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Good afternoon everyone.On behalf of my colleagues here at NSF, it is my pleasure to welcome you to the first distinguished lecture on design in disruptive learning series. I'm excited to be here with you this afternoon. In a moment I will turn it over to Janet to introduce our speaker. Let me say a few words about the summer learning program and the speaker series. As learning platforms merge with more online interactive models, we are seeing some transformative activities, richer collaboration and opportunities for helping to create a richer learning experience, both in formal and informal settings. Data collection, more systematic evaluation for the teachers and students. There are many implications for formal and informal education including our academic institutions across the country. The real potential is improving learning by integrating emerging technologies with knowledge from research about how people learn. Just last month, I'm sure you have seen that NSF posted a cyber learning in future learning technology, this is a new opportunity to build on years of investment by various directors of NSF. This opportunity is now with a new name from from the formal cyber learning transforming education solicitation continues the benefits of putting the work that aims to integrate research on emerging technologies as I mentioned. I am excited about this because of the terrific collaboration that is taking place involved in the science directorate, our colleagues in HR and we're going to build on that. This year our engineering director is involved as part of this solicitation saw a lot of great things are going to come out of this collaboration. As the re- search has supported, on how to design and implement technology to support learning assessment and help people learn in a technology rich e nvironment. The cyber learning program is one example of many that exist throughout the foundation in support research on learning with technology. I am sure you also firmly with a significant investment in the learning centers over the last few years. I'm also excited about this series and the opportunity to showcase projects under NSF programs and imaginative new ways technology can be used to help people learn. This series will demonstrate the transformative potential of learning technology and will enhance our facility and [Background Noise].

Before I close I want to thank the members of the working group that over the last several years especially during the last year for presenting all the directorates -- we want to thank Janet for her leadership of this effort. Let's give her a round of applause. [Applause]. This is a result of their hard work. Again, I want to thank all of you for coming here and I'm going to turn it over to Janet to introduce our speaker.

I am Janet and I am the co- lead of the cyber learning working group. We are the people who just working on the proposals or whatever. What I wanted to tell you about this series is we wanted to help people [Audio Faint/Low S peaker]. I am excited to have Tom as our very first speaker. Tom has come to be known as one of the most creative and imaginative designers of the technology rich learning environment and the technology learning community. He is on the faculty in computer science at the University of Illinois in Chicago are in for the past decade his research has been centered on the introduction of computer interaction and learning technologies, focusing on the designs of ubiquitous technology, that is technologies all around us. And has embodied activities for young learners, the kind of activities -- to support young learners in classroom in learning science.I am pleased to have Tom kick off this series.

Thank you for the introduction. I want to thank everybody who helped me get today. I'm really happy to be here. I will try to go quickly today because I know -- I want to talk about work we have done, my graduate students and collaborators in teachers for about the past 10 years. Designing learning experiences -- focus on activities to support whole class activities engaged in extended inquiry exercises. When Janet asked me to give a talk, she asked me to get a feel for the classroom son going to try to do that today and give you an idea -- and we would have a fair amount of video but I think it's going to be [Background Noise].

I'm going to start, at my age I am -- as a basic behavior driver. I don't mean it in a facetious way. I guess for me and I expect for a lot of you, scientists are interested to break it down a little bit and what I mean by components and what makes something fun and makes science fun for me in the classroom. We have a couple of characteristics of what I think are fun and I want to elaborate on this for a minute. It has to involve something accessible, something that is there that I can get my hands o n. I want to make -- not restrict myself necessarily -- that can be contained within this space the space but allow us to imagine things that come from other places. I wanted to allow me to be productive in some sense. It is accessible, I can make progress on it. I don't get stuck somewhere and unable to move forward. When I think about designing activities, the first question that comes to my mind is a question I think I carry through from when I was a kid is what do I get to do? What is the action? That can be cognitive action. That can be social action. But I'm also interested in a social action. The idea there is an activity structure to engage. I like movies with unpredictable endings and I don't think kids like activities where they know the outcome from the outset. [Background Noise]. An element of the unexpected. I think sharing is important. Learning how to collaborate with each other for work is an important thing we need to do, but also others to share my fun with and share the social experience. Perhaps most of all, experiences need to be fun and hard enough to be fun. The difference [Background Noise]. You have to have something that engages you. To me it means [Background Noise]. It has got to be authentic and disciplined and feel like I am digging in deeply and they do this through the design of a relatively long-term investigation. Our activities usually run 6-8 weeks. My work is about having fun.

One of the techniques I use is working with fun scientists. I found it a great source of inspiration by working with the main scientists who described to me the work they do. This is a picture of my research partners.

Here is the place I want to have fun. I love working in classrooms. We talk about the constraints of classrooms in the curriculum, overcrowding issues, about budget, but to me classrooms are full of interesting -- we have a captive audience in a community that gets to know each other very well and most of all we have an adult in the room that knows something about learning and cares about those children. I see those as assets. I think about embracing the constraints of the classroom so there is a design challenge.

Thinking about the kinds of activities [Background Noise] hearkened back to when I was in elementary school. When I was in sixth grade I had a creative teacher is she organized for us a trip to the moon. We broke into teams. One team was responsible for designing the living quarters. We got cardboard boxes and figured out where we would put our food and close. Some of us planned the trajectory to the moon. Others were concerned with navigation. Sheep brought up -- she brought a big refrigerator box and put it around the door and you had to reverse it go ice pressure.. We didn't have the technology to take it much further to make it something operational. Whenever got to go to the moon, we just got to plan to go to the moon. I'm interested to try to find a way to go to the moon. A couple years ago, we started to think about a framework that tried to utilize the room, where we would could could use the physical space and the physical time of the classroom to try to enact in a way that would make it richer for us. More dials to turn [Background Noise]. To briefly give you the framework, and I apologize this is my own moving slide.We start with a classroom.[Background Noise]. We ask the kid to imagine coincident with the classroom and physical space that there is some phenomenon occupying the space at the same time. They I take is to embed the children within the phenomenon itself that embed the phenomenon in the classroom. I'm starting to talk about this in a coincident reality. Two realities going on at the same time. They are connected by some portals. The idea is the way you access this phenomenon is through B's locations in the room they give you the elephant view of what is going on with this phenomenon. The location of these portals within the classroom are location specific. They kind of you I might get on a stationary computer or portable device. One part of the room is going to be different that other part of the room and they are going to vary across time. The idea with the portals, the Swiss cheese reality, it provides an opportunity to let kids have an experience with kind of a mobile science practice. It is the idea that the scientists are active and challenging and interesting in the area of potential e xpiration. The idea for them that you get to move around and the fact you have to move around because you need data from different locations I think is appealing to a lot of kids.

These representations run all the time, at least ideally. The idea is these representations even though we are doing spelling now or were during reading or social studies, these representations are up all the time and running. The idea is I want to immerse the kids sort of in the timeframe of the phenomenon. I want to maintain for the salience all the time. Sometimes I use the term marinating the kids. It also affords me the opportunity for surprise. Nature happens when it happens, not just because it happens to be science. It also has the advantage of speaking in sneaking in extra time for science which is needed in elementary school. Finally, children in gauge in investigations over multiple weeks. We need the collective efforts of the entire class to gather the data to reflect on those data and identify the patterns are looking for and also because I went to afford kids time to engage. We run into kids whose immediate attention to a new activity might be a little offputting, but after while, these are surrounding all the time and engaged in these activities overwrought for overall couple weeks and at some point it becomes easier to participate than it is to pull it off.

I'm going to take you on a quick tour of a phenomenon. First I want to talk about the picture of the application called [Indiscernible]. The idea, we asked the kids to imagine we are situated in an area that is a very active area of seismic activity in for some reason we might be expecting we might have a lot of earthquakes over the next couple of weeks. We not only give them the question that given the challenge of determining for the fault line is in our classroom is, we want to find out where that is. Learning to do that we need to track a series of earthquakes over time and find out what patterns involve. From one perspective we're interested in the question of how do we know about individual events? How do we know this started with an explanation and figure out where this happened. We get kids to [Background Noise] the process of using seismometers. We wanted to focus on that interpretation on doubt that could be accomplished in the practice of -- and what we learned about patterns of earthquakes. We only talked about the fault line but there other patterns in distributions of quakes. The distributions of intensity.

We distributed -- [Background Noise]. The idea is we distribute these around the classroom and we shrink everything down so instead of talking about hundreds of kilometers, our -- [Indiscernible]. Every now and then the seismographs around all the time, mostly showing simulated flat noise and at scheduled times we have a room quake. When a room quake occurs the task of the kids is to interpret the seismogram. They had to interpret the quake, determined the distance of the quake from their particular seismograph and that would be different for each of the kids. The way we affect trilateral rations, I went to Home Depot and bought some dry lines in use that Ms. Tate measures so the kids pulled the strings out and the point of interact [Indiscernible].When they determine the epicenter, they mark of them, typically we would hang Styrofoam balls to indicate the quakes and the magnitude. We've see physical representation of the accumulation of data over time. I'm going to show a brief video of what the action looks like in the room. We begin the video with a videoconference with the woman who is a seismologist -- and Debbie sent me a conversation and we scheduled a quake while she was having the conversation so she could get an idea on what the action was like.

[Video Playing]

You see the kids going through interpreting the seismographs.

[Video Playing]

I'm not going to go a lot and outcomes that wanted to give you an example of one of the student products that came out of this. Is her kids looking at the distribution of the magnitude of the quakes over time. We know there are a lot of weaker quakes that are stronger quakes but there is a relationship -- these guys got very close to it down here. It is a very simple representation. It helps to understand collections of quakes rather than individual quakes.

Another application is called aqua room. We had a fact we would needed to bring into town and we need to do jobs. It was a good thing the factory was coming in but it was a chemical factory and we wanted to make sure any -- from the factory did not impact the water system. Our task was hydrogeology. We imagined the classroom was a small town and we are on a network of aquifers and we challenged the kids to find the aquifers. The work involved with that, the way that is done is they will inject dyes, we did them as colored dyes, then they start to sample around the point of the injection to see that migrated from the original injection s ite. Their job was to find out by doing those injections and extractions if they could find out -- so the equipment we used was computers as sort of portable drilling stations. We took these tablets and attached a couple things to t hem. We attached an ethernet cord to which we taped a suction cup at the end. That served as the drilling instrument. You had to get to the ground to get at the stuff. I don't know if you are familiar with these one-button reader systems, we put these readers on and -- unique identifiers associated. The kids would walk around with ease, find a place they wanted to do their drilling. They located themselves using a grid system based on the tiles on the ceiling. The kids would walk around and do their drilling. The way they would inject and receive samples is we took test tubes in good buttons to the top of the test tubes. The kids would walk over and by attaching the test tube to the reader, we were imagining the dye would flow down to the ethernet cable into the ground and we wanted to collect samples than we had another test to where they would come back and collect samples. When they received a sample which we knew about because of its unique ID in the location they reported, they would go to this simulated spectrometer and plug in and take a spectrometer reading so they could see what colors emerged. Then they would report that on the table. Let me give you two minutes of that.

[Video Playing]

They had to learn to preserve their samples.

[Video Playing]

The final product is the map they are trying on. They were indicating which sections were rock or the aquifer. They had to find a section that did have water and you will see recommendations about the potential locations for placement of the factory. The question is do they believe it. We asked kids about this exclusively. There were few kids who believed there was some flow under the ground. The balance between make-believe and racing horrible misconceptions, we don't try to deceive them. We are always surprised sometimes when they take it more literally than we expected.

Another more recent one is an activity we call hundred games. -- hunger games. This is an activity where we are using the kids on performance rather than simulated data. We used the stations situated across the room and decorated with leaves and things like that to indicate various food p atches. In this classroom there were six different food patches of different riches situated around the room. The challenge was could you make it as a squirrel? Their job was to try to forage I'm moving from station to station and get as many calories as they can by tending to things like Patrick -- patch richness. I'm not going to show you the video that because I'm afraid were going to run out of time. In this activity, the way they foraged, the originally thought they could use their bodies and lanyards or something to do that. It turned out to be difficult in classrooms given all the materials around the classroom. We ended up buying a bunch of stuffed animals and embedding the tags. You had an avatar which represented you and you could be pure guy in the food patch a while and if you saw better opportunity you could do that. The strategies of individual agents and what would work best for them. We are also looking for the emergent property which was the emergence of an ideal free distribution. The fact the population of animals would distribute themselves in ways to take advantage of the resources available. Again you see examples distracting the distribution and it was based on their own performances and a number of calories they collected so they did equalize fairly closely. It is scary going into that wondering -- but it consistently seems to happen.

What are we learning? I'm not going to go much into results, but I think we are fairly successful at getting kids to situate themselves in the virtual space even though they are physically in their own classroom. This was a count of words we did based on interviews in the aqua room activity. Was the language in describing the activity about the room and computers or things like aquifers and water flow and drills and things like that. We had reason to believe they are situating themselves in that space. We have done more formal -- this is work I did with Jenny Wiley where we created an embedded phenomenon version of -- and then we took one where we situated -- instead of experiencing it in real time, we gave them a series of -- both around the skills demonstration in the ability to read seismograms and conceptual issues. The interesting outcome of that one was we also gave the kids -- participation on the embedded version seemed to mitigate differences.

One of my hopes was what I said before with participation, if you are marinated in this long enough, even if you blow me off that first you are willing to come in and join the activities as time goes on. Some kids got bored. This is a graph of their participation in the first half of the unit versus the second half. Kids above the line are kids that got more into it and became more active in participation.Some very high learners probably got bored. We had some success stories appear the we have some to work on. The advantage of time to buy necessarily awful lot. We also learned about how long these things should be. In order to get a good distribution of earthquake magnitudes, you need quite a number of quakes. This takes a look at distinctive roles could could take on. They have a lot of latitude in what they choose to do. We take a look at their choices and how much they spread those choices out. We wanted them to experience not just the guy that holds the end of the string, but experience the range of activities. It was that may it may be that much to gain when we got out here. We have done some redesign so they don't have to do quite as many quakes.

I want to talk very briefly about more recent work. Up till now, most of our representations have been paper and pencil and physical materials. Using technology to manifest the phenomenon but not necessarily support knowledge construction. About three years ago I started a collaboration in the University of Toronto and -- and we started to put that work together and some of the things we have been doing in the physical and tangible space into a digital space that gave more flexibility.

One more embedded phenomenon which was our first big project, this was a merger between the embedded phenomenon idea in using technologies for knowledge construction. An application that had gone back sometime -- unbeknownst to us up till now at this point in this school year, the walls of our classroom actually contained a carefully designed habitat which is protecting some endangered species. It was a secret government facility within our classroom. Usually we could provide access by the felt growing tablet computers to the wall.The idea is this environment which is being controlled -- all the although scientists are going on vacation and were turning over to the kids and the task is to maintain the biodiversity in this environment. They have the ability to control some of the environmental factors in this space. They can control temperature and light in humidity and those things. We don't want any species to die out. Simulations of bugs crawling around and vegetation and things like that, they have to determine life cycle changes -- they have to identify the food web by who eats who and they have to monitor the population levels by sampling from small spaces and the number of creatures that might be contained in this space. We literally laid tracing paper and they draw around vegetation to see how much stuff there is.

What happened in this project, we brought in the work around knowledge building tools. We started to use tablets that allowed the kids to enter their immediate observations about what was going on. We were doing things like taking counts into cumulative those counts and we were able to form graphs and things like that, but we also started to build understanding and [Indiscernible]. They had a system for notes, you're familiar with like knowledge forms and we build tools for teachers to work with this and work with the notes kids were accumulating and to orchestrate activity in the classroom. This is a relatively long video but I think it is worth it. When we started we thought of this is primarily a technology integration activity. What it became was something Richard. We had the opportunity -- designing and redesigning the activity and adding modeling capabilities and opening it up for broader inquiry [Indiscernible]. This is one where we had tremendous opportunities to work with teachers as authentic partners in the designs of these activities. At the beginning they were very challenging to us. I wanted to show you this video. One of the graduate students in Toronto made it. I think this will give you a flavor of the use of technology not only for the manifestation of the phenomenon but the way the technology was being used to help them build knowledge within the classroom.

[Video Playing]

I just wanted to give you an idea of the range of materials and technologies. You saw physical materials as well as tablets the kids were using to make contributions in addition [Indiscernible]. In the project, in my continuing work with Jim we are looking at a couple other things. One is the notion of knowledge systems sometimes there is [Indiscernible]. Kids are readily able to make contributions the finding material that is useful to share can be a challenge. Looking at the ID instead of kids making -- pushing this knowledge out to them to technologies situated around the room. Becoming aware of the contributions made and representations of progress for the entire class and try to see if we can use the space in the way those technologies are used. The other one was going to talk about was the idea [Indiscernible].We are interested in taking a look at dollars contributions which may be a little larger, something more along the line of posters where we [Indiscernible] more likely to leverage the contributions. I think we have made some progress on the issues of accessibility, activity and -- and I think the challenges we are focusing on now are sharing and continuing to make the activities hard and interesting enough they can engage 25 kids over multiple weeks. The fun isn't just for the kids. We have a lot of fun in what we do. This afternoon at 2:30, if you want to come by and experience -- the point to have a workshop were going to put you in the position of the kids for a while and give you an opportunity [Indiscernible]. It was a bit of a race, but thank you. [Applause]

I love everything you are doing and it seems great. I just think there is a risk involved in doing virtual t hings. These kids are growing up in a world in which they encounter in increasing number of things in a virtual space. All kinds of online things in computer things. How do you know these kids believe these rules of science that drive these simulations are really the rules of science and not just -- and put upon them just like on all these on my things you have to do deal with. There arbitrary sets of rules put upon this.

First of all, as a branch where were poor we go out -- the idea of the phenomenon is if they are driven by simulations they can also be driven by real events in the real world. I don't know what the answer is other than trust. I guess in some sense they have to trust that we are not misleading them. These are models and representations. There elements at the expense of other elements. We do spend time talking about the fidelity of our models. This afternoon I will be talking a lot about that. We had the kids critique our models. At other times it is an article of faith. They have to believe we are not intentionally trying to mislead them.

The follow-on to that, are there opportunities for these students to get out of the classroom and do some of the real world science?

Some things you can do and some things you can't. They are not earthquakes in Chicago. We haven't done this yet but our next round of -- we are also working with actual experiments. You can do simulations -- justify moving acorns it fixed distances. My biologist friend is a no Child left indoors type of guy. Were also working with things like collecting images of animals in the backyard. Where phenomenon are accessible and I can get to them in that way, I love working with the real stuff. But in the middle of winter -- I think both of them are good.

[Inaudible Question/Comment] my question is -- engage with one another -- are they sideload or are you using this as an opportunity to collaborate and have you thought about spreading to other schools -- you can see this environment for collaboration is actually a field some scientists are not very good app. It would be great to have young people we might want to become -- and how to collaborate toward real-world problems at an early age.

We have made some attempts. I agree completely. We worked with two adjacent classrooms.It's a little bit of a tricky situation because we have this sense that the action is here. When we start to make that virtual -- it is a difficult balance but I think were going to do a project this spring where corn -- we're going to be using [Indiscernible].It's hard to share that virtual space.

Along the same lines but looking at [Indiscernible] I love the controlled chaos. I was wondering like in the first video you have all those kids -- [Indiscernible]. Have you incorporated any of the elements of a more structured strategy -- or you limit the number of students.

We usually have left those decisions in the hands of the teachers. Some teachers engage their kids and they are motivated and self organizing enough that we give them that latitude. In the room quake, that teacher was fairly rigorous. This group goes to this station in this group goes to that station. Try different roles and to use different things so the became the cheerleader for the role of distribution. It is an issue of how many activity sites you provide as well.

I would like to see if there are any questions [Indiscernible]

Participants on the phone, to ask a question, press star one.

You had one slide on learning outcomes, and you had time to look at long-term retention? Do kids remember the concepts better because they were so active or do they remember the fun? fund?

I didn't do any longitudinal tracking across grades. They remember. Part of this work was in my neighborhood. We have delayed post tastes on the kids to see with their potential is. I'm not sure have the measure that I'm interested in. Whether they remember exactly how to read a seismic ramp is less important to me that the notion they are defining themselves as legitimized investigators and if I had a way to measure that over time, I think I would do well on that measurement. I can't believe that is a long-term effect I'm likely to get. So yes, it would be a good thing to do and we should probably do more of it.

I have a question about scalability and appliance for scaling. My daughter is a sixth-grader and actually studying -- I am a biologist so it's sad to see my daughter bored by it. Is this something you can give to a teacher and say to do this?

To be honest, no. Natalie and I were having a discussion this morning. From a technological perspective we could deliver it. For a teacher to enact this sort of a units, I'm not an expert in professional development, but I build a value and the need for it. It's not only a one time thing, but over time and in the moments, we need to provide additional tools as the activity is going along. They need exemplars of what the teacher has done. This is not something you can readily -- technology is not such a problem. I think we can deliver early versions of this. In room quake we had a portal where you could -- we could do that for you but that doesn't really prepare you to think about distributions of earthquakes and more deeply about the map. I think the answer is not yet but the other part of the answer is my expertise is not really thinking about how to do that. I'm hoping somebody would like to do that with me but I don't really have the skills to do that.

You mentioned in the beginning -- [Indiscernible]. How in the design do you balance [Indiscernible]?

Increasingly I try to think of ways to make things as embodied as I can within the constraints of the space. For some activities like room quake. Areas [Indiscernible] but that is not really a scientific practice of a seismologist. I look for as many opportunities as I can and I am more and more interested in the enactment of the physical presence of s cience. It is a case-by-case sort of thing.

[Indiscernible]

I don't have a method, I would say trying to maximize [Indiscernible]

There are no questions at this time.

All right, we will go ahead and conclude this. [Applause].

I want to put in a plug for 2:30 this afternoon. The computer is set up in the back and around the room and you will get to be part of the solar system. The other thing I want to do is another plug, the next one of these is Friday, February 21st and it will be [Indiscernible] from the University of Wisconsin in Madison and he will talk about games for learning.[Indiscernible]. Thank you, Tom.

[Event Concluded]

Actions