

An exploration of learners' use of worksheets during a science museum visit

Eunice Nyamupangedengu¹ and Anthony Lelliott²

Marang Centre for Maths and Science Education, School of Education, University of the Witwatersrand, Private Bag 3, Wits, 2050, South Africa

¹eunice.nyamupangedengu@wits.ac.za; ²tony.elliott@wits.ac.za

Abstract

This study shows how worksheets can be used to support learning in an informal learning environment. Although there has been some research into the use of worksheets in museum settings in developed countries, it is still not clear whether worksheets enhance or inhibit learning. Using a case study of grade 4-7 learners visiting a biology exhibition at a university museum in South Africa, the study demonstrates that worksheets can support student learning in the context of the study. Data was collected by audio-recording learners' conversations and directly observing the participants during their visit. Taking a sociocultural view of learning which focuses on the notion of scaffolding, the findings identify five ways in which worksheets can assist students to learn about the biology exhibits: as a guide, for engagement with exhibits and exhibitors, as a prompt to ask questions, to maintain focus and to promote collaboration. The findings further show that the role of the teacher in mediating worksheet use and in briefing the learners is a key influence on how the learners interact with the worksheets and the exhibition. The learners briefed by teachers who allowed a degree of free-choice in visiting exhibits were more collaborative and appeared to have had a more enriching learning experience. The role of exhibitors in relation to the worksheets influenced learners' use of the worksheets. The implications of the findings for museum exhibitors and teachers are also discussed.

Keywords: Worksheet, museum, fieldtrip, informal learning.

Introduction

Research in out-of-school educational settings such as museums¹, science centres, zoos and aquaria has shown that these facilities can expose students to resources outside the classroom that are relevant to the school curriculum thereby supplementing formal education (Mortensen & Smart, 2007). Museums can also enhance students' interest and motivation in science (Jarvis & Pell, 2002; Kisiel, 2006; Mortensen & Smart, 2007). Furthermore, museum visits can result in conceptual gains (Anderson & Lucas, 1997). These and other findings have increasingly popularised museums in many countries over the past decade especially museums which emphasise science and technology (Gilbert & Priest, 1997). In South Africa learning in museums is also gaining popularity as evidenced by the increase in the number of sites of informal learning that not only emphasise science and technology but that also align their resources and activities to the national curriculum. The number of learners visiting these centres is also increasing every year (Damonse, 2008; Malinga, 2007).

¹ The term 'museum' will be used in a broad sense to cover museums, science centres, aquaria, zoos, botanical gardens, planetariums etcetera.

Although museums are becoming increasingly popular in South Africa, school trips to these sites are not often conducted in a manner that could optimise learning (Lelliott, 2009). One way of optimising conditions for learning during museum visits is to ensure that teachers and museum educators use effective instructional strategies during the field trips. A variety of strategies can be used to facilitate learning in informal settings: guided tours, pre- and post-visit activities (Griffin & Symington, 1997), facilitation by teachers or museum educators, and the completion of worksheets by learners (Kisiel, 2006; Rennie & McClafferty, 1995). For the purposes of this study, a worksheet is taken to be a sheet of paper or a booklet that contains problems or tasks that are related to a particular topic for learners to solve (Mortensen & Smart, 2007). The strategy that is mostly used in South African museums is guided tours of school groups by museum educators. Pre- and post-visit activities and facilitation by teachers are seldom used (Malinga, 2007). Some teachers and museums use worksheets but many museums are opposed to the use of worksheets saying they restrict learning. Personal observation of the South African situation suggests that most field trips are characterised by large numbers of learners who are accompanied by chaperones, many of whom are not science teachers. In addition, there is rarely any facilitation or supervision by teachers. Under those circumstances, the use of worksheets may be necessary to ensure that all the learners are exposed to similar and worthwhile learning experiences. Substantial research has been done regarding the use of worksheets during museum fieldtrips. The majority of this research, though, focuses on practice in developed countries. There is a need to look at how worksheets may be used by learners in a developing country context where the fieldtrips are characterised by overcrowding and very low levels of teacher supervision. This was the motivation for this study: to document how South African learners use worksheets during museum visits and to what extent the use of worksheets supports their learning.

Literature on worksheet use during museum fieldtrips

Although worksheet use during museum fieldtrips has been a subject of much research (Krombass & Harms, 2008; McManus, 1985; Mortensen & Smart, 2007), none of this research has been done in South Africa or other developing countries. The available literature on museum learning and worksheet use indicates some of the ways in which learners have been seen to use worksheets, but not how they are used. Some of these ways support learning whilst others are said to restrict it. The various ways of using worksheets that have been identified by researchers as ways that support learning are discussed below.

In McManus' study (1985), comprehensive worksheets were used as 'instructors' for learners. These worksheets were reported to be promoting learning by introducing the concept to be studied, helping learners in locating the exhibits and telling them what to do. Museums in South Africa can make use of this type of comprehensive worksheets in the face of low levels of supervision by teachers. At the British Museum (Natural History), learning was supported by worksheets that, in addition, directed learners to the relevant and salient features of the exhibits themselves (Pollock, 1983). The use of such more structured worksheets at this museum was necessitated by the limited human capacity against the number of learners who were visiting the museum in large organised school groups. This use of the worksheet may be important especially when the logistics of the museum setting or the size of the visiting school groups dictate that learners be broken into smaller groups. Using the worksheet to mediate the museum learning process reportedly ensures that all groups are exposed to similar learning experiences. Krombass & Harms (2008) found that allowing learners to complete worksheets in pairs strengthens their motivation and conceptual understanding. This way, collaboration and hence

meaningful involvement of learners can be promoted by preparing worksheets for use by groups. Some teachers in Griffin & Symington's study (1997) asked their learners to complete worksheets during their museum visits and then collected and marked students' completed worksheets after the visit. When used in this way, the completed worksheet provided evidence of work done by a learner and reflected the learner's understanding of the concepts learnt during the museum visit. Griffin and Symington (1997) note that the information on the completed worksheets can be used by the teacher to clear any misunderstandings that may have arisen during the visit. These data may also be used for post-visit activities, thereby extending the learners' museum learning experiences beyond the museum visit. These are some of the ways worksheets have been used by learners, their teachers and museum educators. While these points make it clear that worksheets can be a useful strategy for facilitating learning during museum fieldtrips, research has also shown that worksheets are sometimes used in a way that restrict learning. The ways of using worksheets that are said to restrict learning are discussed next.

According to Price & Hein (1991) worksheets make students to focus narrowly on the required tasks at the expense of broader observation. Worksheets also control what students have to observe thereby preventing them from making their own choices about the exhibits to visit and the features to consider (Griffin & Symington, 1997). Griffin (1994) observed that the requirement to complete worksheets forced students to search for answers in the displayed text instead of the desired thoughtful derivation of the answers from the exhibits themselves. Students in Bowker's (2002) study were seen walking hastily from one exhibit to another in a bid to answer questions and did not pay attention to anything else. The students became overconcerned with answering and completing the worksheet to the extent that they 'often opted to copy the answer down from friends' (p.129) instead of deriving answers from engaging with the exhibits.

As can be seen from the descriptions above, the use of worksheets can result in planned and intended outcomes thereby facilitating learning but sometimes worksheet use can result in what McManus (1985) described as 'unintended behaviours' (p. 238) which then limit the learning that can be achieved from their use. Despite these unintended behaviours that may result from the use of worksheets, their usefulness as instruments for facilitating learning cannot be dismissed. We therefore decided to further investigate how learners actually use worksheet during museum fieldtrips in the South African context, in this case during a tour of a biology exhibition.

Research questions

The following questions were investigated:

1. How do learners use worksheets to support their learning during the tour of a biology exhibition?
2. What are some of the factors that influence learners to use the worksheets the way they do?

Theoretical framework

The study is situated within Vygotsky's sociocultural theory, with particular reference to learning as a joint activity of a group rather than the activity of one person (Allen, 2002). In order to view the results through a sociocultural lens, we focus on the concept of scaffolding as

a component of Vygotskian theory. A ‘more knowledgeable other’ assists the learner to build on their prior knowledge and extend their learning, which they would be unable to do without mediation (Vygotsky & Cole, 1978). Some of the aspects of scaffolding (such as its temporary nature and its gradual removal, as played out in the classroom) are not possible to observe in a museum situation. Chi (1996) distinguishes between scaffolding and prompting, whereby the latter is a simple request to expand or clarify (“go on”, “what do you mean”) in contrast to the supportive process of scaffolding. The concept of scaffolding has been used in various instructional settings, from the teaching of English (e.g. Walqui, 2006) to mathematics (e.g. Corzo Zambrano & Robles Noriega, 2011). These and other studies have proposed typologies of scaffolding, which are mainly of use in the normal classroom situation. For our context (an out-of-school setting) Brush and Saye’s notion of ‘hard’ and ‘soft’ scaffolding are particularly pertinent. In hard scaffolding, the support is planned in advance and incorporated in a task. In contrast, soft scaffolding involves contextually-specific assistance given by the more knowledgeable other, normally the teacher, in response to how a lesson progresses (Brush and Saye, 2002). Being prepared in advance and provided as printed material, worksheets are best regarded as hard scaffolding in these terms. In our results and discussion we try to demonstrate how knowledge can be co-constructed in a museum with various ‘windows’ for scaffolding by the worksheets, the visitors themselves (teachers and learners) and the exhibitors.

The study approach

The study took a collective case study approach whereby a number of individual studies are carried out to gain a fuller picture (Cohen, Manion, & Morrison, 2000). This approach was chosen in order to find out as much as possible about the use of worksheets during museum visits. Our collective case studies involved 11 groups of learners (cases), and in this article three cases are analysed which portray some of the ways worksheets are used by learners.

Methods used to collect data

Data collection involved audio recording of learner conversations and observing them as they were touring the museum. The combination of both methods helped us to capture tangible evidence of how worksheets are used and gave us clues as to why learners use worksheets in a particular way. The observations were accompanied by detailed notes which included an indication of the exhibits that each group visited and a description of the observable behaviour of the group members as they were moving through the museum. The observation of learners was done to complement and capture that which would not be audio recorded.

Museum and exhibition

The Oppenheimer Life Sciences Museum (OLSM) was chosen for the study. The OLSM is located at the school of Animal Plant and Environmental Sciences (APES), Faculty of Science in the University of the Witwatersrand. The OLSM was chosen because it holds a temporary four to six day biology exhibition in September or October of every year and the majority of the visitors during that exhibition are school groups. The museum prepares worksheets for use by learners during the exhibition. The OLSM exhibition is called *Yebo Gogga Yebo Amablomo* which means ‘Hello [animal/virus/bacteria], hello plant’. This temporary annual exhibition is organised by the OLSM curator and undergraduate students at APES, in collaboration with invited exhibitors. It focuses on the complex interactions that occur in the natural world and the impact of humans on these interactions. The main objective of the exhibition is to engage and educate the public, particularly school learners, about animals and plants and their context

within biology. Schools and the general public are invited to attend the exhibition free of charge. Each year the exhibition adopts a specific theme, which, in 2008, was 'Defence'. The goal of the exhibition was to make the public aware of the strategies plants and animals use to survive in their habitats and the impact of humans on those habitats. There were over 30 stands or exhibits on display but the worksheet was based on only 20 of these exhibits. The stands that were visited most by learners, and from which data was collected for this study, are as follows (the title of each exhibit is in brackets):

1. **The Recycle stand** which had bins labelled paper, plastic, tins and unrecyclable material, and a big picture of a dumpsite full of bottles (Make haste reduce waste).
2. **A Vermiculture stand** with a worm bin full of castings and earthworms (Underground defenders).
3. **Botanical garden stand** with plants (Green defenders for all)
4. **Mosquitoes and malaria stand** (The moz squad)
5. **Palaeontology stand** showing fossils and some skeletons (No title for this stand)
6. **Birds stand** with pictures of a variety of birds but no live birds (Defenders of the skies)
7. **Beekeeping stand** with bees in their beehives (Bee-ing social).

At each stand, exhibitors explained their exhibitions to the visitors, answered questions and helped learners to answer worksheet questions. The exhibitors were final year students from APES, people from exhibiting institutions and individuals who were exhibiting their activities that were aligned with the theme of the exhibition.

Each school group was welcomed by a tour guide at the entrance to the museum who would then take them through the exhibition. On arriving at an exhibit, the exhibitor would introduce his/her exhibit and then wait to answer any questions that learners would ask in connection with the exhibit. Sometimes learners would ask their own questions but most of the time they asked worksheet questions.

OLSM worksheets

Worksheets at OLSM are generated by undergraduate students in the School of APES. The students obtain questions from the exhibitors and then compile them into worksheets prepared for learners in the Foundation phase (grades 0 to 3), Intermediate phase (grades 4 to 6), Senior phase (grades 7 to 9) and in the Further Education and Training phase (FET) - grades 10 to 12.

The exhibition worksheets

The worksheet for intermediate learners (Figure 1) is presented as an exemplar. It shows that worksheets contained some features that were intended to facilitate learning: tasks that connected to classroom topics and were pitched at Bloom's knowledge and comprehension levels of the cognitive domain which are suitable target levels in time limited situations (Green & Rollnick, 2007). The worksheet also contained features that may impact negatively on the museum experience in terms of Kisiel's categorisation of worksheet features (Kisiel, 2003). The worksheet had:

- a high task density (a total of 43 questions which required learners to visit 20 displays);
- an absence of orientation cues (learners had to move around looking for the exhibits of their choice);

- a large number of text-dependent tasks (the worksheet had very few questions that focused learners on the objects of the exhibits. Instead, text, prior knowledge and exhibitors were the anticipated sources of information for the majority of questions);
- exclusively tasks requiring answers in the written format (all 43 questions in the worksheet required learners to write down their answers, with no other forms of responses like drawing or discussion); and
- a limited number of tasks promoting social interaction (Mortensen & Smart, 2007).






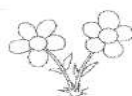
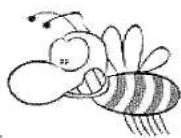
<p>1. Make Haste Reduce Waste</p> <p>a) Why do we recycle?</p> <p>_____</p> <p>_____</p> <p>b) What can we use Organic Rubbish for?</p> <p>_____</p> <p>_____</p>  <p>2. Underground defenders</p> <p>a) How do earthworms improve our soil?</p> <p>_____</p> <p>_____</p> 	<p>3. SA Roachman</p> <p>a) What spends more time washing itself daily - a cockroach or a cat?</p> <p>_____</p> <p>_____</p> <p>4. Defending our Heritage</p> <p>a) What would happen to you if a conservation defender found a huge Jacaranda tree in your garden at home?</p> <p>_____</p> <p>_____</p> 
<p>5. Defenders of water, our most precious resource</p> <p>a) How can you check whether your toilet has a silent leak?</p>  <p>_____</p> <p>_____</p> <p>_____</p> <p>6. Saving Biodiversity for Future Generations</p> <p>a) How many estimated dung beetles species are there in South Africa?</p> <p>_____</p> <p>b) How big is the largest dung beetle?</p> <p>_____</p> <p>c) How small is the smallest dung beetle?</p> <p>_____</p> 	<p>7. Green Defenders for All</p> <p>a) Why do plants have green leaves?</p> <p>_____</p> <p>_____</p> <p>b) Where do plants get their energy from?</p>  <p>_____</p> <p>_____</p> <p>8. Bee-ing Social</p> <p>a) What do bees make?</p> <p>_____</p> <p>b) Where do bees live?</p> <p>_____</p> <p>c) What sex of bees live there?</p> <p>_____</p> <p>d) What else may live with them and may harm them?</p> 

Figure 1: A section of the intermediate phase worksheet

The research sample

The research sample was a convenience sample of 11 schools (8 primary and 3 high schools) that had booked for the exhibition. School Heads of these schools were contacted via e-mail to ask for their permission to involve their students in our study. Seven schools granted this permission. Information sheets ensuring confidentiality and disclosing all aspects of our research as well as consent forms were then sent to these schools for learners' consent (and parental consent) to read and sign if they were willing to participate in the study.

Data collection

Worksheets were given to all learners by museum staff at the entrance of the museum just before the tour of the museum but completion of the worksheets was entirely up to the teacher and/or the learners. For each school whose learner conversations were recorded, the following steps were followed. The researcher approached the teachers and introduced herself. The teachers would pick one learner from among those whose consent forms had been signed. The researcher would then put a recorder in the learners' pockets or under the uniform out of the learners' sight, switch it on and set it on the non-switching-off mode. A microphone would then be connected to the recorder and pinned to the collar area near the mouth of the learner. The microphone was used so that the audio sound from the learners could be amplified for clearer recordings. After completion of the above set up, the researcher would move away and follow the learners at a distance. In some cases the learners and their teacher would move as one big group. In most cases however, learners split into small friendship groups and toured the museum on their own. The researcher would focus on the learners with the recorders or their groups unobtrusively throughout the tour and make detailed field notes. Each school spent at least one hour in the museum.

Data analysis

The audio-recorded conversations were transcribed. After transcribing, the conversations were qualitatively analysed for evidence of instances of learning through scaffolding of the different types, or missed chances of learning through scaffolding. The analysis protocol was a group-by-group qualitative description of each group's tour of the exhibition. Observation notes were used to describe each group's conduct of the museum tour stating how the worksheet was used. The descriptions provided information about the groups' overall activities and movement through the museum. Our fundamental goal was to highlight how learners were using the worksheets and also to draw attention to evidence of scaffolding in the transcribed conversations. Our descriptions therefore brought to light these interesting issues: evidence of learning through scaffolding and how learners were using worksheets. Excerpts from conversations were used as supporting evidence.

Results

We use the following **Key** in this section:

- **WSQ**- worksheet question
- **E**- exhibitor
- **L**- learner

- **Tr-** teacher
- **[comments]**- Comments in square brackets are researcher's comments.

Although 11 groups were observed, the data of only three groups are reported here. These groups portray the different ways worksheets were used and the roles their teachers and the exhibitors played in determining how worksheets were used.

Table 1: An overview of the groups

Group name	Grade	Group size and gender	Stands visited
Group 1	4	2 boys 1 girl	palaeontology, the botanical garden, malaria
Group 2	6	2 boys 1 girl	The recycle stand, vermiculture, palaeontology, birds, The botanical garden
Group 3	7	3 girls	Bees, birds, the recycling stand

Group 1

The teacher's instruction at the beginning of the tour after the learners had been handed the worksheets was that the learners were free to explore the museum on their own or they could move with the teacher and the tour guide. The learners were not to complete the worksheet during the tour but rather just write short notes that would help them to complete the worksheet when they got back to school. Group 1 visited the first two stands together with the teacher and the rest of the learners, then started moving on their own briskly from one exhibit to another, glancing at displays without engaging with the exhibits. Then at some point one member of the group (L3 below) realised that they were not gathering any information for use back at school and reminded the others about it. The group was at the Botanical garden stand where a variety of medicinal plants were on display

- L2: We have to try that thing that clears mouth infection.
- L1: You are not supposed to eat. Look. It says 'a tea made up of mint oil inhaling the vapours when steamed in boiling water or added to the bath water'. [Reads label]
- L2: That means you have to put it in hot water or a bath or smell the steam in it not eat it. [Interprets label]
- L3: Must we write the answer?
- L1: Let me memorise it.
- L3: How are we gonna complete the worksheet if we do not write the notes?

The implication of L3's utterance is that if the learners were not expected to complete the worksheet back at school they would have continued with their adventure type of touring without looking at anything in particular. Reference to worksheet completion was therefore used by L3 to prompt other members of the group to be more attentive to their observations. L1 and L2 read and interpret the exhibit labels. In doing so, they took on the role of 'more knowledgeable peers' (Le, 2003) and assisted in scaffolding the discussion. According to our framework this is soft scaffolding in that it is being effected in context, as the learning experience unfolds.

As the group was going to the Malaria stand, they met their teacher who reminded them that for them to be able to do the worksheets back at school, they were supposed to ask the exhibitors the worksheet questions then write some notes or just fill in one word that would remind them of the answers. The teacher's comments had an immediate influence on how the learners

subsequently used the worksheets. The worksheet questions were used to direct them to the specific information they should look for as they interacted with the exhibits and the exhibitors. In the following extract, the exhibitor takes on the role of the ‘more knowledgeable other’, so that both the worksheet and the exhibitor provide scaffolding, of the hard and soft variety respectively.

- L1: [to the exhibitor] What’s Malaria? [WSQ]
E: Malaria is a disease that is caused by mosquito bites. Yah. [Note here that the exhibitor’s answer is incorrect]
E: Symptoms of malaria? [WSQ]
L1: It’s what happens to you when you get malaria-that’s symptoms
L2: [searches for the symptoms in the text on display; this is a missed opportunity where the exhibitor could have provided soft scaffolds for the learners]
L1: Its not there, it’s not there. I read through it.
E: You can watch the video to get the answers.

The teacher’s reminder also seems to have prompted learners to explore the exhibits more intensely, even beyond the worksheet questions.

- L2: Oh! Oh! Oh! Read this , ‘all 80-90% of cases occur in South Africa’ . [i.e. malaria cases]
L1: Africa, not South Africa. [L1 corrects L2]
L1: What does that say? [L1 pointing to a label in the displayed text]
E: Plasmodium.
L1: What does that mean?
E: It’s a parasite that causes malaria.
L1: Ok, Ok.

The influence of the teacher on how worksheets were used by learners is also reflected in the excerpt below.

- L1: Yah, cool. ‘500 million cases’. Wow! [At this point L3 was busy writing the answer and did not respond to what L1 was saying so L1 had this to say:
L1: We are not allowed to write the answers now; just the words.

According to L1, the teacher’s instruction that they weren’t to write answers to worksheet questions at the museum had to be upheld. There was some significant engagement with the exhibits by this group of learners after their teacher reiterated that learners were to refer to worksheet questions in their interaction with the exhibits and the museum exhibitors, which contrasts with L1’s initial inclination to memorise facts. This observation shows that the use of a worksheet during museum visits can encourage learners to *engage* with the exhibits, and helps to scaffold the interaction.

Group 2

The teacher accompanying these learners told them that they were expected to fill in the worksheet. She however made it clear that they should not be too anxious about completing the whole worksheet. They should move freely at their own pace and only refer to the worksheet when they got to those exhibits that had questions put in the worksheet. By saying this, the teacher intended to prevent a situation whereby completion of the worksheet would dominate the museum experience. This group, on reaching an exhibit, initiated the discussion by asking the exhibitor the worksheet question.

At the recycle stand

- L1: Is this the recycling session?
E: Yes it is
L1: **Why do we recycle? (WSQ)**
E: You tell me. Why do we recycle? [*E throws the question back to the learners – a prompt*]

A discussion then followed between the learners and the exhibitor

- L1: Because to save the environment
E: How do you save the environment by recycling? [*E probes the learner further, an example of soft scaffolding*]
L1: Because, like if you don't; ok it's like, I don't know how to explain, its pollution right ok ok you can explain [*L1 tries to explain but fails and passes over to L2*]
L2: You can save the planet by re-using bottles and you can re-use the leftover food as manure for your garden. You can stop polluting the seas; yah. [*L2 explains*]
E: Now tell me something. What happens at the dumpsite when the dump gets too full? [*further probing*]

As can be seen above, the response from the exhibitor was not a straight answer to the worksheet question but was a combination of question probes and explanations which resulted in learners engaging in discussions beyond the worksheet question. This also shows that when exhibitors use scaffolding question techniques, a worksheet can facilitate learning. The discussion continued:

- L1: To the sea [*L1 answers the question*].
E: So what is going to happen to this bottle when it gets to the sea? Floats, Floats, Floats forever and ever and ever until some sea animal decides to swallow it. That's how the dump damages the environment.
L1: oh
E: Because the bottle will never be broken down. It's plastic. Let me show you something. Come, come over to this side
L1: This is nice [*Learner showing enjoyment of the tour*]
E: Can you see this number? [*E pointing at a number written at the bottom of a plastic bottle*]. This number tells you how long it takes for this bottle to biodegrade. Do you know what biodegrade mean?
L1: Yes, how long it takes to breakdown
E: So can you imagine all this rubbish taking that long to biodegrade.
[Silence]
E: Cool. So are you guys satisfied?
L1: Almost
L2: Another question; what can we use organic rubbish for? (WSQ)

And so the discussion continued until the learners were satisfied.

- L1: Ok. Thank you [*This thank you remark closed the conversation. A remark like this signifies or suggests satisfaction of the learner's needs and curiosity (Gilbert & Priest, 1997)*].

The worksheet had facilitated social interaction between the exhibitor and the learners. The exhibitor prompted the learners (“you tell me”), and then went on to provide didactic explanation (in discussing the bottles), as well as soft scaffolding in the form of probes (e.g. “how do you ..?”) and suggestive feedback (in discussing biodegradation) (Chi, 1996). A similar interaction and way of using worksheets was also observed at the vermiculture stand.

At the evolution stand.

Here we noted learners departing from the worksheet questions:

- L3: Is that a skeleton?
- E: No. That's a chimpanzee [*The exhibit on display was a chimpanzee skeleton*]
- L1: There is no question on skeletons so let's just look around.
- L3: Is this real [*Now pointing at a human skeleton*]
- E: Yes it is real
- L1: That's the stuff about evolution. My mom is actually teaching about evolution. [*Connection to prior experiences*]

Because learners were not anxious about worksheet completion, they took their time participating at each exhibit by asking their own questions and in some cases interacting with the actual exhibits and exhibitors. The learners were relaxed, not over-concerned with the completion of the worksheet. Unlike learners in Griffin's study (1994), the completion of the worksheet did not prevent group 2 learners from free exploration and making their own choices. On reaching those exhibits without any worksheet questions, the learners did not skip them.

The worksheet was not dominating the learners' museum experience and this can be attributed to the teacher's instructions at the beginning of the museum tour:

- Tr: You have enough time to look at the exhibits and to fill in the worksheets. Don't worry about completing the whole worksheet. Just fill it in as you go and enjoy.

The observations with this group, just like with group 1, highlights the central role of the teacher in influencing the way worksheets are used by learners. The relaxed and unhurried interaction of group 2 learners with the exhibits and the exhibitors was likely a result of the way the teacher had handled the tour: making it clear to the learners that they had time to freely explore the exhibits and to complete the worksheets as they were going about the tour.

Group 2 learners also viewed their worksheet completion as a joint venture and this steered them to work together collaboratively to complete the worksheets.

- L1: **Why do plants have green leaves? (WSQ).**
- L2: They never told us
- L1: I know. So that they can attract food and sunlight from the sun
- L2: No not food just sunlight [*L2 corrects L1*]
- L1: Yah. So that they can attract sunlight [*L1 concurs*].

The excerpt above reflects that learners were building on each other's knowledge and understanding of the concept in question. The joint venture approach to worksheet completion promoted soft scaffolding by peers and hence learning.

Group 3

The teacher accompanying this group told the learners that they were to complete the worksheet and that they only had two hours to do that. Although two hours could have been enough time for learners to complete their worksheets, the way the teacher conveyed the instruction to the learners made them to be frantic. This group therefore focused on the business of completing their worksheets and nothing else. They used the worksheet to choose the exhibit to visit, and would run around looking for that exhibit. After finding the exhibit they would read the worksheet question to each other, figure out the answer using the text on display or from previous knowledge, and then fill in the worksheet. The learners chose to go to the bee stand first.

- L1: Let's go to the bees
- L2 and 3: Ok.
- L1 [At the bee stand] There are so many bees.
- L1: Ok. What type of cells do the mites infect? (WSQ)**
- L2: I don't know. Is it maybe this? [Pointing to some small organisms on displayed poster]
- L3: No. That's the mites.
- L1: Guys. Let's look here [Pointing out to some feature on the poster]
- L2: I can't see.
- L3: Attackers. Look here. Look here, I found it. 'Honey bee attackers-verroa mites. The mites attack the body's drone cells'.
- L1: Ok, then, **what is the name of the disease? (WSQ)**
- L3: The mites cause the disease ----[not audible].
- L1: **Name two additional hosts (WSQ)**
- L3: Bumble bee and --- [inaudible]
- L1: So guys two additional hosts that mites are the main pest.
- L3: I think the bumble bee—it's here, it's here --- additional hosts. So it's a bumble bee and skyrol beetle.

From the bee stand group 3 learners went to the birds stand then the recycling stand. Their discussions were guided by the worksheet questions, which can be regarded as a form of hard scaffolding. Although they worked collaboratively as a group (reading out the worksheet questions and searching for answers in the displayed text) the completion of worksheets excluded everything else, and no examples of soft scaffolding were noted in their interactions. They did appear to learn and they observed many things but these things were completely dictated by the questions in the worksheets.

Discussion

This study revealed a number of ways learners use worksheets during a museum field trip. First, learners use worksheets to inform themselves about the kind of exhibits that are on display. The worksheet acts as a form of 'hard scaffold' to learners (and their teachers), guiding them through the exhibition to the exhibits of their choice. Secondly, worksheets as hard scaffolding tools appear to encourage learning when combined with soft scaffolding by exhibitors and peers as in group 1 and particularly in group 2; by directing worksheet questions at the exhibitors, learners prompt exhibitors for information thereby learning a lot about the exhibits from the exhibitors, who take the role of the 'knowledgeable other', providing soft scaffolding support. Thirdly, if no additional soft scaffolding is achieved in the use of worksheets, the learning they encourage remains at the level of knowledge (getting the answers) rather than understanding; this was particularly true in the case of group 3. Fourthly, the ways worksheets are used by learners, (including if soft scaffolding is invited or not) are determined largely by the instructions for worksheet use issued by the teacher, less so by the format of the worksheets themselves. The teacher for group 1 told her learners to write brief notes for completing the worksheet back at school. Her learners moved briskly from one exhibit to another without focussing on anything in particular until she had intervened and explained further that the learners had to ask worksheet questions to the exhibitors, then write some notes. Group 2 learners were assured that they had enough time for completing the worksheet and for free exploration. This group completed the worksheet in an unhurried manner combining the completion of their worksheets with free exploration. However, in group 3, the instruction by the teacher that the learners had two hours only to complete the worksheet seems to have implied that there was no time to study other things. Throughout the tour, these learners focused only on exhibits that pertained to worksheet

tasks resulting in the exclusion of everything else. Fourthly, the use of worksheets helps learners to remain focussed even in overcrowded conditions, and lastly, the use of worksheets encourages group work and collaboration as learners do not answer the worksheet questions individually. They read the worksheet questions to each other and interpret labels, thereby acting as more knowledgeable peers, and so work together in groups to complete the worksheets. They thus mediate each other's learning in a Vygotskian sense, i.e. facilitating the provision of soft scaffolding by peers.

This study also showed the key scaffolding role that exhibitors can play in facilitating and co-constructing knowledge with the learners during the museum visit. When worksheet questions were directed to the exhibitors, it encouraged them to prompt and probe learners to think about the answer. In groups 1 and 2 the thinking went beyond the worksheet answer, to what is actually happening in the environment, and provides some evidence that the exhibition may have an influence in the learners' own lives.

Conclusion and implications

Learners at the Yebo Gogga exhibition used worksheets in different ways. Some learners used the worksheets in moderation combining completion of worksheets with free exploration. Other learners exclusively focused on completion of worksheets visiting only those exhibits that pertained to worksheet questions. Still others used worksheets for orientation purposes, guiding their movement through the museum and their choice of exhibits to visit. The way different learner groups used worksheets appeared to have been influenced by the teachers' instructions at the beginning of the tour and the presence of exhibitors at the exhibits. These findings show that teachers and worksheets play an important role in promoting learning during museum fieldtrips. Teachers need to give their learners clear instructions on how to go about the tour of the museum and also a clear outline of the agenda for the day. The instructions should include a clear indication of how the worksheets should be used, the time available for completing the worksheets and for tea and lunch breaks. Giving learners a clear agenda and proper instructions promotes effective use of worksheets thereby bringing about a worthwhile museum learning experience. The worksheet itself can be designed with scaffolding visitor thinking in mind: it needs to be structured in such a way that it promotes learning by promoting social interaction, focussing learners on exhibits and features of the exhibits that fulfil the aims of the visit and by allowing some free time for learners to pursue their own interests. It may also help to consult with school teachers on how worksheet tasks can be integrated with classroom teaching. With regards to exhibitors, it may help to encourage or perhaps train them to help school students learn when they visit their stands during an exhibition.

References

- Allen, S. (2002). Looking for Learning in Visitor Talk: A Methodological Exploration. In G. Leinhardt, K. Crowley & K. Knutson (Eds.), *Learning Conversations in Museums* (pp. 259-303). Mahwah, New Jersey: Erlbaum.
- Anderson, D., & Lucas, K. B. (1997). The effectiveness of orienting students to the physical features of a science museum prior to visitation. *Research in Science Education*, 27(4), 485-495.
- Bowker, R. (2002). Evaluating teaching and learning strategies at the Eden project. *Evaluation and Research in Science Education*, 16(3), 123-135.

- Brush, T., & Saye, J. W. (2002). A summary of research exploring hard and soft scaffolding for teachers and students using a multimedia supported learning environment. *The Journal of Interactive Online Learning*, 1(2), 1-12.
- Chi, M. T. H. (1996). Constructing self-explanations and scaffolded explanations in tutoring. *Applied Cognitive Psychology*, 10(7), 33-49.
- Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in Education*. London: RoutledgeFalmer.
- Corzo Zambrano, X.P., & Robles Noriega, H.S. (2011). Approaches to scaffolding in teaching mathematics in English with primary school students in Colombia. *Latin American Journal of Content & Language Integrated Learning*, 4(2), 13-20.
- Damonsse, J. (2008). *Science centre management-Can South Africa meet the development goals*. Paper presented at the Annual SAASTEC conference, Sci-bono Discovery Centre Johannesburg.
- Gilbert, J., & Priest, M. (1997). Models of discourse: A primary school science class visit to a museum. *Science Education*, 81, 749-762.
- Green, G., & Rollnick, M. (2007). Let's stop complaining about low cognitive levels of testing in time-limited examinations: The case for fair testing practices. *South African Journal of Higher Education*, 21(2), 255-266.
- Griffin, J. (1994). Learning to learn in informal science settings. *Research in Science Education*, 24, 121-128.
- Griffin, J., & Symington, D. (1997). Moving from task-oriented to learning-oriented strategies on school excursions to museums. *Science Education*, 87, 763-779.
- Jarvis, T., & Pell, A. (2002). Effect of the challenger experience on elementary children's attitudes to science. *Journal of Research in Science Teaching*, 39(10), 979-1000.
- Kisiel, J. (2003). Teachers, Museums and Worksheets: A Closer Look at a Learning Experience. *Journal of Science Teacher Education*, 14(1), 3-21.
- Kisiel, J. (2006). An Examination of Fieldtrip Strategies and their Implementation within a Natural History Museum. *Science Education*, 90, 434-452.
- Krombass, A., & Harms, U. (2008). Acquiring knowledge about biodiversity in a museum-are worksheets effective. *Journal of Biological Education*, 42(4), 157-163.
- Le, H. (2003). *What Does a More Knowledgeable Peer Mean? A Socio-cultural Analysis of Group Interaction in a Vietnamese Classroom*. Paper presented at the NZARE/AARE Joint Conference Auckland, New Zealand. 29 Nov-3 Dec, 2003.
- Lelliott, A. D. (2009). *Teacher practices during science school visit in Gauteng*. Paper presented at the Proceedings of the 17th Annual SAARMSTE conference, Grahamstown.
- Malinga, C. (2007). *The Sci Bono Discovery Centre*. Paper presented at the Science Awareness, Informal Learning and Schools (SAILS) Research Thrust symposium "What role does informal learning play in science education?", Marang Wits Centre for Mathematics and Science Education, 21 September 2007.
- McManus, P. (1985). Worksheet induced behaviour in the British museum (Natural History). *Journal of Biological Education*, 19(3), 237-242.

- Mortensen, M. F., & Smart, K. (2007). Free-choice worksheets increase students' exposure to curriculum during museum visits. *Journal of Research in Science Teaching*, 44(9), 1389-1414.
- Pollock, S. (1983). An inside view of education at the Natural History museum in London. *Journal of Biological Education*, 17(2), 119-122.
- Price, S., & Hein, G. (1991). More than a fieldtrip: science programmes for elementary school groups at museums. *International Journal of Science Education*, 13, 505-519
- Rennie, L., & McClafferty, T. (1995). Using visits to interactive science and technology centers, museums, aquaria and zoos to promote learning in science. *Journal of Science Teacher Education*, 6(4), 175-185.
- Vygotsky, L. S., & Cole, M. (1978). *Mind in Society: the development of higher psychological processes*. Cambridge: Harvard University Press.
- Walqui, A. (2006). Scaffolding instruction for English language learners: A conceptual framework. *The International Journal of Bilingual Education and Bilingualism*, 9(2), 159-180.