

Case Study B: Seeing it for real up-close

Science, technology and mathematics

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Introduction

The kids – I've never seen them sit there with their mouths open for that long, and they just weren't off task at all – they were like that the whole time. (Sarah, teacher)

This case study follows the work of a Year 4 and 5 class of students as they prepared for and visited a glow-worm cave site and its associated museum and education centre. The children in this class attended a large state primary school which had a roll of 627 students. The school had a decile rating of three and was situated near the centre of a large New Zealand city. The ethnic composition was 50 percent New Zealand Pakeha, 42 percent Māori, and eight percent other ethnic groups. The gender split was 45 percent girls and 55 percent boys. The teacher, referred to as Sarah in this case study, described the class as having a wide range of abilities. Students selected to participate in the case study interviews were seen as academically more able and confident enough to share their thoughts and ideas with the researcher.

Sarah was in her second year of teaching. She had a Bachelor of Teaching degree and had taught both years at the same school, working with Year 4 and 5 students. She had participated in several other LEOTC-type projects including an overnight camp, the Technology Road Show, Water World and a visit to the local recycling centre.

The programme director at the education centre is referred to in this study as Kate. She was a trained teacher and had worked at the site for the last few years.

Before the visit

Teacher views and planning

Goals and rationale

Sarah was very clear about the value to her students of learning experiences outside the classroom. During her time at the school she had noticed that many of the children lacked the opportunity to visit museums, science centres and other types of educational sites with their families. Many of the families either did not value the experiences or were unable to take or pay for their children to go there. For this reason, the school actively encouraged teachers to provide these experiences for them. In Sarah's case, she organised about three visits per year.

Providing a variety of school experiences for students was another important consideration for Sarah. She felt it was valuable to get the children out of the classroom and into the fresh air and to see how they behaved and related to each other in a different environment. She also made this comment:

I notice that for a lot of these kids, it [the experience] has got to be in a real life context for them to actually put meaning into it – and I'm a bit like that myself. I know that if you show it to me – what does it look like, what does it smell like – I understand it so much better - and that is the case with them too.

Sarah believed that every experience she could provide was going to further enhance her students' self-esteem and confidence, often by just knowing how to act in certain situations, and how to interact appropriately with other students and adults. She believed that young people today are sometimes disadvantaged by being branded 'the techno generation':

I feel sorry for that generation. They get branded as the techno generation – it's technology everything. But a lot of them just crave for more stuff and I think we're a bit too quick to give them that label because they do still love hammers and nails and being able to draw themselves, and things like that.

The excursion to the glow-worm caves and the education centre was just one of several visits carried out during the later part of the term by Sarah's class. The site was selected for several reasons. Firstly, the students were studying 'Me and My Environment' and, as a very valuable part of their regional environment, the caves seemed appropriate. The school was also categorised as an Enviroschool, with a lot of discussions having taken place about how humans have influenced the environment, and the impact of environmental change. The themes of

conservation and preservation, which ran so strongly through the work of the site education centre, seemed particularly relevant. A final reason, and one of equal importance, was that most of the students in the syndicate had not been to glow-worm caves before. Sarah made this comment:

My grandparents have always said to me you should never go and see any other part of the world until you've been and seen every part of your own country – and I think it's really important for these kids as well because it's so easy to overlook what's in your own backyard.

The real world context was another incentive, which influenced, the visit to the caves. Students were able to see, hear, touch and experience the underground caves and the insect life that they sustained, along with having the opportunity to travel by boat along the most inaccessible parts of the cave, and see the glow-worm grotto. Sarah believed these experiences are ‘what memories are made of’.

The education officer based at the site education centre had established a good reputation for the support she offered to teachers and the teaching sessions she presented. She was also a trained teacher, and was known to Sarah’s syndicate, because she had worked with them as a student teacher.

Teacher preparation

As mentioned previously, this trip was planned as part of the end-of-year activities and, in particular, a special week of learning experiences outside the classroom. It was to be fun and an end-of-year treat, but it also slotted into the current science topic being studied in Sarah’s class, entitled ‘Me and My Environment’. Preparation for the trip was primarily organising the trip and preparing the students, but they also did some work on the life cycles of the weta and the glow-worm, along with a number of pre-visit activities provided by the site’s education officer. The specific learning outcomes planned for the students are listed below. These were identified by the education officer at the site, and were also incorporated into Sarah’s planning. The learning outcomes Sarah identified were that by the end of the unit students would be able to:

- describe how water makes caves and cave formations/crystals out of limestone
- describe how the caves have been changed for tourists
- name the parts of a weta/glow-worm and what each part is used for
- explain how wetas and glow-worms have adapted to survive in caves

- describe the life cycle of a weta and a glow-worm.

As part of the preparation for the visit, Sarah and her colleagues were invited to go on a site visit, and it seemed they enjoyed it as much as their students did:

It was amazing, it was really cool – we went out there and basically went through the museum and had a look at all the ‘squeezes’ – as if we were a bunch of kids ourselves. We had a look through that, and then she [Kate] went through what she would be doing, where they would be going and when they would be doing it. We didn’t do the walk as most of us had done it before.

Teacher roles

Sarah saw her main role as preparing the students for the visit, and helping to manage them during the time they were at the site. She made the following interesting comment about student expectations:

My role before the visit will be brainstorming the expectations of the visit – like getting them to have expectations. A lot of the time these kids don’t have expectations of anything and it’s making them think, you know, “What do they expect to see? What do they expect to do?”

Sarah expected that during the visit her job was to manage the students’ behaviour, and make sure they kept themselves safe. Considerable emphasis had been placed on this idea prior to the visit, and students were encouraged to ‘stick with their buddy’ at all times and not allow anyone to become separated. Another factor that Sarah signalled very clearly was the importance of ensuring that the parents were comfortable:

[Making sure] that the parents are coping and that they’ve had lunch and that they’ve had something to drink and are okay. I want them to come next time when we go on camp – you’ve got to be nice to them if you want them to keep coming back.

Student views

Views about the site

Five students were interviewed in this case study and, contrary to the experiences of the other students in the class, three of the five students interviewed had been to glow-worm caves previously with their families and one student had been to another similar cave system near by. They all had clear memories of their experiences, mostly to do with unusual things they had seen; for example the stalactites and stalagmites. Some of them talked about experiences which evoked some kind of physical response; for example, having to walk through very cold water in the dark. One student made this comment:

[I learnt] that glow-worms like not to be disturbed because they like their privacy. It's better to go there [to the caves] because you are up close. If you saw it on a video it might be animated or something.

The students were all quite clear about their expectations for the day, in terms of how it was going to be organised and what they thought they would see. They seemed unaware of the museum and the activities it had to offer, and none of them mentioned working with the education officer – their thoughts were understandably focused on going into the caves. Maria's comment summarised what the five children had to say:

[We'll] probably explore the caves and watch the fishing rods that glow-worms make and things like that. We'll probably be in two lines, and yeah, we will probably have to stay with the large group cos we might get lost – it's a pretty big cave.

Preparation

The students all had similar things to say about their preparation for the visit to the caves. They mentioned organisational factors such as being on time, remembering to take any medicines they might need, knowing the day's programme and behaving well when they got there. The work they had carried out involving the life cycle of the glow-worm and weta, and which they later demonstrated good knowledge of, was not mentioned as being part of the preparation. Kirsty summed it up with this comment:

Our teacher told us that you have to behave well, and not yell, cos it will echo like in a hall. And don't run cos you will slip or fall over.

Help with learning

The students had a multitude of ideas about what they expected to learn while they were at the caves, despite making no mention of this as part of their preparation for the visit. They were also starting to articulate why they thought going to the caves would offer advantages over reading about the glow-worms or just watching a video. The children made these suggestions about their expected learning:

Probably about people that discover the cave and things like that.

We would learn more about how the caves are formed and what the water does in the caves to make the forms.

Yeah – like what the life cycles of a glow-worm and wetas are. More about stalactites and stalagmites and more things about glow-worms and wetas and how columns are formed.

The children struggled at times to articulate their ideas clearly, but these comments show the developing insights of these 10-year-olds as they explain why it is better to go to the caves than just reading about them in a book:

Oh, if you go on a trip you can see it for real instead of looking at it on the TV. Oh, because it could be... like from the TV... you could be... not believing it, and then once you go there, you would!

I reckon it is worth it to go out there because you can experience it and it'll be much fun for the kids. And the teachers will have a good time, too. Because like, it is dark and cold in the cave, but it is always light and warm outside the caves – it's like your emotions. Sometimes they don't even use the right caves on TV, they use different ones.

Because its fun cos it's more fun than just reading it and we get to see it in real life. You can touch it. The animation videos they don't really tell us what happened and what other things there are – they don't tell us that much, but looking at and seeing it does.

The visit

Sarah and her students, along with another class, travelled out to the caves by bus. On arrival, the children lined up outside the caves where their tour guide collected them and took them down to the cave entrance. He talked to the students briefly about the early Māori and Pakeha explorers and how the caves were first opened up for tourists in the early twentieth century. Once the party had entered the caves, the guide paused at various spots and quietly spoke to the children about the most significant features of the caves. These included the now famous *arachnocampa luminosa* – the glow-worm; the cave itself; the various formations; and a little of how they have been formed over the last 24 million years. In a high-domed section of the cave aptly named the cathedral, they paused again and the children were encouraged to sing one of their favourite waiata. The acoustics in this section of the cave were particularly good and the children and parents were all impressed by the sound they were able to produce – a very special moment.

The party then moved on to the *piece de resistance* – an underground boat trip through to a glow-worm grotto. Waiting quietly in the pitch dark for the boat to come and collect them was a memorable time for the children – the scattering of glow-worm lights, the water sloshing and dripping down from the cave roof, and the coolness of the air was a very new experience for most of these children, and it was only spoiled by the arrival of an international group of travellers who wanted to jump the queue. Quick intervention by the teacher and guide solved the problem.

After re-emerging into the daylight, the children made their way to the reception area outside the museum for a late morning tea, after which they were invited into the education centre by Kate, the education officer. Kate delivered a very good session with good humour, enthusiasm and a raft of stories and descriptions about the caves and the countryside. These conveyed the basics of the geological activity that has occurred over the past 24 million years and which has resulted in the formation of the glow-worm limestone caves. The session was interactive with frequent questions and opportunities for students to engage in the discussions. Kate provided a range of objects which the children were able to handle, such as fossils found in the area. In order to explain more difficult concepts such as the movement of the tectonic plates under the floor of the Pacific Ocean, she invited some of the children into a little role playing. The messages she had to deliver were clear, fun and the children were attentive and appeared interested.

The final phase was to visit the museum next door, which the children were able to explore freely with their buddy and parent supervisor. The exhibits were in two categories: one was the range of exhibits which were behind glass, and which included photographs and examples of cave creatures; and the other was a series of interactive ‘squeezes’ (or tunnels) and climbing activities, which had been built in and around the walls of the museum. There was also a video that the children could watch. The atmosphere as the children engaged with this place was ‘a happy buzz’. After a quick investigation of the area, the children mostly concentrated on trying out the ‘squeezes’ and discovering if they could manage the feet first, head first and finally the two person swap over as they wriggled through the little tunnels. Apart for approximately 30 minutes, the children were free to use this area as they chose. It was a good example of informal learning, whereby student interests combined with the draw of the exhibits, determined what they did and what they learnt. It also provided a contrast with the more controlled, structured nature of the cave tour where the learning opportunities were decided and directed by the tour guide.

After the visit

In the classroom

The work carried out at the site education centre addressed the specific learning outcomes of how water can construct caves and cave formations out of limestone, and how the guardians of the caves have made changes to the caves in order to both accommodate tourists and preserve

the caves. The other learning outcomes, focusing on cave life and creatures, were touched on briefly. Several post-visit activities were suggested in the resources provided by the centre, and Sarah made good use of these. Just prior to the visit, the children began making a mural. Sarah describes the task in this statement:

We have started making a mural of the different parts of the glow-worm caves, the tourist changes that they have made, the rock patterns, the glow-worms, other cave creatures, the limestone – and they have to pick which part they are going to do and they have a big sheet of cartridge and they're going to draw it. We'll add labels, words, recounts of the trip – what they saw, heard, felt.

This was to be a fun but effective way of revisiting the tour through the caves, and a chance for the students to reflect on their experiences and feelings at the time. It was also an opportunity for Sarah to introduce and/or revise new vocabulary, and to get an informal feel for the learning that students had achieved. Assessment tasks and other post-visit activities were referred to in the planning, but at the time of the interview, these had not yet been carried out.

Student reflections

The students were emphatic that the trip was worthwhile and none of the five was able to suggest aspects of the day which would have been better left out. The comments were all positive, with the exception of Kirsty, who was not overly enthusiastic about having to walk to the top of a hill to find the toilets, only to discover that she had to share them with her male classmates. Also Richard would have liked to have his morning tea and lunch a lot earlier.

The students were able to describe details of what they had seen and learnt, and although the trip to a zoo was probably their favourite excursion during their LEOTC week, it would appear that these students had developed sufficient understandings about the cave environment and its inhabitants to provide them with a valuable example of preservation and conservation in their region. Some of the students were challenged to express their ideas clearly, and some confused the new concepts and associated vocabulary, but there were consistent, sound understandings achieved by the five students interviewed. Connor talks about how he thought the caves were made:

I think they were already there but all the rainwater comes down and it drips off the stalactites onto the stalagmites, and I think he [the tour guide] said [in] 1000 years and the stalactites and stalagmites will grow an inch. Rain just drips in from the top, like through the soil, and then it will go into the caves and trickle down a stalactite.

Richard talks about the life cycle of a glow-worm.

Well I learnt how the life cycle went. First they are just eggs and after the eggs they hatch into glow-worms. Then when they are glow-worms they have to make about 100 net fishing lines and then after that they might go into a chrysalis and they turn into a fly. The nets are for catching the mosquitoes and bugs and stuff that go into caves.

Amy talks about damage that has been done in the caves.

I didn't know that these little stalagmites and crystals could be orange. Kate said that if you touch them, they will break off cos she said when she was little it was all bright and orange, and then 20 years later, it was all broken cos somebody had touched it and said, "Oh cool, I'll take it home!"

The final questions in this process asked the students about advice they would give to their friends, another teacher or the education officer. Interestingly, they all made comments about the importance of their friends listening carefully and behaving properly, and there were several suggestions about having a quiz or a test afterwards to make sure they had. None of the five had suggestions for the teacher or the education officer. Richard sums up how the children all felt.

I thought it was really fun – and it was fun how she [Kate] told us lots of stuff and we touched more stuff than we did in the caves. We touched a fossil and some limestone and yeah, when we were in the caves, we only got to touch the ground!

Teacher reflections

Sarah was very positive about her class's visit to the caves, museum and education centre. She felt the students had a great time and learnt a lot. She commented that they were still telling her things about it a week later, and were confidently correcting her about some of the details of their experience. In terms of their attitudes and self-perceptions, Sarah related the experience of one of her students, Sharon, who was a very nervous child and frequently refused to try out anything new. During the cave walk and boat ride she was faced with a number of new experiences but, despite protesting and clinging to her parent supervisor, she cautiously made her way into and through the caves and got into the boat in the pitch darkness for the ride through the glow-worm grotto. This was a significant step forward for her and demonstrated to Sarah the advantage of offering exciting tasks in order to encourage less confident children to take risks.

In terms of how the visit enhanced student learning, Sarah could identify several features of the trip which helped to achieve this. Firstly and perhaps most importantly, entering the caves was a real experience:

It was real; it was right in front of them. It wasn't something abstract that they had to think about. They got the feeling of what it's like to be in a cave and they [the students] kept saying to me – "There wasn't light when those first people came in here. Why did they go in here?"

A real experience in the present helped them to relate more easily to what they thought had happened in the past.

Sarah also thought it was worthwhile for the students to have another person apart from herself talking to them, and she particularly mentioned the tour guide:

It must be boring listening to the same person every day, and as exciting as I try to make their day [laughter] they still look at me every day and hear me talking in the same voice. Also, having a male role model – it's someone new, different and refreshing. They haven't seen him before, they haven't heard him before. He talked about things that I wouldn't normally talk about.

She was also very impressed with the way that Kate worked with the students; her great sense of humour, her quick wit, and the way in which she was able to simplify quite difficult concepts down to a level the children could all understand:

The kids – I've never seen them sit there with their mouths open for that long, and they just weren't off task at all – they were like that the whole time. The resources she used were good. It kept those kids that get a bit fidgety focused – like this is a fossil and this is what they actually look like – the visual – it was basically set up for every type of learner. Any of those kids, no matter what type of learner they were, got something out of it – she had the visual, she had the movement, she had the kinesthetic hands-on stuff.

The final interview question asked about advice for other teachers who might be attending this site. Sarah had two things to say. First, having another group of tourists so close behind them in the caves, particularly when waiting for the boat, marred the experience a little. This group was quite aggressive, with some adults attempting to push ahead of the children in order to get into the boat first. Secondly, their programme for the day was too extensive, and this factor, along with one or two slight delays, caused them to run out of time. Sarah commented:

Give yourselves heaps of time because the kids were disappointed and so were we that we couldn't take them on the walk, but we just didn't have the time – we couldn't afford to be late.

In summary, Sarah reflected on the bus ride back to school at the end of the day:

It was an awesome day. I was really nervous about going, but on the way home they were all sitting there and the kids just started crashing – they were zonked, but you knew they had had a ball and it was great. And they were talking about going back and taking their parents – "Oh I'm going to ask Mum and Dad if we can go back there".

Key points from Case Study B

Considering the case study in retrospect, several key points emerge:

- Organisational details were taught before the visit, and this study showed the benefit of this.
- This study showed that it may be valuable for students to understand the purpose of pre-visit activities, such as studying the life cycle of the glow-worm and weta. In this case, although students later demonstrated good knowledge of these life cycles, they had not all made the links between the classroom activity and the visit.
- Providing the opportunity to experience exciting activities during the visit outside the classroom was the incentive some nervous students needed to take risks they would not normally attempt. For example, students took the risk of entering and walking through a dimly lit underground cave system, and also took a boat ride in an unlit section of the cave.
- Time to discuss the expected site etiquette was important, both for students and parent visitors. For example, the underground environment was particularly vulnerable and easily damaged, and visitors were asked not to touch any of the formations.
- It was helpful for students to appreciate that they were going into a learning environment, and that there would be opportunities for them to move on in their understandings and knowledge.
- In this study, the education officer was able to link new information to the student's own world. The case study showed that this enhanced their understanding and memory. For example, students were asked to compare the limestone countryside with their school playground, and this was something they remembered and referred to during interviews.
- Having the opportunity for liaison between the site education officer and the visiting teacher was a critical part of the visit preparation. The teacher had an opportunity to become acquainted with what was on offer, and as a result, was able to ensure that students were adequately prepared for the experience.
- Knowledge of good teaching practice by the education officer was vital. There was evidence of an ability to interact easily with students, to reduce complex ideas down to a level they understood, and to provide an interesting and varied presentation. All of these factors helped students gain the most from their experience. For example, the education officer made good

use of role play about tectonic plate movement, thus enhancing students' understanding and memory of the newly introduced ideas.

- Allowing time for students to explore and investigate on their own was important. Time to freely explore the museum was provided. This offered physical challenges for those who were interested, and an opportunity to select, and learn about, a range of features relating to cave formation and creatures.
- A feature of this case was the provision of resources that gave the teachers background knowledge, follow-up activities and resources to use with their students. This was an economical use of their time. Along with a pre-site visit, this culminated in improved preparation prior to the visit, and enhanced conversations between staff and students during the tour.

Evidence of learning

Evidence of learning from Case Study B is provided in the commentaries in Tables 1, 2 and 3 below.

Table 1. Student commentary on their learning

Before the visit	After the visit
[We'll] probably explore the caves and watch the fishing rods that glow-worms make and things like that. We'll probably be in two lines, and yeah, we will probably have to stay with the large group cos we might get lost – it's a pretty big cave. We'll probably learn about people that discover the cave and things like that. I know that glow-worms don't like being disturbed. I'll see stalactites and stalagmites, glow-worms, boats. (Grace, 9)	It was very worthwhile because it is making you feel like its really come alive and you can discover a whole new world. Normally up there it is all green and windy and busy and light but in the caves it is dark and cold and things like that. We saw stalagmites and stalactites, glow-worms, boats. The really big holes were 30 metres long. The museum was fun because there was this 'squeeze' and you can go through it. There were dead bats and wetas and there were big fossils everywhere. Being in the cave helps you learn more than photos, cos you know what it actually looks like and you could feel it and not like a photo and you could hear it properly – not like a drawing or something. The cave is very precious and you have to try not to touch them because they will break and because the limestone can pop out of the ground you need proper covered shoes. Caves are made by lots of water and shells and sand and islands and then they dissolve water into big caves with stalactites and

Before the visit	After the visit
	<p>stalagmites all over the place. A glow-worm's life cycle starts off with eggs and then it goes into a bit of larvae and then it goes into a bigger larvae and then it goes into a full grown and then it has eggs and keeps going and going. They eat bits of food that fly up on the roof, or they just fly down to the bottom and feed on the ground. When they are larvae they have fishing rods and that attracts the insects and things for them to eat. You couldn't see much of them because they like being in the dark and not being disturbed too much. (Grace, 9)</p>
<p>We will learn more about how the caves are formed and what the water does in the caves to make the forms. Yeah, we'll learn like what the life cycles of a glow-worm and wetas are. More about stalactites and stalagmites and more things about glow-worms and wetas and how columns are formed. I'll see all the formations and creatures. We'll see some wetas and maybe some spiders. (Connor, 9)</p>	<p>The museum was fun because there were these little 'squeezes' that we went through, we were seeing how many people could get through. We learnt how the caves were formed and how the people went through and discovered and the different kinds of rocks they went through. It was made by the rainwater coming down, and it drips off the stalactites onto the stalagmites, and I think he [the tour guide] said [in] 1000 years and the stalactites and stalagmites will grow an inch. Rain just drips in from the top, like through the soil, and then it will go into the caves and trickle down a stalactite. The glow-worms were really interesting, how they protect their nets and I liked the video clip of a glow-worm catching a mozzie with its fishing net. They put their fishing nets down and the mozzies and all the other stuff go flying into the nets and then they just pull it up with their mouth and they eat it and then they repair all the broken lines that have been broken. The glow-worm's mum and dad mate and then they get eggs. The adult glow-worms go away cos they only live a short time. I'm not sure how they make the light, they have all this stuff in their bodies that makes the light, (Connor, 9)</p>

Before the visit	After the visit
I'll see glow-worms maybe, wetas, stalagmites and stalactites. I'm not sure what I'll learn (Kara, 9)	It was very enjoyable. It was great to see it in real life. It's not just a picture of it, to me that doesn't seem real. We got to go in this little cave in the museum. I learnt that you have to be very small to go through holes and things. And to be very careful when we were walking around the caves. We saw some of the glow-worms, fishing lines, and stalactites and stalagmites. The water rushes through the caves and shapes the limestone and most of the rocks are made out of clay and limestone. The tour guide told us it was millions of years ago. The glow-worms have to wriggle back to get their food and then they try to catch a bug and they eat it and they have to make a new fishing line. (Kara, 9)
We might learn more about what the life cycle of a glow-worm and weta and more about stalactites and stalagmites and more things about glow-worms and wetas and how columns are formed water. I'll see stalactites and stalagmites and glow-worms and water. (Reupena, 9)	Well I learnt how the life cycle went. First they are just eggs and after the eggs they hatch into glow-worms. Then when they are glow-worms they have to make about 100 net fishing lines and then after that they might go into a chrysalis and they turn into a fly. The nets are for catching the mosquitoes and bugs and stuff that go into caves. I thought it was really fun – and it was fun how she [Kate] told us lots of stuff and we touched more stuff than we did in the caves. We touched a fossil and some limestone and yeah, when we were in the caves, we only got to touch the ground! The glow-worms were up on the roof when we were going for the boat ride. I learned that if you look at it more better you will see how it really looks. Cos if you look at a picture it don't tell you that much information than just looking at it with your real eyes. (Reupena, 9)
I've been to different caves, we had to crawl through and walk through water that deep – it was cold. We'll learn not to touch the glow-worms, and not to shout in the caves. (Kainoa, 10)	I saw the stalagmites and the fishing lines. They looked funny. The glow-worms made them to catch the bugs so they can eat them. It was cool in the boat cos we saw heaps of glow-worms. I learned not to touch the glow-worms cos they might die or something. The glow-worms they start off from eggs. Then once they have their food they turn into pupa and after a few months they turn into adults. Their light attracts the bugs and the bugs like light and they fly towards it and get caught on the fishing lines. (Kainoa,

Before the visit	After the visit
	10)

Students' before views reflect their thoughts about what they will most likely see on their visit. For example, 'I'll see stalactites and stalagmites, glow-worms, boats'. They had already undertaken some study in preparation for the visit and this is reflected in their comments. For example, 'We might learn more about what the life cycle of a glow-worm' and 'We will learn more about how the caves are formed'. Their statements reflect the topics they have covered – glow-worm life cycle and cave formation. In addition, two students commented on the behaviour they should exhibit on the visit to a cave environment.

Students' after-visit comments indicate that they thought the visit was interesting for them and that they had had an enjoyable time, affective aspects that impact on learning. They commented on what it meant to learn in a real context, and showed understandings of the impact of this on their learning. For example, 'Being in the cave helps you learn more than photos, cos you know what it actually looks like and you could feel it' and 'I learned that if you look at it more better you will see how it really looks. Cos if you look at a picture it don't tell you that much information than just looking at it with your real eyes'. Students were able to specify their own learning gains. There is evidence of content advancement in concepts. For example, 'I liked the video clip of a glow-worm catching a mozzie with its fishing net. They put their fishing nets down and the mozzies and all the other stuff go flying into the nets and then they just pull it up with their mouth and they eat it and then they repair all the broken lines that have been broken' and 'The water rushes through the caves and shapes the limestone and most of the rocks are made out of clay and limestone. The tour guide told us it was millions of years ago'.

Table 2. Teacher commentary on student learning

The kids – I've never seen them sit there with their mouths open for that long, and they just weren't off task at all – they were like that the whole time. The resources she used were good. It kept those kids that get a bit fidgety focused – like this is a fossil and this is what they actually look like – the visual – it was basically set up for every type of learner. Any of those kids, no matter what type of learner they were, got something out of it – she had the visual, she had the movement, she had the kinesthetic hands-on stuff. The visit fostered learning because they could see it - it was real. It wasn't something abstract they have to think about. They got the feeling of what it's like to be in a cave.

Sarah's commentary on student learning relates to her observations of her students while visiting the caves and the museum. She commented on their engagement in learning, particularly on their attention throughout the visit, and the intense nature of this focus. This total on-task behaviour was in contrast to what she had previously observed. She commented that student learning was facilitated through the variety of artefacts used, and the activities they were involved in. She also commented on the value of students seeing actual things, and being in real places, and that these had impacted on their learning.

Table 3. Education officer commentary on student learning

We're constantly getting letters and thank you letters and things back from the kids. But I want to know how we've enhanced their learning and if our programme has in some way enhanced their learning. I make anecdotal, mental notes. How can you provide for assessments in certain activities for students that you have for sometimes an hour and sometimes two hours? The handouts I send to schools before they come are great. I can really start focusing and tailoring what the programme is and what they want out of the programme and making sure we do that. I get teachers to discuss it [the programme] with their students so the students, they might have some burning questions that they want answered when they come to the museum, then they let us know what they are. We give out handouts [before the visit] of how to get the most out of the experience ... it makes it flow a bit easier and then we can concentrate on the outcomes they [teachers] want. I also hope they'll share it with the students as well, I still hope they will discuss what sort of questions that they [students] want to ask and I think it makes a much richer experience for them.

Kate, the education officer, mentioned that although the students appeared interested in the visit, she also wanted evidence of their learning. Kate identified ways in which she worked with teachers to maximise student learning.