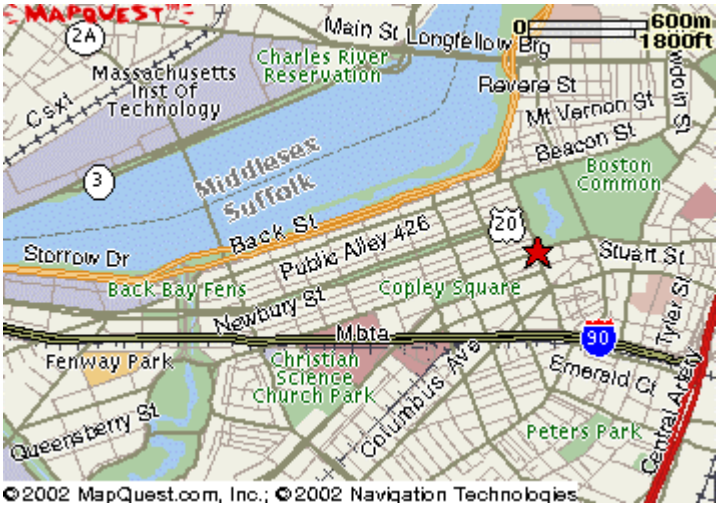
EXPLORATION
3 types of exploration sites: spill, interview, lab stations. Each group has a certain number of agents dedicated to either spill sites or interviews (i.e. each person is effective only at a particular kind of site). Spill agents have a good number of RESOURCES while Interview agents have very few (only enough for 1 or 2 lab visits). All agents can go to lab stations.

SPILL

Flow: map levels/gain background->scan location->extract chemicals->analyze->report

MAP LEVELS

Players get an overhead map with marked areas of interest. As they get closer to a site, the map zooms in. As the player travels, he can read whatever background information is available for the site.



High up map

Mid range map

Close range map

SCAN, EXTRACT, ANALYZE

Once at the site, the player can scan the area for chemicals. The scan uses RESOURCES but not too many. Scanning is done by switching the device to scan mode and walking around the area. Scan mode collects data from areas within a 3ft radius of the device. A color map (looks like a infrared scan, different colors representing different chemicals, hue relates to amount of chemical present, brightness relates to accessibility for extraction) of the area is compiled from the area scanned and the player can choose an area to extract from.

Extraction takes a good amount of RESOURCES and should be done wisely. Some teams may opt to have one person do a lot of scanning, transfer the maps to others who only extract. Once a chemical has been extracted, analysis can be performed. Scan maps can be traded, but extractions are kept locally and can only be analyzed by the extractor or at a lab.

Analysis takes more RESOURCES than scanning, but less than extracting. The player must choose what kind of analysis to perform – each test capable of producing different types of

results – and on how much of the extracted chemical to perform the test on. [I WANT TO MAKE THE TESTS INTERACTIVE IN SOME WAY. HOPEFULLY THIS CAN BE SMOOTHED OUT WHEN WE HAVE MORE INFO ON CHEMICALS] Analyzing at a lab requires no RESOURCES – the penalty is going to the lab, the payoff is that the lab can work quicker and offer more and offer more tests.

REPORT

There are 2 kinds of reporting: HQ reporting and News reporting. Most information found will go to the player's HQ for compilation. Certain info reported to HQ will increase a team's point total. Some info can create new areas of interest for a team (finding chemicals near a playground could trigger interview spots). Should a player come across evidence that points to a particular group, that evidence can be reported to the News. All players will receive the headline and the finder's group will gain bonus points (PENALTY TO ACCUSED? MAYBE IF THEY CAN'T COUNTER-ARGUE WITHIN A CERTAIN AMOUNT OF TIME).

INTERVIEW

Flow: map/background->questioning->examination->report

MAP – same as above

QUESTIONING

A simple dialog tree for the player to traverse and gain info on what symptoms a sick person has, where people have been recently, etc. What info the player gets is dependant on what questions are asked and the order asked (questions eliminated as certain ones are asked until tree comes to an end). Players will be able to take notes on places and objects mentioned in interviews. Places will spawn more areas of interest while objects can be examined and collected.

EXAMINATION

Sick people can be examined to try and determine what illnesses they have. Some people will have been affected by chemical leakage, some will have allergies. Each person has a tell-tale sign as to what kind of illness (spill vs. natural) she has. Certain tools must be applied correctly to yield proper results. An information database will aid players in forming a diagnosis. Some interviewees will volunteer to give blood samples for lab analysis. Objects collected can be thoroughly examined (3D view if possible), can be given to Spill site agents for testing, or taken to labs for testing.

REPORT – same as above

LAB STATIONS

Flow: Choose analysis

Labs serve the function of performing analyses for free and performing tests that spill agents are unable to. Labs are in general faster than manual analysis, but there are not too many labs and once a person is using a lab station, no one else can use the station until that person is done. Each team has certain labs dedicated to them and there a couple independent labs. Dedicated labs are free to the group, but independent labs cost RESOURCES and have the most tests and work the fastest.

GROUP SPECIFIC TRAITS
Each group will have certain advantages over other groups

Corporations: The money of these big businesses allows their agents to have more RESOURCES (possibly even regenerate RESOURCES while in the field). The downside is that their disregard of environmental issues leaves them with not as much background knowledge as other groups.

EPA-ish group: Classified lab techniques and government funding allow the EPA to have more labs that are superior to the other groups' (e.g. they work just like independent lab, but are free). People don't like G-men asking personal questions so some interviewees may be hostile if approached incorrectly (translates into less likely to get blood samples and other info).

Greenpeace-ish group: Being very environmentally aware, this group has developed tools that allow field agents to scan and extract much better than other groups. People are also more willing to help them since they fight for the environment. Unfortunately they do not have as much RESOURCES or labs as the other groups.

OTHER GROUPS

Rouge group – if included they should be a discovery for players and not necessarily a group to be. Maybe they are an NPC force behind the scenes manipulating things.

Hospital – the surprise ending (if chosen as such). Can offer diagnosing services on interviewees, but ends up being the source of chemical leakage (people leave healthy but are ill soon after due to being so close to the source?)

Hours of Gameplay
4-20

Victory Conditions
Players create a compelling case to meet their objectives. Some of this is decided by the simulation of public opinion, which changes in response to students' actions.

TECHNICAL INFORMATION

Technology

Enviornmental Detectives is designed to integrate GPS, Bluetooth, and handheld computing technologies in one platform. As such, the platform could be coded in a combination of C++, Java, and .Net. Several research projects have begun experimenting with integrating these technologies, although none are currently using them for educational gaming.

We envision the system running through a gridded map-driven system. So, the simulation might know where the contaminant enters the system and its rate and direction of propagation, as well as any barriers or other geographical features that affect its spread. From there, the system will also track in the coordinates of the players, and calculate the sampling data and other information that would be made available to the player.

We are encouraged about the prospects of this map-based simulation system hosting a whole suite of handheld applications in the future. In addition to the pollution scenarios mentioned here, science teachers might create scenarios where other entities move through the environment, such as populations of animals, or diseases. One could also imagine this same format being ported to an historical or social sciences context, where students might create historical maps of an area, and tie photographs, interview data, or other writing to a particular location.

This last feature -- using creative writing to as a medium for augmented reality simulations has many other potentially interesting applications. Imagine experiencing Frank McCourt's Limerick, Jack Black's trip through Los Angeles, or Hunter S. Thompson's Las Vegas -- or perhaps a combination of all three. A natural extension of each of these projects is to create a web-based database where users can upload their own media, and express themselves.

SUBJECT

Overview

Environmental Detectives is designed to be used in Environmental Education Courses. Environmental Detectives would meet standards in both content areas, such as global chemical flows and transport of toxins, as well as investigative and process skills. Working with MIT Professor Heidi Nepf, we are also developing scenarios where Environmental Detectives could be used in toxicology and transport classes at MIT.

Flexible Platform

The flexibility of the platform editing tools allows Environmental Detectives to be tailored to several different age groups and content areas. In advanced courses, players might only be given symptoms that they must use to decipher what toxins have caused the problem. Younger students could be given more hints as to the source of the problem. The basic metaphor of the platform – a map-based system that simulates the spread of substances through an environment and then reveals to the player only the information that corresponds to the part of the environment they are in – can also be used to represent the spread of viruses or radioactive substances through an environment.

PEDAGOGICAL APPROACHES

Overview

Environmental Detectives is a unique gaming experience that draws on several pedagogical traditions and approaches. In some respects, the "mystery" portion of the exercise, trying to solve the problem of what is causing this contamination, owes much to problem-based learning, where students are presented with a problem, a set of tools, and a set of resources to solve the problem, and then are set loose. Several pedagogical models have been developed for problem-based learning, including Barrows, et al. 1999, Savery & Duffy, 1995, Jonassen, 1999, and Nelson, 1999. Problem-based learning has been gaining increased support in both K-12 and higher education for its ability to help learners become more skillful at solving real world problems. There also have been encouraging results showing that students in problem-based learning environments develop more robust understandings of concepts and have better retention than students in traditional learning environments.

Environmental Detectives also shares much in common with traditional role playing game exercises. Role playing games have been used across all disciplines, but are most often used in social studies. Researchers in gaming and simulations also have found that the cooperative learning and reflection activities around games are a better predictor of success than the game play itself. In other words, how the game is situated within the curriculum, and how teachers find ways of supporting students' play through debriefing, reflection, discussion, and just-in-time lectures are as integral to the gaming experience as the game itself. The little comparative research that has been done on games in these settings reflects this difficulty, as researchers find great variability in what players learn from educational gaming. One particular problem has been that many students learn to play the game very well, but fail to make adequate connections back to the real-world experiences that are being represented or modeled through the game. Better games map the game mechanics on to real world phenomena fairly closely, so thinking in the context of game play maps closely to disciplinary thinking. Good games also use information and interfaces that students might encounter later, so that students develop skills using tools, managing and accessing resources, and thinking with the kinds of information that we would like them to use outside of the gaming context.

Simulations and Models.

Research in simulations and modeling offers another lens for using Environmental Detectives to support learning. Models and simulations are frequently used in education to allow students to gain more holistic perspectives of how systems interact. Research in simulations and modeling has shown that there are several ways of reinforcing students' interactions with models to lead to more robust learning exercises. Students can form hypotheses, and use models to test hypotheses. They can change parameters of a model to test their understandings of how systems behave. With Environmental Detectives, we are hope that students will form ideas and debate different interpretations of the simulation game through the challenges of gameplay.

Assessment.

Teachers will be able to assess students' learning through the final product that they produce – the case that they can make for having identified the cause of the contaminant, make a case for

what caused it, and their ability to prevent its further spread. Students will have opportunities for self-assessment, as they develop ideas try them out, and get feedback from peers. The handheld device will also be able to log all of the students' activities in the environment, which can then be presented as data for the teachers and students to analyze. Imagine a team getting a graphic report of how much time they spent interviewing people versus collecting chemical data, and then comparing this data against other groups. Or, the class might map where different groups went searching for contaminants and devise better strategies for collecting and analyzing data. We believe that one of the most powerful uses of this handheld technology may be to capture students' actions, location, and interactions, in the world, and then to present graphical visualizations of how students' performance.

"RESOURCES APPENDIX"

Mercury Poisoning

a) http://www.cdc.gov/mmwr/preview/mmwrhtml/00037313.htm
b) http://www.cdc.gov/od/oc/media/pressrel/mercury.htm
c) http://mercury1.50megs.com/
d) http://bmj.com/cgi/content/full/319/7206/366?view=full&pmid=10435962
e) health effects http://www.beatcfsandfms.org/html/HgRootCause.html
f) EPA report http://www.epa.gov/ttn/oarpg/t3/reports/volume3.pdf

http://www.thehawaiichannel.com/hon/news/stories/news-139407520020411-160423.html

Pesticides
http://www.ewg.org/reports/cadrift/pr.html
http://www.ewg.org/reports/camb95/mb_press.html

MATH/SCIENCE ENGINEERING / CONTENT