EVOLUTION OF IDEAS

BEV CASWELL: I'm here to talk to you about the grade 4 study of the giant Madagascan hissing roaches. And so when I was a classroom teacher here at the Institute of Child Study, we had as a classroom pet, 11 giant Madagascan hissing cockroaches and they became a study that lasted for part of the year and students became very interested in them and developed scientific literacy through their study and so I'm just going to talk a little bit about that process and what it looked like from the first day on.

So on the very first day of school – well, actually before school began, I sent each child a postcard that had the picture of a hand holding one of these giant Madagascan hissing roaches. And basically, in the postcard, I asked students to bring their guesses to school with them on the first day. I was welcoming them to school and wanted to bring their guesses on what this creature might be. And so already, when they came on the very first day of school there was a little anticipation and there was a kind of a buzz in the room and in the centre of the classroom, I had an aquarium tank with Vaseline on the edges, so the cockroaches couldn't escape, and I had 11 of these wonderful hissing roaches, and they were, you know, about that size and they're a wonderful class pet. They don't bite; there only form of defence is that they hiss and they look kind of fierce because they have this sort of shield and two pro-natal humps that look like eyes. But if you actually pick up the roach and look underneath, it's just like the shape or size of ant underneath, and they're very gentle.

They survive on dog food and a few little scraps of vegetables and water. So they're a great classroom pet. And the species is ancient in evolutionary terms and so there's – there are lots of possibilities for the study of biology and getting at big ideas in biology.

How the day began is that we gathered around this tank of roaches. Children were very, very curious. I, as the teacher, you know, picked it up just showed what it was, what the name of it was. Showed underneath, these cute little creatures who their only form of defence is this shield and the ability to hiss, to sort of posture and hiss. And so the children seemed very interested and so what we did, and I had the opportunity of working with Joan Moss at the time, and so we designed this unit together. And so we put children in pairs and so if you think of the classroom structure, we first had whole group looking at this exciting new pet, and then we instructed the children in pairs and one child would hold the roach and the other child would sketch it; either on paper or at the time we had, I think, three or four classroom computers as well. And what was really interesting was children have such a remarkable sense of ability to observe. As one was holding it, the other one would be looking and as they were sketching, they looked at very minute details. For instance, they saw that the roaches had suction cups on the bottom of their feet. They noticed that they groomed themselves like cats. They noticed that if you put the roach down in a container that it went around the perimeter of the container and so the children started to make all of these observations. And when you think of the scientific method, you know, often in science classes it's taught, now we're going to do observations and we're going to do questions and hypothesis and design the experiment. If you're using this knowledge building approach, and actually having something that sparks children's natural curiosity, you'll find that that kind of science comes about through the children.

We had these observations which we collected on chart paper on the wall and also on their computers, because they were using Knowledge Forum, and after that, then we put the drawings up both on the computer and up around the walls of the classroom. And those observations, those initial observations, then began to lead to questions. Some of the questions that

the children asked, they asked how quickly can a roach flip itself back over, or right itself? How many times a minute do they groom themselves? They asked, can they learn to, you know, to come on command? Like a pet dog. I mean, all of these questions were welcomed by me, as the teacher, and recorded, and around the classroom, these big questions started to come.

Children then started to hypothesize. They made hypothesis about some of these questions, and we saw that the children started to form their own research groups, in a way, just through the questions that they were asking in the interest that they had. Some of the questions were could – did the roaches survive the Ice Age? And the way that some of these questions came about is that between the time that they were making the observations and beginning to ask questions, we started to look for some text that children could use in this study and what's interesting about the roach study, is that there were not a lot of books that would explain much about the cockroaches. We found something by Carolina Biological Supplies that gave kind of basic facts about the roaches, and so we formed reading groups, and we supported children in reading the articles and they – each child on that very first day, was given a lab book, so a research lab book and basically we said, you know, this is what scientists use out in the field. You're not going to be graded on what you're writing in this book. You're going to use this to make observations. You're going to use it to ask questions, to keep track of your ideas. This is going to be your research field book, to take field notes. And children, you know, right away, they were being immersed in an authentic community of scientific research. And we really wanted to model it on what a zoological department would be doing. Here would be this community of learners, studying the insects or animals, whatever's in the lab, to actually create some new knowledge around this. And so what was great about the roach study is that because there wasn't a lot written about cockroaches,

the children actually felt like they were making contributions to our overall classroom understanding of this phenomena.

AN AUTHENTIC EXPERIENCE

BEV CASWELL: So I want to just talk a little bit about student designed experiments. And the whole idea that if students are given the opportunity to design experiments that come from their mind, even if they seem simple in the beginning. The investment that the children put into it and the actual progressions through scientific knowledge or the development of scientific knowledge is quite amazing to witness and be part of. And so often our – the experiments that the student's came up with somehow had to do – sometimes had to do with play. And so one of the best experiments that was designed came after a session of special friends. So the grade 4's teamed up – once a week the grade 4's teamed up with the grade 1's to do – it wasn't reading buddies, we called it special friends. Sometimes they read, sometimes they created structures together and sometimes this would happen in the grade 1 class and sometimes it would happen in the grade 4 class, and so this one particular week, in my grade 4 class, I had a lot of blocks, and I had building materials. And the grade 4's loved this time period, and they started to create mazes for the roaches. So they did these pathways, and mazes and watched the roaches walk along these and they did different doorways and then, you know, the students said, yeah, like I wonder if they would prefer chocolate or orange at the end of a maze. And so they kind of started, through a playful way, designing these experiments and watching the, you know, as the roaches walked down these little pathways. They could see their antennae eye, you know, going in both directions and they really like chocolate and they also liked oranges and then they did a door number 3, which had an apple and none of the roaches went down that way. And so that – after, you know, after that time period was finished and we packed up the blocks and put the roaches away, the grade 4's, who were studying roach behaviour, started to get together and it was like this science research team and they were saying, you know, what if roaches could learn. And so with their lab books they designed what a maze might look like and what a little gateway and if

it would be – if they could design some kind of gate that a roach would be strong enough to push through to reach a food item, and if they could train it to keep doing that. And so I was watching this, I had a degree in psychology and I was thinking, oh, my goodness, they're actually designing behaviour experiments that are done in psychology. They noted that the lines on the back were hinged and that that might – it might be like an exoskeleton, 'cause they'd been reading some books about other insects. They noticed that they had little feelers on their back and they noticed that if any air came near those little feelers, which they then found out were cerci, that the roach would move, and so it was almost like a mechanism for adaptation, just to protect it; another protection other than the hisses. They noticed that if two males were in a container, there was some posturing and hissing and so from all of these hypothesis, the children then began to design experiments, and because these were also the classroom pets, the children were very clear that they were going to be ethical experiments. And they were not going to do anything to harm the animals.

So as they started to form these research groups, we actually put up on the wall, we had children sort of decorate their research page, so that we could see that there were children that were studying external anatomy. There were children that were interested in things around the evolution of the roach.

Another group was very interested in roach behaviour; can the roaches learn and how could we design experiments to find out whether roaches can learn. And then another was about perceptions. You know, they were wondering whether they could see colours.

Remember elementary school teachers, you know, don't have the opportunity to only teach science. We teach math, we teach language

arts, we teach art, drama, and so, while this unit was going on, we actually developed literacy through some of the study, and so for instance, the name of this wonderful classroom pet, the name in Latin is *Gromphadorhina Portentosa*. So doesn't that have a wonderful rhythm? And so, as a class, we created a chant.

As the momentum for the unit – at least in my mind, the momentum was slowing down a little and I thought, you know, they've really done a lot of work on here. We've done a lot of meetings. We've gone into the zoology lab. I talked to the children, like what do we do now? And they said, well, what does David Suzuki do? He makes a movie. So let's make a documentary. And so the kids, each of the research teams, decided on their own, a creative way that they were going to share all of the knowledge that they had been working on and put it into the public, the public realm. And so it was so fun; I mean grade 4 students are amazing to work with. So their senses of humour; one group, you know, dressed up in lab coats and were sort of these kooky scientists or mad-scientists but they really got a lot of facts. They basically did an interview of each other; this comedy interview, but it had roach facts embedded all throughout it. Another group did a game show where it was, you know, there was trivia and the audience answered. Another one did a more – they took geography, so they really showed where Madagascar was. They showed the habitat that the animals lived in. And another group really played up the evolution. Like they really wanted to know how the roaches survived through the ice-age.

You can see that my job as a teacher was quite huge, to try and find the research to support this but also help them design experiments and in a way, well, it sounds like a lot, but there's actually structures in knowledge building classroom that support this kind of learning. And so some of the structures would be that we did something called reciprocal reading where

when we were looking at text, one of the text that we used was – I had to go to the Sig Sam Library at U of T, which is for science and I found one authentic text by a Dr. William Bell, describing some cockroach experiments that he had done, and so I had either summarized some of it or actually had the children read authentic text and I would support them. And reciprocal reading is basically about having children read a paragraph at a time. One person would read it out-loud in the group; another person would summarize it. We would look at words that we might not understand and we'd use the context of the article, to help us understand the words. And so this is a real reading comprehension tool. So one group I might be working here. Another group might be at the bank of computers doing some research or posing questions or responding to notes on Knowledge Forum. Another group may have their experiments set up and they're using their lab books and they have timers and they're actually recording some of their – some of the actual experiments.

When I would see what kinds of questions the children were interested in, you know, that night or after school I would really think about what kind of whole group lesson I could offer to the class. And so one of the experiments that Dr. Bell had done, in his lab, was they actually timed a roach flipping, righting itself. The next day I said to the children, you've all been noticing these roaches flipping over and getting on their feet and so we can time them. And so, you know, we just did a sort of experiment like that. I went through what an experiment looks like. And so later on, this was about months later, the children said what they've been noticing and this was a hypothesis that one of the students had written in their lab book or written on Knowledge Forum, he hypothesized that the more the roaches were handled, the slower they were to flip themselves over. And so they compared their data from two months earlier to – and then they now set up an experiment and put the roach on their back and the roach basically laid there. It was like this prime example of learned helplessness

and that these grade 4 students had discovered in 1998. And it's really interesting because just a few years ago, I was reading the Globe and Mail and I saw, you know, Guelph researchers discover that giant hissing roaches demonstrate learned helplessness and I read the article and basically they had done the experiment that the grade 4 students had done a number of years earlier. If only my students had published.

If we allow students to delve deeply into a subject area, to develop expertise in an area of science that interests them, we start seeing that they follow a similar progression to what scientists follow in their community, in their research communities. And it's our job to provide opportunities for the students to share so we all – we would have at least three times a week, a whole group sharing of, you know, what's your group working on and what did you learn? And there was this excitement about bringing new knowledge into the centre of the classroom and we really were this community of learners, contributing more and more to our overall understanding of what these insects....

SHARING THE LEARNING

BEV CASWELL: It was through the zoology department at U of T that we were able to borrow these roaches. There was Dr. Kochira Yogi lent them to us. They had them as pets. And so it was time now that the students had actually gathered a lot of information and done a lot of – they were building a lot of knowledge, it was time now to bring some experts in and what was really interesting is we went to the lab and the researchers at the lab, I know Dr. Kochira mentioned that the questions that those children were asking and the theories that they were putting forward, he said it was like talking to his own graduate students. Some of the theories that the children had were, in fact, true. Like that was the current theory that they had – that his lab had been coming up with as well. And so rather than it – rather than do this field trip, where the children sit quietly and are passive receptacles of the information of the experts, this instead was again, more of a knowledge building community, whether they learnt things, of course, from the experts, but they also felt – they felt, I guess because of the knowledge that they had been building, they felt like they were contributing to the scientific community. And it just furthered what they – you know, it furthered their motivation to continue. And so when they came back from that visit with Dr. Yogi, they you know, wanted to read more, they wanted to do more research and do more experiments.

Their ideas progressed from naïve understandings to more and more complex ideas and so, the external anatomy group, you can see that they're sketches, they were getting more and more detailed and finding out more and more information about the anatomy. And then the anatomy group, can then inform the behaviour group, you know, when they were finding things and so this whole – the whole research community, there would be overlap and there would be lots of conversations that would help each other move their thinking forward and move these ideas into more

and more complex objects. And so the external anatomy group also in their script for the documentary, first of all, one of the things I noticed in – just in teaching is that I would make script paper and that would also improve the student's writing. I don't know, something about having script paper, just a line down the side and – so that they could do dialogue. That really improved or seemed to spark their imaginations as well. So they had their lab book where they did a lot more writing than in the past, when I didn't use things like that. And the script paper, I mean this is a lot of writing. This is one page, one of five pages of writing from a group of students in my class, who previously were not that interested in writing. And so in this script, you know, you have directions for the camera. It says, close-up shot of the diagram, so you know, they're planning out how they're going to film the documentary and then they have the script. They have the scientist saying, as you can, the cockroaches have two brains. They're called ganglions. And so it's a wonderful way and this creative way to consolidate the student's understanding. So to me, this is one form of assessment. What have those students learnt in their science unit? You know, it's coming out through their drama, through their writing. It's coming out with the way that they design experiments.

There was another group of students in the roach behaviour. The roach behaviour group had heard from the anatomy group about these cerci and how – that if they're – it seems that if there was air, I think somebody had dropped a paper or – there was some kind air, the little cerci would come out further and then the roach would run. And so the behaviour group designed an experiment; they had stop-watches and they had trials, you know. Because we did talk as a group about, you know, what are some of the things that scientists do and what are some of the rules scientists use? You can't just do one trial and say this is truth. You have to do a series of trials and so what they did is set up an experiment where they blew air at the back of the cerci or at the back at the cerci and then timed how quickly

the roach ran. And so it was amazing that these children in grade 4, you know, keeping these charts and all these numbers and then they were adding up the numbers and then they said, you know, what wanna figure out like what would be the common? You know, they're talking about average. They are – they themselves are wanting to find and they were thinking about how would they do this? Well, they'd take numbers from here and numbers from here and these are common. And you know, eventually after they came up with a lot of the strategies of how to do the average, I showed them a formal way of how to do – how mathematicians find the mean. And they used this in their work, and so it's just another example of how this kind of knowledge building approach improves and draws in other curriculum areas and it's just – it strengthens everything that we do.

It doesn't really take more time – it just takes a reorganization of the time. So in the beginning, when we first used it, there was this question of what to do with the children who weren't on CSILE and that, for the first few days or maybe the first week or so, that was a problem too, because I had always been used to teaching the whole class, the same thing, at the same time, you know, or little variations. But it was mostly the same projects. So that took some rethinking and almost from the beginning then, there are great ways to, you know, you have somebody on CSILE, some group doing reciprocal teaching, and other groups reading and doing their research and writing in lab books.

I had no idea it would go this far. Really, I was just excited to find a kind of new pet for the classroom, so my expectation and hope would be that, you know, children would like these pets, they'd learn maybe a little about what is an insect and, you know what, if I looked at the curriculum, it's, you know, looking at habitats. I wasn't thinking of biology as having these deep concepts of evolution, adaptation. You know, how does anatomy

link with the habitat that you're in? Anyway, I didn't have those questions in the beginning but I had the good fortune of, you know, working with Joan. I also worked with Mary Laiman who had some ideas around big ideas in science, so as a beginning teacher, because that was in my early years of teaching, I had – it was very helpful to really think about planning. Building on what the students brought to me, building on their questions and always keeping the big picture of what are these scientific concepts that the children are coming into and so, you know, I did a lot – I was very excited about the roach, cockroaches and biology and I would do a lot of reading at night. The children got me excited.