"A Large Object with a Small Museum": A Narrative Analysis of Tlotlo's Experience of an Astronomy Science Center

Anthony Lelliott and Shirley Pendlebury

Abstract This paper presents a narrative analysis of an elementary school student's view of his visit to an astronomy science center in South Africa. We illustrate the power of narrative in illuminating the importance of the student's perspective in understanding the conditions for learning in a museum setting. Using principles of narrative presentation, the paper describes Tlotlo's thinking throughout his participation in a school visit to the visitors' center at a radio telescope. The paper discusses six features of the visit: student misconceptions; inadequate preparation and follow-up; memories and imaginings; enjoyment; attention; and socio-economic constraints on visits. These features are examined within the context of a developing country: both confirming previous research on school visits and providing new insights into how such visits can be interpreted. The significance of narrative analysis for science center educators is discussed and suggested as appropriate for current research in museums.

Tlotlo kneeled on the turntable and Kate gave him weights to hold in his hands. He held them out while Kate spun the turntable slowly, making him rotate. Then on Kate's instruction he pulled his arms into his sides and found that he immediately spun much faster and nearly fell off. Everybody laughed. He got off the turntable and other students tried, with similar results. Feeling dizzy

Anthony Lelliott (anthony.lelliott@wits.ac.za) is head of the Division of Mathematics and Science Education in the School of Education, University of the Witwatersrand, Private Bag 2, Wits 2050, South Africa. Shirley Pendlebury (shirley.pendlebury@uct.ac.za) is director of the Children's Institute at the University of Cape Town, South Africa.

but excited, Tlotlo didn't really listen to Kate explaining why he spun faster with his arms pulled in, but heard her saying something about how the energy needed to spin a large star (arms out) was converted to speed in a small star (arms in). He just liked spinning and feeling the difference in speed, and wasn't too disturbed by the shouting of the other students outside. He couldn't see what they were doing, but it sounded fun as they were making a lot of noise and he could hear water splattering around.

This type of description — of a child experiencing spin on a turntable — will be familiar to science center practitioners and researchers. The context and format, however, may be less familiar. Tlotlo is a composite of several student voices condensed into one representative example of a South African student, age 13, who is visiting the Hartebeesthoek Radio Astronomy Observatory (HartRAO) Visitors' Center, west of Pretoria, as part of a school visit. In contrast to purpose-built science centers, HartRAO is an example of a "large object with a small museum attached" (Gregory and Miller 1998), the large object being a 26-meter radio telescope and the small museum being the Visitors' Center, once a mess hall for the NASA staff who operated the telescope in the 1960s.

The first author conducted a study in 2003 that examined cognitive learning about astronomy at HartRAO, as well as aspects of students' affective learning (Lelliott 2007). The study investigated the learning experiences of 34 students from four schools using a combination of semi-structured interviews and observation along with Personal Meaning Mapping (see Adelman, Falk, and James 2000; Falk 2003). Students were selected for interview on the basis of their personal meaning map and their representative relation to the overall cohort in terms of gender and race. The data were analyzed to determine formal learning that had taken place, as well as the incidental and idiosyncratic learning not normally identified. This paper presents findings in the form of a composite narrative (based on several students) and attempts to answer the research question "What are students' individual experiences of the visit?"

Narrative has been used in museum research in various ways, for example to determine how exhibits can be better designed (Martin and Toon 2005) or by visitors recounting a narrative that helps them make sense of the experience (Falk and Dierking 2000; Paris and Mercer 2002; Roberts 1997). In this paper, we use narrative to show how a student's viewpoint can yield insights into the learning experience — observations which might not be clear from an analysis of conceptual or attitudinal change across a large cohort. There are several examples of the use of composite characters in narrative reporting in science education research (see Dawson 2007; Geelan 2003; McRobbie and Tobin 1995; Tippins, Tobin, and Nichols 1995). We chose to use a composite character in order to provide a compelling and graphic account of a child's experience at the center. Like Tippins and colleagues, we believe that the "significance and meaningfulness of this paper would be gauged by the reader" (1995, 148).

First, the narrative illuminates contexts that are particular to a developing country such as South Africa, for example the different meanings of the word "satellite" used by the characters and the (formerly) racially segregated residential areas. Secondly, the narrative shows the protagonist's view of interactions during the visit and the authors' interpretation of these interactions as learning and teaching relationships. Thirdly, in

building a narrative from a variety of sources — including observation, personal meaning mapping, and interviews — a richer and more authentic view of the learning experience is presented.

Narrative as a Tool for Research in Museums

In the qualitative research literature, "narrative" refers to a variety of prose texts that present research findings in the form of stories of the participants. We use Polkinghorne's description of narrative as a text that is organized thematically by plot. In our case, the "plot" refers to the experiences the student has had during a visit to the astronomy science center. Polkinghorne identifies two types of narrative study: "analysis of narratives" and "narrative analysis." The former examines people's stories and life histories and generates themes or taxonomies, while in the latter a researcher uses data collected to "produce stories as the outcome of the research" (Polkinghorne 1995, 15). This paper is an example of such a "narrative analysis," together with discussion.

Dollard developed a set of criteria that he "viewed as indispensable for judging a life history technique" (1935, 8). In his paper on narrative configuration, Polkinghorne adapted Dollard's seven criteria as guidelines for narrative analysis writing (1995). We have followed Polkinghorne's advice and attempted to use these guidelines in the development of our narrative. The seven guidelines can be summarized as follows:

1. Attention must be given to the *cultural context* in which the story is set.
2. The *protagonists* (main characters) in the story should be clearly described in terms of how they are *embodied*.
3. *Relationships* between the people in the narrative need to be clearly explained in the development of the plot, so that the effect on the main characters can be brought out.
4. *Interaction*: A narrative that involves a main character "needs to concentrate on the choices and actions of this central person" (1995, 17).
5. All characters have a *history*; the researcher-author of the narrative needs to be able to relate the protagonist's actions in relation to his or her past experiences.
6. The narrative should be time-bounded and presented in enough detail to demonstrate that it is a *unique description*, not merely an average account abstracted from a series of observations of different people.
7. Finally, the story resulting from the analysis needs to be *credible* and *comprehensible*.

Zeller (1995a; 1995b) recommends a particular style for a narrative analysis: that of the "new journalism" as described by Tom Wolfe. The writing devices recommended for new journalism are "the telling of a story in scenic episodes," "character development through dialogue," "experiencing an event through the perspective of one of its participants," and "the full detailing of the '*status life*' — or rank — of scene participants"

(Zeller 1995b, 79). Each of these techniques is pertinent to a school visit narrative. Scene-by-scene construction consists of a series of events, each with its own "story." In a science center context, the main character's experiences of a series of exhibits are the scenic episodes of the narrative. According to Zeller, the development of character through dialogue presents particular challenges for the researcher regarding the extent to which to report actual dialogue or an impression (and therefore an interpretation) of the data. Similarly, the actual process of obtaining conversations in museum settings is difficult due to the nature of the interactive experience (Allen 2002). Zeller's recommendation of a subjective viewpoint created by telling the story through the eyes of one of its participants is intended to show that no account can be truly objective. An attempt to offer an objective description of a science center visit could result in a mechanistic account of the exhibits and presentations, which would not properly capture the nature of the experience for the majority of visitors. The final writing device (the provision of relevant life detail) is suggested to make the story and characters believable, and is found in many genres of writing. In the case of a school visit, how the main character interacts with his or her surroundings, fellow students, teachers, and science center staff is important to provide the reader with evidence that the narrative presented is plausible, and relates to several of Dollard's criteria.

In the narrative we present, we have attempted to follow all these guidelines in order to create a rich and textured narrative analysis of what it means for a student to visit HartRAO. In making this composite portrait, we have drawn mainly on students' personal meaning maps, field notes and video- and audio-taped recordings of school visits to the sites, as well as field notes made during visits to the schools and interviews with the students and teachers. Some of this data is presented in the discussion section. However, what we are presenting is not a life history, but a snapshot of an event in life, so some of the guidelines (such as the "central character," the "character's life experiences" and the "unique description of the event") are more relevant than others (such as the "character embodied" and "how the character relates to others").

Tlotlo is the central character in the following narrative of a visit to an astronomy science center. Like Falk and Dierking's (2000) descriptions of museum visits, the narrative provides one example of what school children experience at the Hartebeesthoek Radio Astronomy Observatory. While we based the character of Tlotlo on an individual selected from the study, the experiences we describe are from the data drawn from several students. In this sense, his story is unique, and yet it is representative of his classmates who visited the center. In order to maintain the flow of the narrative, evidence for the interpretations provided is given in the discussion section, which follows later.

The Narrative: Great Expectations

Tlotlo was very excited to be visiting Hartebeesthoek Radio Astronomy Observatory. His science teacher, Mr. Maoto, had told him that all three classes in the seventh grade (the final year of elementary school in South Africa) would be able to go, but that they had to pay R90 (approx. USD $9) for the trip. His excitement was tinged with a concern that his parents would not be able to pay, and that he would be left behind. He felt this would

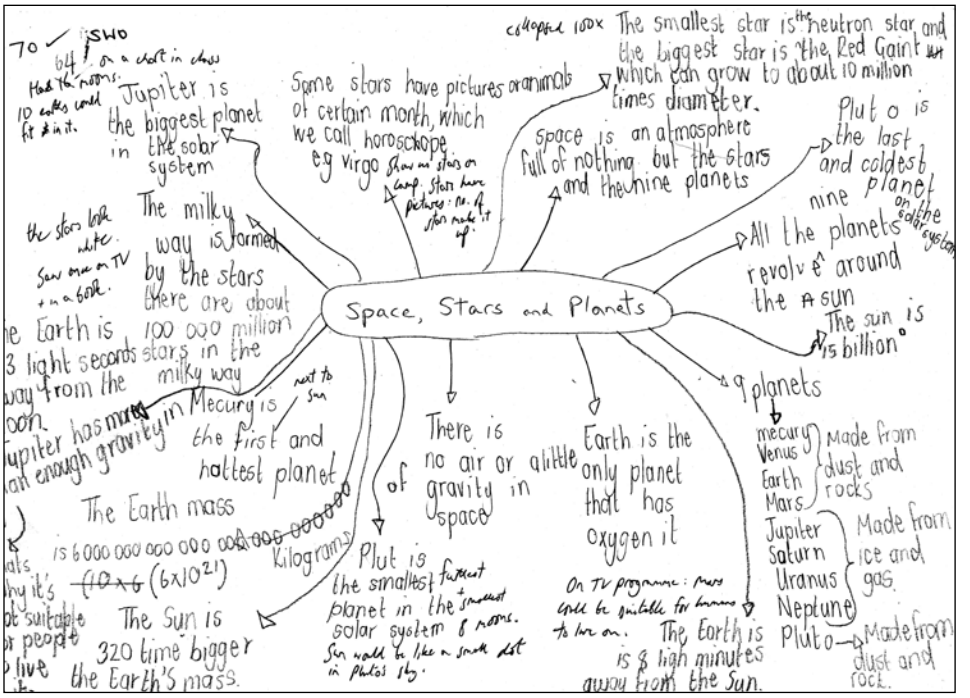
be unfair. If this was a school trip related to the topic they were doing in Natural Science, they should *all* get to go. When he told his parents and gave them the information sheet and indemnity form for their signature, he feared the worst, but when he reminded his Mom the following week, he was thrilled that she signed and gave him the money to take to school the next day.

Tlotlo had celebrated his 13th birthday in June at his home in Alexandra, a township in northern Johannesburg. It wasn't a big party, just a few friends coming around. Until recently, he had been going to elementary school in the township, but his mother was concerned that the high school he would soon progress to was "not doing well." Tlotlo didn't understand what his mother meant, but he didn't complain when she moved him to Balfour Forest School, since he knew he could make new friends quite quickly. For Tlotlo, that was the main reason for tolerating school: his friends.

In Science, all the grade 7 classes in term three were doing the same topic: energy. Tlotlo didn't really notice that the trip to an observatory didn't have much to do with energy. He didn't think about it. He knew that an observatory had something to do with the stars and astrology — or was it astronomy? The idea of going on a trip was cool. In elementary school they had once been on a trip to Joburg Zoo, which he still thought about. A few days before the observatory trip, a tall white man called Mr. Halliday had come to the school and asked some questions. He drew a sort of spider diagram on the chalkboard and said he'd like the class to draw their own diagram, but based on "space, stars and planets." (The diagram was intended to be a Personal Meaning Map.) Tlotlo didn't mind doing this — at least it was different from his normal class — but he found he couldn't write much on the diagram. He mainly put down words he was familiar with — the names of the planets he knew, "galaxy," "comet," "asteroids" and suchlike. He didn't really know much about the words, but he did know that they were in space, and that's what the man seemed to want. A few days later, Mr. Halliday came again and called a few people from the class, including Tlotlo, to talk about their diagrams with him. Tlotlo struggled a bit to explain what he had written on his diagram, but was pleased he had been selected.

When the day finally came — a Friday — Tlotlo was almost bursting with excitement about the trip. But it was unfair for his seven or so classmates who wouldn't be going. His best friend Karabo was amongst them, and he avoided talking about the trip when Karabo was around. Still, nothing in class had been done in preparation for the visit anyway. All Mr. Maoto had done was to collect the money and indemnity forms, and tell the class what they should wear for the trip. In fact, Mr. Maoto told them that he wouldn't be going himself, but he didn't say why. At seven o'clock, Tlotlo arrived at school by minibus taxi as usual, met up with his friends, and they climbed on the bus together. After about 80 minutes, Tlotlo saw that they were among hills, and there were some "satellites" in the distance, like the ones people had on their houses to watch DSTV, only much bigger. (DSTV is the main satellite pay television channel in South Africa. Many people use the term "satellite" to refer to the dish as well as an orbiting body.)

Then the bus turned onto a narrow road and began to descend steeply. They suddenly saw a really big "satellite," as well as a number of buildings, and Tlotlo realized that they had arrived.



Personal Meaning Map: The author provided the three keywords in the center and a 13-year-old student (on whom the character of Tlotlo is based) drew the remainder after being asked to write anything he knew about the topic.

"Planets and stars and like, well, space" — The students, chattering loudly, all got off the bus. Kate and Daisy met them, introduced themselves as "educators," and said that they would be showing the students around the observatory for the next few hours. The students were split into two groups. Tlotlo started off with Kate, who acted just like a teacher. She asked: "What is astronomy? Can anyone tell me what it is?"

"It's space, ma'am."

"The study of the stars."

"It's like when people tell your future."

"Planets and stars and like, well, space."

After a few answers from the class and an explanation from Kate, Tlotlo heard that astronomy and astrology were two different things, although he still wasn't quite sure of the exact difference between them. He wasn't surprised to hear that HartRAO (as Kate called the observatory) was built as long ago as the 1960s. Tlotlo thought that it *looked* old. His mind began to wander a bit when Kate went on to describe why the observatory was built for several of the space missions to the Moon, Venus and Mars, and how the South African government now owned it. He did notice that Kate mentioned something called "Nasser," which he knew was involved with space travel.

They went inside a large hall which had pieces of weird apparatus, some exhibits and posters on the walls, as well as a very large model of what Tlotlo thought must be the Moon. The students sat on the floor. Kate began asking questions about the solar sys-

tem. Most of the students called out planet names, as well as other words like "moons," "meteors," and "galaxies." Kate stressed that the visit today was about having fun and learning at the same time, and that they should try to think as well as play with the exhibits. Kate then talked to them about the sun and stars. Tlotlo knew some of what she was saying, about how the sun is a star, but he had thought that the sun is the biggest star. He heard that the stars are mostly the same size as or bigger than the sun and that it is only because they are far away that they seem so small. Tlotlo liked Kate's idea that the tree in the car park looks big compared to the trees on the hill, but they are actually the same size. His mind wandered a bit when she started talking about light traveling from the stars to Earth, and he started whispering to Sipho about the big satellite. Kate talked about light years. He listened again when she started to talk about the death of the sun when it runs out of fuel to burn. Tlotlo thought the idea of the sun dying was cool! She said that stars spin. She asked if a star will spin faster when "living" or when "dead and collapsed." Tlotlo jumped up when Kate called for volunteers to sit on a sort of turntable, and laughed when he was called first, wondering what he was going to have to do on this rotating disc. It looked a bit like a giant version of a turntable that DJs use to play vinyls at the community hall back home. He'd been to a very loud party there once.

[*We return to Tlotlo's experience on the turntable, repeated here to continue his narrative*]

Tlotlo kneeled on the turntable, and Kate gave him weights to hold in his hands. He held them out while Kate spun the turntable slowly, making him rotate. Then on Kate's instruction he pulled his arms into his sides and found that he immediately spun much faster and nearly fell off; everybody laughed. He got off the turntable and other students tried, with similar results. Feeling dizzy but excited, Tlotlo didn't really listen to

Kate explaining why he spun faster with his arms pulled in, but heard her saying something about how the energy needed to spin a large star (arms out) was converted to speed in a small star (arms in). He just liked spinning and feeling the difference in speed, and wasn't too disturbed by the shouting of the other students outside. He couldn't see what they were doing, but it sounded fun, since they were making a lot of noise and he could hear water splattering around.

Whispers and rockets—Tlotlo and his group moved outside where Daisy, the other educator at HartRAO, announced "Girls like to talk on the telephone." This was something that Tlotlo knew, as his older sister often chatted for ages on the phone to her boyfriend. Tlotlo thought they were going to do something with cellphones, but they walked over to what he thought of as a satellite, facing another one across the grass. Daisy called them dishes. She split the students into two groups, with a group standing next to each dish. The dishes were about 20 meters apart. The students took turns to whisper into one dish and listen at the other. When it came to Tlotlo's turn he found he could hear the person whispering from the other dish perfectly. Daisy asked them if they knew how this "phone" worked.

"There are wires running under the ground, ma'am."

"It's like a cellphone, ma'am."

"No miss, it's the shape of the satellites."

Daisy picked up on this last suggestion and ignored the others. She compared the

dish shape to a reflector on car headlights or a torch. She said that the shape concentrated the sound, which carried perfectly between the two dishes because they were lined up so carefully. She said something about a parabolic shape of the dishes, but Tlotlo didn't quite get that part of it. But he did see the similarity between these dishes and the enormous dish pointing at the sky. Daisy said that it was a radio telescope, and that its shape concentrated waves coming from stars so that they could be detected by the astronomers studying them. Daisy also said that DSTV dishes did the same thing, and that they were pointing to a satellite in the sky sending television signals. Tlotlo wished that he had DSTV; he had watched the cartoon channel at his friend's house a few times. At this point the group stood under a tree, and Daisy answered lots of their questions on all sorts of aspects of astronomy. Tlotlo asked, "If the DSTV satellite in the sky is going round the Earth, how come there is no break in signal when it goes the other side?"

Daisy replied: "That's a very good question. In fact, the DSTV satellite orbits the Earth at exactly the same speed as the Earth spins. So it is always in our sky, and there's no break in signal."

Tlotlo heard Daisy, but he wasn't sure he really got it. He wondered if satellites ever smashed into each other, but he didn't ask Daisy.

Daisy walked the group to the other side of the car park where Tlotlo had earlier noticed the shouting and sloshing-of-water sounds coming from the other group. Daisy told them that they were going to be launching rockets into space! In fact, they were using Coke bottles and bicycle pumps, but it still looked fun. Tlotlo paired up with Ross and they half filled their bottle with water from the tap, fitted it to the "rocket launcher," and pumped it. Ross started pumping, but got tired when nothing happened. Tlotlo took over and noticed air bubbling through the water inside the bottle. Suddenly the bottle shot high into the air, showering them with water.

Yo! Tlotlo thought this was cool, the best thing they had done here so far. He ran to the tap to refill the bottle. Daisy suggested that they experiment with different amounts

of water in the bottle. They tried with a full bottle, but it didn't fly very high: it seemed to be too heavy. A quarter bottle flew highest in the air and Tlotlo found that if he held the bottle on the launcher with a finger while it was being pumped, it flew even higher. Then they tried it with no water at all but it hardly rose off the launcher. After more fun, Daisy called the group together and asked if they could explain what had been happening. If he had been asked he would probably have said that rockets should only carry a small amount of fuel (water) in order for them to rise highest in the sky. "Why ask us about this?" thought Tlotlo, feeling frustrated.

Break with gravity—At about 10.40, Daisy said it was time for a break. After eating, Tlotlo saw some other exhibits he hadn't noticed before. He called Ross over and they picked up Coke cans from a table. Each one was a different weight, and they were labeled with the names of planets and the Moon. The "Jupiter" can was very heavy, while "Pluto" was very light. Was this to do with the size of the planet, or was it that Pluto was very far from the Earth?

"Why's Pluto so light?" Tlotlo asked Ross.

"I dunno. Probly an alien drank all the Coke!"

They both laughed. There wasn't anything explaining what the Coke cans were for, and if there had been, Tlotlo probably wouldn't have read it anyway.

Tlotlo then saw four bathroom scales on the floor, marked Earth, Moon, Sun and Jupiter. On the Moon scale he only weighed about 8.5 kilograms, while on the Earth scale he weighed 52 kg, which he thought was about right. He weighed 132 kg on Jupiter and 1400 kg on the Sun, which was weird! Tlotlo remembered that the Jupiter Coke can had been heavy.

"Hey, you're lighter on the Moon because it's closer to the Earth" said Ross.

"No, it's not that. It's because the Moon has no gravity, that's why."

Tlotlo chatted about it with Ross, and they decided that it *was* something to do with gravity. They knew gravity on the Moon was low—in fact, if asked, they would probably both have said that people float on the Moon. Now it looked like gravity on Jupiter was high and it was really high on the Sun. Ross couldn't really understand this, as he thought both Jupiter and the Sun were made out of gas, so how could they have a lot of gravity? They both went away a bit puzzled from the scales, but with the impression that gravity was different on different planets and the Sun.

Landing on the Moon—The room for the slide show was cool and dark, and Tlotlo got a seat at the back with a group of his friends. Daisy began by asking questions:

"Who was the first man in space?" "Who was the first man on the Moon?" Tlotlo didn't know the answer to the first one, but shouted out "Mark Shuttwerth" to the second, as did many of his classmates. Daisy said that while Mark *Shuttleworth* was the first South African into space, it was an American called Neil Armstrong who was the first man on the Moon.

When Daisy asked who wanted to be the second South African into space, the class called out "Me! Me!" Daisy quickly chose a small boy called Titus, and said "Today I'll take Titus, and I'll take another tomorrow." She went on to say, "OK, he's been trained, can he go dressed in uniform?" The classed chorused "No!"

"Why not?"

"He'll bounce."

"There's a special suit."

"For protection."

Titus then dressed in a white overall, with a NASA logo, and Daisy sometimes referred to him as Titus Shuttleworth or Tito Armstrong. She then suggested he would need boots: "Why?"

"So that he doesn't float." Daisy said that the gravity on the Moon is one sixth that of the Earth, and he needs something heavy to keep him on the ground. This fitted with Tlotlo's own idea that people float on the Moon, and that they need to be held down with something heavy. Titus then donned rubber boots as well as a pair of gloves. Again, Daisy asked the class why he would need gloves, and settled on the idea of protection against extremes of hot and cold. She then handed Titus a helmet to wear, and asked the class why he would need one.

"No atmosphere."

"Dangerous gases."

Tlotlo heard Daisy saying that the helmet was needed to protect his head from the Sun's rays and extremes of temperature. Finally, she gave Titus an "oxygen tank" (which Tlotlo could see was just a plastic Coke bottle) and told him he had a microphone inside the helmet, since there is no air in space so sound cannot travel.

Some slides didn't make much impression on Tlotlo, but when it came to the first steps taken on the Moon, he paid more attention. He remembered he had heard the phrase "One small step for Man, one giant leap for mankind" and could now understand what it was talking about when he saw the photos of the astronauts walking on the Moon's surface. Daisy suggested that heavy boots are needed to keep the astronauts on

the ground. Tlotlo was surprised to see what Daisy called a "lunar buggy vehicle," which the astronauts used to explore the surface. Daniel suggested, "Their vehicle help them to not float. Maybe their vehicle have gravity" and everybody laughed, though Tlotlo wasn't sure why. Daisy ended by showing a footprint in the dust of the Moon, and asked if it was going to stay there forever. "Yes!" they chorused, and Daisy emphasized that there is no wind to blow it away, no water to wash it away, and no weather. It would stay there unless a meteorite hit it. After a few more slides, it wasn't long before they were out in the sunshine and walking back to the visitors' center.

Afterwards—The trip back to school passed quite quickly for Tlotlo, and although they sang songs and messed around on the bus, he felt tired. He caught the minibus taxi from school and rushed home to tell his mother what they had done at HartRAO. His mother listened patiently as the words tumbled from his mouth: pumping the rockets, spinning on the turntable, picking up Coke cans, talking through the whisper dishes, walking on the Moon, hearing stars drumming, and seeing the big dish moving. After the evening meal he watched some television and went to bed enervated, but still quite excited.

Over the weekend, Tlotlo thought about the trip from time to time, and wondered whether he might ask his father to take him back to HartRAO sometime. But his father always seemed to be so busy, even at weekends, that he wasn't sure whether to or not. On Monday, back at school, Mrs. Kathrada talked to the class about the trip during the English lesson. She said that they ought to carry on studying about space, and gave them a piece to read about Neil Armstrong's first footprint on the Moon. Tlotlo liked this; he could relate the article to what he had seen on the slide show at HartRAO. However, Tlotlo had to be a bit careful around Karabo, who hadn't been able to go on the trip. Tlotlo held back talking about the trip too much, so that Karabo wouldn't feel bad about it.

During the week, Mr. Halliday came back and all the students who had been on the visit went to an empty classroom with him. Mr. Halliday gave the students the spider diagram each one had completed before the trip, and Tlotlo was pleased to be able to add to his, as well as cross out one or two things that he now decided were not right. In fact, Tlotlo had so much to add that he wrote some things on the back of the sheet. Later on Mr. Halliday asked the same students he had seen before the trip to speak with him again, and Tlotlo eagerly answered the questions put to him.

Over the next few weeks, they didn't do anything related to the trip in class, either with Mr. Maoto or any of the other teachers, and the visit slowly faded from Tlotlo's mind. One day, when he happened to see the television news his father was watching, there was a report of a Chinese astronaut going into space and orbiting the Earth. Tlotlo started chattering to his father about how they had seen pictures like this at HartRAO and his father appeared quite interested. But then there was a program that his father wanted to watch in peace, and Tlotlo left the room to do some homework. Over the next months, the visit faded further in Tlotlo's memory, and in January he started grade 8 at the nearby high school. He found that even over the next year, he was reminded from time to time about the visit, by schoolwork topics, by occasional items on the television, and in talking with his friends. For Tlotlo, the brief visit had made a lasting impression.

Discussion

In building the narrative, we followed Polkinghorne's guidelines closely (1995). "Great Expectations" and "Afterwards" are built from questions we asked during the interviews. These included: "Where are you going on the visit?" "What do you think the purpose of the visit is?" "Have you been doing any preparation for the visit at school?" "Are you looking forward to the visit?" "Why?" The post-visit talk to his mother and seeing the Chinese astronaut on television were all built from interview data where students responded to questions such as: "have you told anyone about the visit?" "Have you thought about the visit?" "What have you thought about?"

The bulk of the "action" in the narrative was put together from observations of video recordings of visits. All quotes were uttered by either the educators or the visiting students. The section on the gravity discussion between Tlotlo and Ross was a combination of video observation of students chatting about the Coke cans and students explicating their ideas about gravity during the post-visit interview. The following exchange is an example:

> *Interviewer*: Okay. What about on somewhere like Jupiter? Do you think there's gravity on Jupiter?
>
> *Student*: There's lots of gravity on Jupiter, it's very, very much.
>
> Interviewer: Why? Why is that you think?
>
> *Student*: It's because when we went to the visitors center I picked up a Coke can and saw how much it weigh on Jupiter, it was very heavy.
>
> *Interviewer*: Was it. Right. Okay. So there is lots of gravity on Jupiter. And what about, so what do you think gravity might be related to? Why would it be heavier on Jupiter than the Earth?
>
> *Student*: It's because Jupiter is bigger, it's the biggest planet I think that's why it has more gravity than the Earth's.

Where we have represented Tlotlo's "meanings and understandings . . . purposes, motivations and interests" (Polkinghorne 1995, 17) we have based them on interviews with the students. The first example: When the students used the whisper dishes, the narrative suggests thoughts in Tlotlo's mind: ". . . thought they were going to do something with cellphones" and "what he thought of as a satellite." These thoughts were based on the following post-visit interview:

> *Interviewer*: Was there anything else that was surprising or amazing?
>
> *Student*: I was surprised how we could communicate through those satellites, 'cause I didn't know how, so I also thought there was something connected to them underneath the ground, but I saw there's nothing and that really surprised me.

The second example is when the rocket-launching activity was completed, and Tlotlo "would probably have said that rockets should only carry a small amount of fuel (water)," because several students misunderstood the analogy of the activity:

Interviewer: Okay. Right. What things did you most enjoy about the visit?

Student: I learned a lot and what I've enjoyed, we had a lot of fun, and what I've learned that the rocket or, let me say, the space shuttle needs, it doesn't need more maybe like air or gas or more air or more gas in it, it just needs a little bit of gas so that the gas and the air can combine together so that it can lift off. So if it's too much gas or if there's no gas it can't go up.

In the narrative, there are a few occasions when we suggest that Tlotlo's attention wanders. The evidence for this is two-fold: examination of the video recordings where students are observed not listening to the educator speaking, but instead chatting to a friend about another exhibit (for instance, when the radio telescope began to move, some students were distracted by it). Also, in the post-visit interview, some students expressed lack of concentration, for instance: "Sir, I enjoyed everything sir, but I was tired sir, I couldn't really concentrate."

Narrative analysis is not intended to provide general "truths," but to illuminate. Here we discuss selected experiences of Tlotlo's as they relate to themes in the literature, and comment on how they are drawn from the data gathered in the study. We focus on six features of the visit: student misconceptions; inadequate school preparation and follow-up; memories and imaginings; enjoyment; discussing the visit afterwards; and socio-economic constraints on museum visits. Although these findings are not entirely new, we do provide some fresh insights into school visits in the context of a developing country such as South Africa.

First, Tlotlo was presented with a lot of factual information about astronomy, some of which didn't make sense because, as the narrative shows, he entered the center with several misconceptions. We will illustrate this with a vignette from Tlotlo's story, and show how the center both changed and reinforced his previous ideas about gravity.

Tlotlo and Ross had several misconceptions about gravity, demonstrating a limited understanding of it: they thought there was no gravity on the Moon and that the Sun and Jupiter would not have gravity, since they are made of gas. The following excerpts show how one student's thinking changed.

Prior to the visit:

Student: Yeah. Gravity is the . . . The . . . The air of the . . . The air that pulls us down from, like, floating around.

Interviewer: Okay. What would gravity be like on the Moon?

Student: I don't know 'cause there's no gravity in space.

Interviewer: Okay. What about on Jupiter?

Student: Umm . . . Nothing. There would be no gravity.

After the visit:

Interviewer: And what would gravity be like on the Moon?

Student: There is a little bit of gravity, but you'll just float around because there's not much gravity like on Earth.

Interviewer: Okay. But there's some.

Student: Yeah, there's a little.

Interviewer: Okay. What about on somewhere like Jupiter?

Student: Jupiter has more than enough gravity. It's not suitable for humans to live in, it's more than enough gravity.

Interviewer: Okay. So what would it be like if we were there?

Student: It would just push us down and up.

Interviewer: Okay. So if we have gravity like we have here, the Moon has a little bit of gravity and Jupiter has a lot of gravity, what's gravity related to? What causes it?

Student: I think it's big and *there's enough space for a lot of gravity. You can hold up more than enough gravity.*

Interviewer: Okay. Does the sun have gravity?

Student: I think on the atmosphere of the sun because there's a lot of gravity.

By interacting with the Coke can exhibit and the gravity scales, Tlotlo came away with a slightly changed knowledge of gravity, but the interview transcript demonstrates that his post-visit understanding of gravity was still very naïve (the words in italics) and his idea that atmosphere is involved has apparently not changed. The gravity exhibits at HartRAO were not themselves sufficient to result in a major shift in his understanding of gravity. Intervention by a more knowledgeable person might have assisted in this, but the center did not address the issue except by educators answering students' questions.

The misconceptions demonstrated by Tlotlo were similar to those recorded in the astronomy education literature regarding the sun, stars, gravity and space (Bailey and Slater 2003; Comins 2001). Museum researchers are usually careful not to make claims about a substantial change in visitors' knowledge as a result of a visit to a museum. The evidence from Tlotlo's interview transcript suggests that there were some limited shifts in his conception of gravity. Although HartRAO provided a number of gravity-related activities, no explicit linkage between them was provided either by signage or by the educator. The case of Tlotlo suggests that further research should be conducted to determine the efficacy of giving explicit connections between themed exhibits in improving conceptual knowledge of visitors. This would be particularly important in contexts such as South Africa, where school visits are seen as closely linked to the curriculum, and cognitive learning is valued as one of the main outcomes of such visits.

Second, the narrative alludes to the fact that Tlotlo and his classmates did no classroom preparation for the visit.

Interviewer: Have you done any preparation for this visit on Friday? At school have you done anything about space?

Student: Uh-uh [indicates negative]. But usually every year we do it during the second term, but we haven't.

This was the case for all schools in the study, except one whose science club had visited HartRAO. Six students across the study did some personal preparation, but Tlotlo was not one of them. The narrative also mentions that Tlotlo's science teacher, Mr. Maoto, did not attend the visit with his students, and instead other teachers accompanied the

class. This too was a common occurrence across the study. There was a similar lack of follow-up after the visit, although Tlotlo's narrative shows that Mrs. Kathrada did get the students to think about the trip by giving them a reading about the Moon landings, thus:

> *Interviewer*: What did you hear yesterday?
> *Student*: About Neil Armstrong when he first printed his [foot].
> *Interviewer*: How was that, what happened at school for you to hear that?
> *Student*: Mrs. Kathrada said she wants us to continue our studies about space.

In Tlotlo's post-visit interview he did not really connect the English activities with the content of the visit to the science center. Across the study, no students worked on astronomy between the time of the trip and when they were interviewed. This was clearly a missed opportunity on the part of Tlotlo's science teacher. There is substantial evidence in the literature that teachers fail to use school visits to museums as effectively as they might (see Griffin 2004; Storksdieck 2004), as well as exhortations from researchers on the advisability of correcting this situation (see Falk and Dierking 2000). The narrative identifies another area for further examination: how teachers work with their classes after a visit, both from the viewpoint of learning about subject matter, and in terms of using the visit as a focus for other work (for instance, in language classes).

Third, Tlotlo was able to relate some of what he experienced to his own life and imagination. He remembered that he had heard about Mark Shuttleworth, the first African in space and second "space tourist" to visit the International Space Station. Eight students across all four schools referred to this, mainly in their Personal Meaning Maps, for example:

> *Student*: Our first afronaut [*sic*] is Mark Shuttleworth.
> *Student*: The first South African in space was Mark Shuttleworth. He paid 1,000,000,000 [Rand, approximately 100,000,000 USD] to see space."

These instances suggest that making space personal and relevant is important to the students in our study. Tlotlo also recalled the phrase "One small step for Man, one giant leap for mankind" and was able to imagine himself as Titus, his fellow student, being dressed as an astronaut. Paris and Mercer describe how a person's narrative account can be referenced to "one's autobiographical sense of self, to experiences and events in one's life whether actual, imagined, or potential" (2002, 406). We would suggest that the slide show was able to "touch" Tlotlo in this personal sense, and that he could imagine himself as the dressed-up astronaut. More importantly, the visit made some students question their own beliefs. The following extracts from post-visit interviews provide interesting examples:

> *Interviewer*: What do you think God has to do with the planets and space and sun?
> *Student 1*: Since I went to the trip it's very complicated, because from what I've learned in HSS [Human and Social Sciences, a subject in the school curriculum] the world started as a small, tiny little thing and the water, that was written by I don't know who, some-

thing Darwin, but in the Bible it says it's Adam and Eve and then comes the planet and all. I think it's a lot complicating.

Interviewer: Hmmm. So you're not really sure.

Student 1: I'm not sure. I don't know which one to believe, the Bible or evolution or something.

Student 2: Well, God is the one who created the planets and stuff, but I don't think that God also created the other planets because in the Bible they say it was Earth and in the books from the library they say other planets were created from dust and dead stars and ices and stuff, so yeah, that's why.

These responses pose interesting questions for further investigation: To what extent should science centers (especially those involving big ideas in science such as the cosmos) set out to challenge visitors' existing beliefs?

Fourth, it is clear from the narrative that Tlotlo both learned about astronomy and had fun at HartRAO. One student commented: "I think many people who went, they were happy to go there, and they learned more, because there's some people who, they don't, they aren't really interested, but because they had fun they learned at the same time because of the fun. Now they learned because there's fun, so what I've learned is that most people who learn they learn through fun, so whatever they do should be fun so that they can learn."

Much of the research literature on museums and science centers has tended to dichotomize fun and learning, with several opinion pieces decrying the hands-on experience as being "minds-off" (see Parkyn 1993; Sanders 1998). As Falk and others have demonstrated, however, education and entertainment are not likely to be on a continuum, but instead complement each other in a science center environment (Falk, Moussouri, and Coulson 1998; Griffin 2004). Recent work provides some evidence for enjoyable learning as a motivator (Packer 2006) and as being related to other theoretical constructs such as situational interest (Hidi and Harachiewicz 2000) and flow experience (Csikszentmihalyi and Hermanson 1995). The narrative of Tlotlo's visit demonstrates the integrated nature of learning and fun, and supports Packer's notion that the process of learning is as important as the product.

Fifth, the need to tell people about the visit should be exploited to help visitors get the most from their encounter. With one exception, all students in the study told someone, usually a member of their family, of their experiences. A typical example in response to "What did you tell her [student's mother] about the visit" was as follows: "I told her about the satellite, I even told her about the dead star and the big star and that it, like, which one spins the fastest and then about the gravity and the weight in different kinds of planets, and then I even told her about the launching of the rockets and that the bottles inside there were water and stuff. And she was very interested about that, she didn't even know anything about space because when they do [inaudible] they didn't know anything about space so she was interested."

Given the recommendations in the literature that an after-visit "follow up" is of such value to visitors (see Braund 2004), we maintain that it is important for both teachers and museum educators to capitalize on this "need" to tell others about the visit.

Doing so can be a way of getting visitors to think about the visit and hopefully reflect on it in a meaningful way. In South Africa, increasingly greater numbers of students have their own cellphones, and use *sms* (text messaging) to communicate with each other. Museums could send bulk *sms's* to remind visitors a few weeks after their visit, and obtain feedback on their opinion of the visit. This could help to keep the trip in the visitor's memory for longer, ensuring that it provides an effective cognitive and affective experience (Falk and Dierking 2000).

Lastly, the narrative brings out a contextual feature regarding the visit. Only students whose parents could afford and were willing to pay for the trip actually took part in it. Out of a total of 75 students in the two grade 7 classes at Balfour Forest School, only 37 (49 percent) completed consent forms and 30 (40 percent) went on the trip. Tlotlo's school can be regarded as representative of the majority of urban schools in South Africa, although it too is somewhat privileged, being located in a former "white" suburb of Johannesburg. Tlotlo's mother's remark that the local township school was "not doing well" indicates the current reality in many South African schools where teaching and learning is still of poor quality, 15 years after the end of apartheid. Although the number of science centers in South Africa has increased substantially over the past decade, affordable access to such centers remains an issue. Under apartheid, museums and other public galleries were designed specifically for the white population. Tlotlo's parents would have been excluded from such institutions until reforms after 1990, and are likely to have little or no experience of museum visits. The majority of parents in the study were therefore either unwilling or unable to pay the R90 for the trip. In the U.S. there is concern that minorities such as African-Americans are not well enough represented as museum visitors (see Rahm 2004). In South Africa, the *majority* of the population was previously excluded, and needs to be brought into such institutions for them to have their intended impact.

Conclusion

Our story of Tlotlo describes experiences that are unique instances in the study — yet may also resonate with other school children visiting museums. A student's previously held misconceptions — for instance, Tlotlo's idea that in order not to float on the Moon one needs to wear heavy boots — can remain unaltered or be further reinforced during the visit. His teacher appeared rather indifferent and neither prepared for nor followed up after the visit, yet the trip provided Tlotlo with experiences that were personal and salient. Tlotlo's learning seemed to be small and incremental (Anderson 1999; Anderson, Lucas, and Ginns 2003). Yet the narrative shows that learning occurred continuously and was combined with an enjoyable experience. Moreover, children returning from visits have a desire to share the events of their visit with those close to them — a fact that museums (and teachers) should consider utilizing to extend the learning experience. We hope that this account has demonstrated the generative possibilities of narrative analysis as a research tool in illuminating the experience of the student visitor, enabling us as researchers to "open a window on the mind" (Cortazzi 1993, 2).

Acknowledgments

Thanks to Professor Marissa Rollnick and two anonymous reviewers for providing useful comment on earlier drafts of this paper.

References

Adelman, L. M., J. Falk, and S. James. 2000. Impact of the National Aquarium in Baltimore on visitors' conservation attitudes, behavior and knowledge. *Curator: The Museum Journal* 43 (1): 33–61.

Allen, S. 2002. Looking for learning in visitor talk: A methodological exploration. In *Learning Conversations in Museums*, G. Leinhardt, K. Crowley and K. Knutson, eds. Mahwah, NJ: Erlbaum.

Anderson, D. 1999. The Development of Science Concepts Emergent from Science Museum and Post-Visit Activity Experiences: Students' Construction of Knowledge. PhD dissertation, Centre for Mathematics and Science Education, Queensland University of Technology.

Anderson, D., K. Lucas, and I. Ginns. 2003. Theoretical perspectives on learning in an informal setting. *Journal of Research in Science Teaching* 40 (2): 177–199.

Bailey, J., and T. Slater. 2003. A review of astronomy education research. *Astronomy Education Review* 2 (2): 20–45.

Braund, M. 2004. Learning science at museums and hands-on centres. In *Learning Science Outside the Classroom*, M. Braund and M. Reiss, eds., 113–128. London: Routledge-Falmer.

Comins, N. 2001. *Heavenly Errors: Misconceptions About the Real Nature of the Universe*. New York: Columbia University Press.

Cortazzi, M. 1993. *Narrative Analysis.* Edited by R. Burgess, Social Research and Educational Studies. London: Falmer Press.

Csikszentmihalyi, M., and K. Hermanson. 1995. Intrinsic motivation in museums: Why does one want to learn? In *Public Institutions for Personal Learning: Establishing a Research Agenda*, J. H. Falk and L. D. Dierking, eds. Washington, D.C.: American Association of Museums.

Dawson, V. 2007. Exploring students' learning experiences through narrative tales. In *Contemporary Qualitative Research: Exemplars for Science and Mathematics Educators*, P. Taylor and J. Wallace, eds. Dordrecht, the Netherlands: Springer.

Dollard, J. 1935. *Criteria for the Life History*. New Haven: Yale University Press.

Falk, J. H. 2003. Personal meaning mapping. In *Museums and Creativity: A Study into the Role of Museums in Design Education*, G. Caban, C. Scott, J. H. Falk, and L. D. Dierking, eds. Sydney: Powerhouse Publishing.

Falk, J. H., and L. D Dierking. 2000. *Learning from Museums: Visitor Experiences and the Making of Meaning*. Walnut Creek, CA: AltaMira Press.

Falk, J. H., T. Moussouri, and D. Coulson. 1998. The effect of visitors' agendas on museum learning. *Curator: The Museum Journal* 41 (2): 107–120.

Geelan, D. 2003. *Weaving Narrative Nets to Capture Classrooms: Multimethod Qualitative Approaches for Educational Research*. Dordrecht, the Netherlands: Kluwer Academic Publishers.

Gregory, J., and S. Miller. 1998. *Science in Public: Communication, Culture and Credibility*. Cambridge, MA: Perseus Publishing.

Griffin, J. 2004. Research on students and museums: Looking more closely at the students in school groups. *Science Education* 88 (Supplement 1): S59–S70.

Hidi, S., and J. Harachiewicz. 2000. Motivating the academically unmotivated: A critical issue for the twenty-first century. *Review of Educational Research* 70 (2): 151–179.

Lelliott, A. 2007. Learning about astronomy: A case study exploring how grade 7 and 8 students experience sites of informal learning in South Africa. PhD dissertation, University of the Witwatersrand, Johannesburg.

Martin, L., and R. Toon. 2005. Narratives in a science center: Interpretation and identity. *Curator: The Museum Journal* 48 (4): 407–425.

McRobbie, C. and K. Tobin. 1995. Restraints to reform: The congruence of teacher and student action in a chemistry classroom. *Journal of Research in Science Teaching* 32 (4): 373–385.

Packer, J. 2006. Learning for fun: The unique contribution of educational leisure experiences. *Curator: The Museum Journal* 49 (4): 329–344.

Paris, S. G., and M. J. Mercer. 2002. Finding self in objects: Identity exploration in museums. In *Learning Conversations in Museums*, G. Leinhardt, K. Crowley, and K. Knutson, eds. Mahwah, NJ: Erlbaum.

Parkyn, M. 1993. Scientific imaging. *Museums Journal* (October): 29–34.

Polkinghorne, D. 1995. Narrative configuration in qualitative analysis. In *Life History and Narrative*, J. A. Hatch and R. Wisniewski, eds. London: Falmer Press.

Rahm, J. 2004. Multiple modes of meaning-making in a science center. *Science Education* 88 (2): 223–247.

Roberts, L. C. 1997. *From Knowledge to Narrative: Educators and the Changing Museum*. Washington DC: Smithsonian Institution Press.

Sanders, M. 1998. No simple panaceas: A response to Fish. In *Promoting Public Understanding of Science in Southern Africa*, M. B. Ogunnyi, ed. Cape Town: SSME, University of Western Cape.

Storksdieck, M. 2004. Testing a model for understanding field trips in environmental education. PhD dissertation, Department of Education, Universitat Luneburg.

Tippins, D. J., K. G. Tobin, and S. Nichols. 1995. A constructivist approach to change in elementary science teaching and learning. *Research in Science Education* 25 (2): 135–149.

Zeller, N. 1995a. Narrative rationality in educational research. In *Narrative in Teaching, Learning, and Research*, H. McEwan and K. Egan, eds. New York: Teachers College Press.

———. 1995b. Narrative strategies for case reports. In *Life History and Narrative*, J. Amos Hatch and R. Wisniewski, eds. London: Falmer Press.