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Worksheets and learning in South African museums

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Worksheets and learning in South African Museums

Eunice Nyamupangedengu

A research report submitted to the Faculty of Science, University of the Witwatersrand, Johannesburg, in partial fulfillment of the requirements of the degree of Master of Science.

Johannesburg 2009

Abstract

The use of worksheets during museum field trips is shrouded in controversy. Some researchers say that worksheets are useful as they facilitate learning while others condemn the use of worksheets arguing that they restrict learning. Still others say there is no apparent difference in learning between learners who are given worksheets and those that are not. A critical analysis of the literature on museum learning shows that the usefulness of a worksheet depends on how appropriately the worksheet has been designed and used as an instrument for facilitating learning during museum field trips. I analysed and evaluated museum worksheets in the Gauteng Province of South Africa for appropriateness as instruments for facilitating learning during field trips. I also conducted a case study at Oppenheimer Life Sciences Museum. This was to investigate the extent to which the worksheets that are used at this museum during the Yebo Gogga annual exhibition promote learning during a museum field trip.

I designed an analysis tool using the characteristics of a worksheet that have been shown to impact on learning during museum visits: task density, orientation cues, information source, level of choice, cognitive level, response format, question format, curriculum connection, site specificity and social interaction. I then used the tool to analyse nineteen intermediate phase (grade 4 to 6) worksheets from four museums. I further conducted a case study with 11 groups of learners from four primary and two high schools in Gauteng. The case study involved observing the learners and recording their conversations. Learners' conversations that were initiated by the use of worksheets were examined for evidence of learning.

Analysis of the structured worksheets showed that the worksheets exhibited some features that were likely to facilitate learning and some that were likely to restrict it. The worksheets also lacked some features that are necessary for effective facilitation of learning. These findings suggest that the worksheets were not optimally designed to facilitate learning during museum field trips.

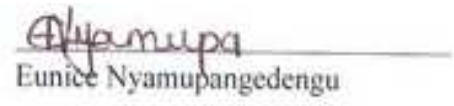
In the case study, the observations showed that some learners used the worksheets in moderation by combining completion of worksheets with free exploration. Other learners exclusively focused on completion of worksheets visiting only those exhibits that pertained to worksheet questions. Still others used worksheets for orientating themselves. The worksheets guided 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 what their teachers said at the beginning of the tour suggesting that the teachers or chaperones played an important role in determining how worksheets were used by learners to support their learning. Analysis of conversations indicated that there was meaningful and active participation by the learners who were using worksheets which shows that the use of worksheets promoted learning.

In view of these findings, I concluded that the usefulness of worksheets as instruments for facilitating learning can not be dismissed. However, a constant critical appraisal of worksheet use is necessary to improve their effectiveness.

Declaration

I declare that this research report is my own unaided work. It is submitted for the degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.



Eunice Nyamupangedengu

Dedication

To Cuthy, Kuda and Ruva

Acknowledgements

My grateful thanks go to the following:

- My supervisor Doctor Anthony Douglas Lelliott for his constructive criticism and support throughout this project.
- The Museums (names not mentioned here for confidentiality reasons) for allowing me to analyse their worksheets.
- The Oppenheimer Life Sciences Museum Curator Dr Caroline Crump for the permission to use the Yebo Gogga exhibition.
- Mrs Cheryl Dehning for helping me with the details of the Yebo Gogga exhibition.
- The staff and learners of the schools who participated in the study.
- My husband Cuthbert for his unwavering support and encouragement that sustained me to the end and also for proof reading my penultimate draft.
- My children Kuda and Ruva who suffered my withdrawal from their lives during this period of study.
- My cousin Gladys Mapanzure who agreed to take care of my children during this period of study.
- My colleague, Doctor Fhatuwani Mundalamo for proof-reading and helpful comments.
- My friends Gwandures, Chikumbas, Magidis and Matutus for their prayers and encouragement especially Sarah for her slogan “It’s possible, it has to be possible.” It kept me going.
- My parents who have always inspired me to work hard through their own hard work of raising us.

Finally, I thank **The Almighty God** for the strength and the wisdom to complete this research report.

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Chapter one

An introduction to the problem

1.1 Introduction

Research in out-of-school educational settings such as museums[1], science centres, zoos, aquaria and other institutions has shown that these institutions are important educational resources (DeWitt & Osborne, 2007; Tal, Bamberger, & Morag, 2005). According to Mortensen and Smart (2007), these facilities can supplement formal education by exposing students to resources outside the classroom that are relevant to the school curriculum. Museums can also enhance students' interest and motivation in science (Mortensen & Smart, 2007; Kisiel, 2006; Jarvis & Pell, 2002). Furthermore, museum visits can result in conceptual and cognitive 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). Interest, motivation and conceptual understanding are important aspects in the learning of science. If museums can develop these aspects in learners as claimed by the researchers mentioned above, it is necessary to make sure that schools and teachers make effective use of these institutions.

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). 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). It has therefore become essential to make sure that learners who visit museums are provided with optimal conditions for learning during the visits. One way of achieving this is to ensure that teachers and museum educators use effective instructional strategies during the field trips. Research in museums has shown that a variety of strategies can be used to facilitate learning in informal settings such as making students complete worksheets, take notes, join guided tours, attend presentations by museum staff, discuss, or answer verbal questions (Kisiel,

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

2006; Rennie & McClafferty, 1995). The focus of this study is on the use of one of these strategies: the completion of a worksheet. To what extent are the worksheets effective as an instructional strategy in promoting learning during field trips?

1.2 Background and rationale for the study

The presence of a wide range of resources in South African museums that are relevant to many topics in the school curriculum has made the museums increasingly popular and attractive to schools. Museum resources that are aligned to the school curriculum can be of potentially great educational value especially when one considers that many South African schools have a shortage of resources (Department of Education (DOE), 2001). It is however important to note that quality learning is not a result of the availability of resources only, it is a combination of material resource availability and quality instruction. Therefore it's not enough that museums have resources of great educational value, but teachers and museum educators must also have the ability to fruitfully make use of them in their teaching. There is therefore a challenge upon teachers and museum educators: how to realize and utilize the potential of museums to improve the quality of learning that the learner can achieve during field trips (Gilbert & Priest, 1997). As mentioned earlier, a variety of instructional strategies can be used to facilitate learning during field trips and among them is the completion of worksheets.

A survey of the literature (see chapter 2), shows that there are conflicting opinions on the role and usefulness of worksheets among researchers and students in informal education. Some researchers say that worksheets are useful and support learning (Kisiel, 2006, 2003; Rennie & McClafferty,1995; McManus, 1985) while others have condemned the use of worksheets arguing that they are problematic and restrict learning (Griffin, 1994, Price & Hein, 1991). Still others say there is no apparent difference in learning between children who are given worksheets and those that are not (Rix & McSorley, 1999). A critical analysis of the cited literature reveals that the researchers who are in favour of worksheets do acknowledge that their usefulness depends on how the worksheets are designed and utilised and those researchers who are against worksheets seem to be blaming the tool (the worksheet) instead of poor workmanship (poor design and wrong use of worksheets); this is because their conclusions are based on how the worksheets have been used by teachers, museum educators and students. Despite this controversy, teachers and museum educators still use worksheets

(Durbin, 1999; personal observation). It is therefore worth further investigating the use of worksheets with the aim of finding ways of making them more effective.

1.3 Statement of the problem

When one considers the South African environment where many field trips are characterised by large numbers of learners who are then divided into small groups accompanied by different chaperones (some of whom will not be science teachers), worksheets are important to ensure that all the learners are exposed to similar experiences. Furthermore, many learners could be visiting the museum for the first time and would therefore not be familiar with the museum environment. Worksheets can then provide the guidance and the mediation that is required in the unfamiliar environment. It follows therefore that although worksheets may be problematic they are however necessary where there are no alternative strategies. The use of worksheets cannot therefore be dismissed. It is however necessary to ensure that the worksheets are designed and used in a way that maximises learning. This was the source of my motivation for this study which sought to identify the features of a worksheet that have been recommended in literature as likely to support learning. The identification and consolidation of features of worksheets that promote learning will provide important knowledge for both teachers and museum educators who could then use this knowledge to construct and use worksheets in a way that facilitates learning. Furthermore, research on how worksheets are used by learners and teachers, and the extent to which worksheets promote learning can help the teachers and museum educators to make informed choices on which strategies to use during museum field trips.

1.4 Aims of the study and Research Questions

The aims of the study were (a) to analyse the worksheets that are used at various museums in the Gauteng province of South Africa for appropriateness as instruments for facilitating learning during museum field trips and (b) to evaluate (as a case study), the extent to which the worksheets that are used at Oppenheimer Life Sciences Museum (OLSM) promote learning during a museum field trip. The study sought to answer the following research questions:

1. How appropriate are the worksheets used at various museums in Gauteng as instruments for facilitating learning during museum visits?

2. How are worksheets used by school groups during the tour of a biology exhibition at the Oppenheimer Life Sciences Museums (OLSM)?

3. To what extent are the worksheets at the OLSM effective in facilitating learning during a school visit?

1.5 Conceptual framework for the study

In this study, the Contextual Model of Learning (Falk and Dierking, 2000) was used as a framework in the development of the worksheet analysing instrument and in the analysis of worksheets. In the Contextual Model of Learning (CML), Falk and Dierking described learning as influenced by the interaction among three different contexts: the physical, the social and the personal. Vygotsky's socio-cultural theory of learning (Vygotsky, 1978) was used to guide the collection and analysis of data in the second phase of my study. Socio-cultural theory was chosen on the basis that learning in museum has been shown to be social in nature. Furthermore, the theory focuses on learning as a process rather than a product, a joint activity of a group rather than the activity of one person (Allen, 2002). The CML within two of its contextual domains: the physical and the personal contexts, incorporates two important components of Ausubel's theory of meaningful learning, that of advance organisers and prior knowledge (Novak, 1977). Ausubel's theory of meaningful learning was therefore also incorporated into my theoretical frameworks. These frameworks are discussed in chapter 2.

1.6 Purpose of the study

Some teachers and museum educators make use of worksheets to facilitate learning during museum fieldtrips. These worksheets are however not always constructed and used in a way that promotes learning during fieldtrips. The identification and consolidation of features of worksheets that promote learning will provide important knowledge for both teachers and museum educators who could then use this knowledge to construct and use worksheets in a way that facilitates learning.

During and after this study, workshops and presentations at conferences can be done to make the players in the field of museum learning aware of the research findings. The presentations will focus on providing findings that are expected to help museum educators and teachers to become more aware of the characteristics of an effective worksheet which in turn may help

them to make better use of museums. The latter are becoming increasingly important in South Africa where many schools are experiencing a severe shortage of classroom resources (DOE, 2001).

1.7 Delineation of the study

Many strategies can be used to facilitate learning during field trips to museums. All these strategies could have been explored in order to identify good practices about museum learning. However, in order to limit the scope of the study, only one strategy, the completion of worksheets during museum field trips was studied. The study was carried out in two phases. Phase one was analysis of worksheets and phase two a case study of worksheets in use.

1.8 Organisation of the research report

This research report has six chapters. Chapter 1 provides the introduction and background to my research. Chapter 2 is a discussion of the relevant literature on worksheets, learning and theoretical frameworks for the study. Chapter 3 is a description of my research methodology and design, my research instruments and how I collected the data as well as issues of ethics and rigour. Chapter 4 is the analysis and discussion of phase 1 of my study: An analysis of museum worksheets. Chapter 5 is a narrative description and discussion of learner conversations during a tour of a biology exhibition at OLSM. Chapter 6 contains a summary of the research findings and implications in the field of museum learning.

Chapter 2

Literature review

2.1 Introduction

The literature review is divided into three sections: worksheets, learning and the theoretical frameworks of the study. The use of worksheets during museum field trips and learning are reviewed since my project was focussing on worksheets and their impact on learning during field trips. How learning is interpreted is key to developing an understanding of the potential role of worksheets during museum field trips. The last section outlines the theoretical frameworks that guided my study.

2.2 Worksheets

A worksheet is a sheet of paper or a booklet[2] that contains problems or tasks that are related to a particular topic for learners to solve (Mortensen & Smart, 2007). The worksheet is one of the educational tools that was developed in the 1960s in England and Wales with the aim of promoting individualised learning and child-centred education (MacManus, 1985). In Britain the use of worksheets was prompted by the introduction of an all-inclusive education which resulted in children of mixed ability being put in one class. When a teacher is faced with a challenge of teaching a large class of children with a full range of abilities, there is a tendency to focus more at the upper middle of the ability band at the expense of the most and least able (Dowdeswell, 1981). Worksheets were therefore introduced to overcome this problem, helping children to take charge of their own learning, allowing them to work at their own pace, in school and at home. Worksheets were also used to alleviate the difficulty of verbally transmitting instructions to learners which was undesirable due to the variations in the speed and competency of writing among the learners. The introduction of worksheets was also a way of saving time as there was no longer need for the teacher to write practical instructions on the board or to dictate them (Dowdeswell, 1981). After the introduction of worksheets, teachers started to use them in the classroom to accomplish a variety of functions: remedial, revision, extension, practical or written work (McManus, 1985).

[2] In the modern times, with the advent of e-learning one can also talk of electronic worksheets

2.2.1 Worksheets in classrooms

The use of worksheets is now extensively practised in schools in Britain and the United States (Dowdeswell, 1981) and in South Africa (Personal observation). In the classroom worksheets can be used for a variety of functions. For example, worksheets could contain instructions on how to set up practical work in which case the worksheets would serve the purpose of directing and coordinating practical activities. A worksheet can also be used in theoretical activities whereby it would be made up of questions for learners to answer in class or as homework (Dowdeswell, 1981).

Use of worksheets in the classroom has both advantages and disadvantages. One advantage of using worksheets is the saving of time that would have been spent on orally giving or writing instructions on the board. The other advantage of using worksheets in the classroom is that they ensure that instructions are given to every student. In addition, with the use of worksheets, greater responsibility is placed on the learner which can have a strong motivating impact especially with the most able students. Most importantly, the worksheet will contain an individual learner's personal responses to given tasks and will serve as a record of the learner's work with reference to a particular activity (Dowdeswell, 1981).

The disadvantages of worksheets include firstly, the problems of students who do not complete worksheets due to poor motivation or inability. Secondly, there is a challenge of having to deal with management problems when worksheets are completed at different speeds due to the same problems as stated above: inability and poor motivation. Lastly, preparing effective worksheets is labour intensive and time-consuming. Not all teachers have the expertise and the time to prepare quality worksheets. When poorly prepared, worksheets can cause confusion and become a waste of time especially for weak learners (Dowdeswell, 1981). There is also the issue of cost as copies of worksheets need to be made for each learner. In their study, which was a comparison of the worksheet method with the group discussion method, Anderson & Butts (1980) found out that there was no difference in the cognitive gains between those who had been taught through the discussion method and those who had been taught using the worksheet method. They however observed that the worksheet method presented more adminstrative challenges in the classroom than the discussion method. Teachers had to answer the same question in the worksheet over and over again and some students had problems understanding the worksheet instructions. In addition, discussion

classes made faster progress than the worksheet classes. Despite these negative effects, Anderson and Butts acknowledged that the introduction of the worksheet brought in a necessary variety to the teaching approaches in the classroom.

2.2.2 Worksheets in museums

The introduction and use of worksheets in the classroom has also extended to museums (McManus, 1985). Completion of a worksheet by students is one teaching/learning strategy that is now used in modern practice by teachers and museum educators to facilitate student learning during museum visits. The introduction of worksheets in museums has also carried with it the typical problems associated with their use described above. As a result, there is now disagreement among researchers regarding the usefulness of worksheets during museum field trips. Some say worksheets are useful and can facilitate learning while others oppose the use of worksheets saying that they restrict learning. Below is a discussion of the views and the arguments of both groups: those for and those against the use of worksheets during museum field trips.

Pollock (1983) supported the use of worksheets during museum field trips. His view is summed up in the following quotation which emanated from his observations at his workplace the Natural History Museum in London :

“Activity sheets are without doubt, the most cost effective method of offering the museum’s educational expertise to all the 250 000 pupils who visit the museum in organised school parties each year. And with exhibitions that are more didactic, there is less need to have museum staff spending time undertaking repetitive and labour-intensive interpretation in the form of tours and lectures” (Pollock, 1983, p. 120).

Pollock’s view stemmed from the knowledge that sometimes exhibitions are designed to be understandable to visitors of a particular age group. For example, exhibitions in the Natural History Museum in London were designed to be comprehensible to those around fifteen years of age. This implied that for school pupils below this age range, it was difficult for them to follow the exhibitions without any assistance. Furthermore, school groups visiting the museum would have pupils of different abilities. To overcome this problem, a range of activity cards and worksheets were therefore prepared and were expected to meet the educational needs of pupils of different ages and abilities as well as of the visiting public.

McManus (1985) is also of the view that worksheets can facilitate learning. This view stemmed from her 1985 study, which was a survey of how worksheets were used by groups of children in the British Natural History Museum. McManus made a number of observations which highlighted both the positive and the negative effects of using worksheets during museum field trips. On one hand McManus observed that for the children up to ten years old, the worksheet acted as an instructor for the groups, helping them to locate the exhibits to be attended to, introducing the concept to be studied and telling the learners what to do. The worksheet therefore, controlled the general course of the visits, directing and extending the learning experiences of the learners. On the other hand however, McManus observed that there were a number of typical problems that were associated with the use and management of worksheets. The first problem was that of children who were neither fast nor competent readers. These children were spending more time reading instructions instead of exploring the exhibits. The second problem was that of children who were not competent in writing yet they were expected to write answers from dictation. Finally was the problem of children who did not have anything firm to press on in order to write properly thus making it difficult for them to write fast and legibly. All these problems resulted in worksheets dominating the museum experience for both teacher and pupil at the expense of the exhibit. These problems made the use of worksheets appear undesirable. McManus did not however dismiss the usefulness of worksheets. She made recommendations as to how these problems could be overcome. These recommendations are however beyond the scope of what is discussed here.

For children around ten to fifteen years, McManus observed that the children usually moved round in friendship groups and she concluded that this social aspect was an essential source of satisfaction during museum field trips. She then suggested that by capitalising on this observed social behaviour, a worksheet could promote collaboration and hence meaningful learning among learners if it is prepared for use by groups. Overall, McManus was of the opinion that for children of all age groups, in addition to structuring the field trip which advances personal participation by a child, a worksheet also provides evidence of work done by the child and a record that can be referred to later in school.

According to Rennie and McClafferty (1995), students need both structured activities and some free exploration during field trips. Structured activities before and after the visit promote learning by creating a framework for the museum experience and linking it with classroom work. Although they had reservations about the use of worksheets, Rennie and

McClafferty recognized that worksheets could be used to structure the activities during the field trip. The worksheet would promote learning by acting as a pointer or signage directing learners to the relevant and salient features of the exhibit.

Teachers in Kisiel's study (2003) were also of the opinion that worksheets are useful. Their argument was that the informal nature of the museum environment was not conducive for maintaining student attention. External factors like crowded halls could also make it difficult for students to stay on-task. They therefore believed that using a worksheet would keep the students focussed as they go through the museum. Kisiel (2003) also observed that when students visited museums in large numbers, they were divided into small groups some of which were then led by parent volunteers. The students that were led by parent chaperones were not exposed to similar museum learning experiences as the students led by teacher chaperones. Teacher chaperones effectively facilitated the learning process as they were moving through the museum. Some parent chaperones focussed on making sure that worksheet tasks were completed. Other parent chaperones took a back seat and allowed the students to lead themselves. These observations led Kisiel to recommend that in a situation like this, where the logistics of the museum setting requires teachers to break students into smaller groups with chaperones who are not able to foster the same kinds of learning experiences as the teachers, worksheets are necessary to ensure that all students have similar experiences.

Information that is presented to a learner about a concept before the learning of the concept commences (what Ausubel, 1977 called advance organiser) can strongly facilitate the learning of that concept (Falk and Dierking, 2000). In connection with this suggestion, Mortensen and Smart (2007) think that if a museum worksheet is made available to teachers prior to the visit, the teachers can use the worksheets to prepare learners in advance for the learning that would take place during the field trip. Mortensen and Smart observed in their 2007 study that learners who were using worksheets had more curriculum-related conversations compared with non-users. This means that a worksheet can connect learners to the curriculum-related content during museum field trips. Kisiel (2003) called this feature of worksheets "classroom connection".

Kubota and Olstad in their 1991 study, observed that the novel physical and social contexts of museums can cause confusion and apprehension to learners leading to ineffective learning.

In response to this observation Mortensen and Smart (2007) suggested that worksheets could be effectively used to mediate the novel contexts of the museum thereby helping learners to learn.

Krombaβ & Harms in their 2008 study with 148 Austrian grammar school students aged 11 to 15, observed that the use of worksheets while students were learning about biodiversity in a natural history museum contributed to knowledge gain. These researchers are of the opinion that when worksheets are used during museum visits, "the information from the museum is learned more accurately and remembered longer" (KrombaB & Harms, 2008 p.157). This opinion may however be debatable as in my opinion the design features of a worksheet are also likely to influence how the learning process occurs.

In view of the above statements, the usefulness of worksheets cannot be dismissed. However, those against the use of worksheets during field trips claim that worksheets cause students to narrowly focus on the required tasks at the expense of true and broader observation (Price and Hein, 1991). Students inteviewed in Griffin's study (Griffin, 1994) felt that the obligation to complete worksheets had forced them to search for answers in the displayed text instead of the desired thoughtful derivation of the answers from the exhibits themselves. Ironically, the same students however, said that they would not have learnt if they had not used worksheets. Students in Griffin and Symington's study (1997), when asked about worksheets, also reiterated the same sentiments as those in Griffin's 1994 study saying that they did not like the worksheets as they were controlling what they had to observe and had therefore prevented them from making choices about the exhibits they looked at. The observations about students becoming too concerned with completion of worksheets at the expense of everything else were also confirmed by Koloko (personal communication, 2008) a museum educator at Hartbeeshoek Radio Astronomy Observatory in South Africa. Bowker observed in his study (2002) that when students were using worksheets, there was little engagement with anything else as they would walk hastily from one exhibit to another in a bid to answer the questions on the worksheets. The students would also become overconcerned with answering and completing the worksheet to the extent that they would copy answers from their friends and not engage in anything else.

Despite these arguments against the use of worksheets, they still remain a useful tool especially in cases where there is no pre-visit preparation, no post-visit follow ups, and no

facilitation by teachers which are seen as better strategies (Griffin and Symington, 1997; Kisiel, 2006). According to Malinga (workshop presentation, 2007) and Koloko (personal communication, 2008), school field trips that take place at their science centres rarely include pre-visit and follow up activities and there is rarely any teacher facilitation or supervision when learners go through the museum. Learners would be on their own for the most part of the visit. Such scenarios again point to the fact that worksheets are a necessary strategy during museum field trips in South Africa. What is required is to make worksheet users and designers have a better understanding of how a worksheet can support or restrict learning during a museum field trip.

2.2.3 Characteristics of a worksheet that impacts on learning

In 2003 Kisiel conducted a study in which he examined teacher-generated worksheets with the aim of finding out how the worksheets might support or restrict learning (Kisiel, 2003). Kisiel analysed worksheets for the following: content, grade, visit duration, number of halls (displays) visited to complete the worksheet and number of questions on the worksheet. From the analysis of the worksheets he identified eight distinct characteristics of worksheets which he said impacted on learning. These are task density, orientation cues, site specificity, information source, level of choice, cognitive level, response length and response format. From teacher interviews he identified additional factors that also have the potential to influence the learning process during museum field trips. These factors are visit purpose, worksheet rationale, museum familiarity, classroom connection and teacher or chaperone involvement. Below is a description of some of these characteristics and how they can influence learning. I describe these in some detail here as they are relevant to my study.

Task density refers to the amount of work that learners are required to do. It is expressed in terms of the number of questions on the worksheet and the number of halls or displays students are expected to visit in order to complete the worksheet in relation to the duration of the tour excluding lunch breaks. The dimensions of task density are therefore time available per question (T/Q) and time per hall (T/H). Low T/Q indicates that less time is given to answer each question and low T/H indicates that less time is given for each hall. Low T/Q and low T/H in a worksheet therefore, suggest that there is less time for students to examine the exhibits, and high T/Q and high T/H indicate that there is more time given to answer each question. (Kisiel, 2003). I will use worksheet 1 in Appendix A to explain task density. The

worksheet has eleven questions and learners have to visit one area (hall) to complete the worksheet. Learners are given twenty minutes to complete the worksheet. Therefore, task density in terms of (T/Q) is (20minutes/11questions). This approximates to 1 minute 48 seconds per question. In terms of T/H, task density is 20 minutes/hall. T/Q seems to give a clearer picture of task density as it shows the amount of time that is available to answer each question. Time per hall is not a good indicator of task density as one will still need to find out how many questions needed to be answered per hall in order to determine whether task density is high or low. Kisiel recommended a worksheet with fewer questions and more time (high T/Q) as it allows for personal exploration by the learner and for orientation and overcoming novelty effects. An interesting question however is 'how low is low' and conversely, 'how high is high'? Kisiel did not address this question. This may be because in order to determine whether task density is high or low one requires to consider many other factors like type of questions in the worksheet, visit purpose and worksheet rationale.

Orientation cues describe the extent to which the worksheet guides students through the museum to find the locations of displays, exhibits and halls specified in the worksheet tasks. The cues may include wayfinding systems such as maps, directional signs and location of the exhibits that the worksheet tasks pertain to (Kisiel, 2003). Orientation cues may help students to answer the questions or may help to introduce structure in an environment that may be chaotic. According to Mortensen and Smart (2007) museums can overwhelm first-time visitors with their visual displays and aural stimuli causing distraction and anxiety. A worksheet with orientation cues can help students orient themselves and therefore promote learning. The Sterkfontein caves worksheet by Sanders (2007) which is labelled worksheet 2 in Appendix A is a good example of a worksheet with orientation cues. It has a map with directions and labels showing where the various exhibits can be found. Worksheets like this which provides visitors with the location of the exhibits help visitors to orientate themselves. By providing the location of exhibits, a worksheet can reduce the novelty effects of the museum environment. Any novelty reducing interventions can increase the extent of involvement of learners (Kubota and Olstad, 1991) and hence learning.

Site specificity indicates the extent to which learner tasks in a worksheet are based on a specific exhibit. Low site specificity means that a task is not limited to a particular site or display but can be accomplished in a larger area and high site specificity means a task can only be accomplished at a specific display. An example of a task with low site specificity is

'Choose an ecosystem of your choice. In the space below, sketch your ecosystem. Include biotic and abiotic components'[3]. This task is not specific to a particular display. The museum to which this worksheet task pertains has many displays showing a wide range of ecosystems from which a learner can choose an ecosystem of choice. This question can be answered anywhere in the museum or even outside the museum. An example of a question with high site specificity is 'Go to the waterwise garden and find a plant that is found on the 50c coin'.[4] The question can only be answered at a particular exhibit and is therefore site specific. McManus (1985) recommended that worksheets must reflect low site specificity so that students can have a choice as to where and when to do the tasks. This is however contrary to Kisiel (2003) who thinks that a worksheet should have high site specificity so as to facilitate orientation. I also think that high site specificity will quickly focus learners on the task once they get to the appropriate display or exhibit.

Information source refers to whether the response to a task is found by reading labels (text-dependent) or by observing objects or specimens (object-dependent). An example of an object-dependent task is 'What features are exhibited by the tree in the display that are adaptations to its aquatic environment'? Learners have to examine closely the tree and its environs to get the answer. So the question is object-dependent. An example of a text-dependent question is 'Why do owls have such big eyes?' Learners can not get the answer by looking at the big eyes of an owl although they can see it in the display. They will have to read the text to get the explanation why owls have big eyes. Therefore this question is text-dependent. Kisiel recommended object dependent responses rather than text-dependent so as to provide students with that which would be difficult to experience in class. Object-dependent tasks promote personal construction of knowledge (Smith, DiSessa, & Roschelle, 1993; Mortensen & Smart, 2007) by offering students an opportunity to observe, think deeply and derive their answers from the objects. According to Allen (2002) object-dependent responses also elicit a higher diversity of learning-related conversations than text-dependent responses.

Level of choice indicates the number of possible correct answers to a task. Level of choice ranges from no choice where there is only one correct answer to some choice with several

[3] Question 1, Worksheet E2, Appendix A

[4] Question 8, Worksheet 1, Appendix A (NB: The source of worksheet 1 cannot be disclosed as I promised confidentiality)

possible correct answers or options for a response. An example of a no choice task is "Name the animal found on the R1 coin"[5] This task has one correct answer and hence there is no choice for the learner. An example of a task that offers learners some choice is "List 2 benefits of growing indigenous plants"[6] There are many benefits for humans from indigenous plants. A learner has a number of correct answers to choose from hence the learner has some choice. Research suggests that tasks that allow learners some choice cultivate a positive attitude towards the museum experience and also cater for individuals' prior knowledge and interest (Falk and Dierking, 2000; Kisiel, 2003).

Cognitive level refers to the six levels of questioning as described by Bloom's taxonomy: knowledge, comprehension, application, analysis, synthesis and evaluation (Kisiel, 2003; Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). Knowledge questions require an individual to simply remember given facts (Clarke, 1999) e.g. "List five different sources of water that you know". Comprehension requires an understanding of facts that will enable an individual to process information (Clarke, 1999) e.g "Why is it our duty to protect the environment we live in?" Learners need to understand what is meant by environment and its importance in order to be able to provide reasonable answers. Application calls for one to put knowledge to work, to use gained knowledge in new situations (Clarke, 1999) e.g "How can you purify the water shown in the pictures?" The type of pollutants determine the method of purification. Learners will have to identify the pollutants first then use their knowledge to determine the suitable methods. Analysis is the ability to recognise hidden meanings. Synthesis means ability to use prior knowledge to solve problems. For example when answering questions like 'How can we improve? or "How can we solve?" (Bloom et al, 1956) Evaluation is when one is required to compare, to appraise, to defend and make choices based on reasoned arguments (Clarke, 1999). e.g. "Your ecosystem has been destroyed by human activity. You are part of the rehabilitation team. Which animals and plants will you re-introduce into your ecosystem? You must be able to justify your answer"[7]. A useful worksheet is one that incorporates some questions at higher level especially comprehension and application as it accounts for differences in student experiences and expertise (Mortensen & Smart, 2007).

[5] Question 6, Worksheet 1, Appendix A

[6] Question 3, Worksheet 1, Appendix A

[7] Task number 9, Worksheet E2

It is important to note that the decision on the cognitive level of a question is always debatable as it maybe person, content and context sensitive (Kadijevich, 2002). Person sensitive means that the cognitive level of a task will depend on the learner's prior knowledge experiences, skills and preparation. The suggestion by Rennie and Johnston (2004) that a person' prior experiences structure new learning is what makes the learning process to be personal in nature. The museum environment where a learner is provided with authentic exhibits can also make a task to be a knowledge level task whilst the same task can be at a higher level when it is done theoretically in the classroom thereby making the cognitive level of a task to be context sensitive. It is therefore difficult to assign questions to cognitive levels based on Bloom's taxonomy without the knowledge of the context (Green & Rollnick, 2007).

One way of possibly overcoming the challenge of assigning cognitive levels to worksheet tasks is to use a combination of at least 2 taxonomies. The TIMSS (Trends in International Mathematical and Science Study) science framework is another more recent taxonomic tool that can be used to detemine the cognitive levels of tasks in a worksheet. The framework has three cognitive domains: knowing, applying and reasoning (TIMSS, 2007). The other way is to simplify Bloom's six levels before applying it. A good example is the simplification described by McMillan and Lawson (2001) as cited by Green and Rollnick (2007) whereby only two categories were used namely recall and higher order thinking. One may however argue that this kind of simplification is problematic as it is likely to group together worksheet tasks with differing cognitive demands.

Response format describes how the student is directed to respond. Is the student directed to write, draw, touch, talk or do something? Written responses make accounting for completion of worksheets by students easier. Tasks that require students to come in contact with the objects (touch) e.g 'feel the skin of an earthworm' help students to experience those objects and therefore facilitate learning. Questions that direct oral responses promote learning by social interaction (Kisiel, 2003). A well constructed worksheet should therefore include a variety of combinations of response formats for example touch/feel and then write, discuss and then write. Other response formats include underline, spot similarities or differences, join matching pairs (Durbin, 1999).

Classroom connection is a characteristic highlighting the extent to which the visit and the worksheet are connected to the content that is covered in the classroom. According to Kisiel

(2003) very often museum visits are detached from what happens in the classroom and as such they are viewed as separate events outside the classroom. A worksheet that connects to the school curriculum especially to topics that have been covered in the classroom is likely to facilitate learning by linking what is observed to learners' prior knowledge (Mortensen and Smart, 2007).

Kisiel's study lacked two important characteristics namely, social interaction (McManus, 1985; Rahm, 2002; Rennie & McClafferty, 1995) and question format. A worksheet can either promote or restrict social interaction. A worksheet that promotes social interaction is one that offers opportunities for learners to work in groups, to discuss with other learners, the teacher or with tour guides. A worksheet with open-ended questions foster group discussions and hence social interaction (Mortensen & Smart, 2007). Including activities that encourage social interaction in a worksheet is very vital as social interaction is a typical component of museum learning (Stainton, 2002).

Question format focuses on whether the tasks in the worksheet are open-ended or closed-ended. Open-ended questions are the type of questions that offer learners a chance to speak freely and to share more than just facts whilst closed-ended questions require simple and brief responses. An example of an open-ended question is 'Give reasons why you think the ocean is important to humans'. This kind of question requires complex thinking and yields multiple answers. An example of a closed-ended question is 'What do we call plants that come from other countries?' This question requires a specific answer. Previous studies that have looked at the importance of proper questioning have noted that open-ended questions promote children's creative thought, problem-solving skills and cognitive growth (Herman, Morris, & Taylor, 1987). Krombaβ and Harms (2008) however observed that closed-ended questions that required learners to look for clearly defined solutions led to greater knowledge gains than open-ended tasks. Contrary to Krombaβ and Harms (2008), Wilde & Urhahne (2008) observed that open-ended and closed-ended tasks with identical contents did not result in different learning gains. I would suggest the use of closed-ended tasks when teachers or museum educators want specific facts and concepts to be learnt as closed-ended tasks can focus learners towards specific outcomes. Open-ended tasks should be used when educators want to stretch the imaginative thinking of learners and hence expose them to high level thinking. I am of the opinion that incorporating both types of questions may improve the effectiveness of the worksheets.

2.2.4 Types of worksheets

From a synthesis of the data on the worksheets, Kisiel came up with two broad types of worksheets namely: the survey agenda worksheet and the concept agenda worksheet. The latter are worksheets that have the following characteristics: Fewer questions that give students more time to spend on each question, "opportunities for more student choice and a greater emphasis on student observation of objects rather than label reading" (Kisiel, 2003: p15). Survey-agenda worksheets are described as those having a greater number of questions requiring the visitation to a greater number of exhibit areas, thereby allowing less time overall for each question and less time at each exhibit (Kisiel, 2003). Table 1 below compares the two types of worksheets. Only those characteristics that clearly show the differences between the two worksheet types were used. Response length and response format were left out as they seemed to be comparable in the two worksheet.

Table 2.1: A comparison of survey agenda and concept agenda worksheets (After Kisiel, 2003)

Distinguishing characteristics	The survey agenda worksheet	The concept agenda worksheet
Task density	High (more questions overall)	Low (Fewer questions overall)
Orientation cues	Yes	Not always
Site specificity	High; Questions are very label- and exhibit-specific	Low; Questions can be answered using a variety of exhibits or sites.
Information source	Text; Responses are based primarily on label-text	Object; More object-based questions
Level of choice	Few choices for students if any	Some choice incorporated into questions
Cognitive level	Less likely to use higher order questions	More likely to use higher order questions

Kisiel made it clear that no worksheet is likely to fall cleanly into a survey or concept agenda category. Any worksheet is likely to have elements of both types. He used this dichotomy only to aid comprehension rather than to represent accurately how the two worksheets look like. He therefore, went on to suggest that the relationship between these two worksheet types should be represented as a continuum rather than a sharp dichotomy (Kisiel, 2003). I have tried to represent this continuum in Fig 2.2 below.

Table 2.2: A representation of survey agenda and concept agenda worksheets as a continuum

Concept-agenda worksheet		Survey-agenda worksheet
Low	**Task density**	High
Low	**Orientation cues**	High
More	**Information source (Object-dependent)**	less
Low	**Information source (text-dependent)**	High
High	**Level of choice**	Low
High number of higher order questions	**Cognitive level**	Low number of higher order questions
Low	**Site specificity**	High
←	**continuum**	→

2.2.5 Characteristics of a worksheet that is likely to promote learning

Kisiel used the characteristics he had identified from the worksheets to hypothesise a worksheet that is most likely to promote learning. When Kisiel hypothesised this worksheet, he took into consideration the different learning contexts that are described in Falk and Dierking's Contextual Model of Learning (CML) (Falk and Dierking, 2000). In the CML, Falk and Dierking described learning as influenced by the interaction between three different contexts: the physical, the social and the personal. The physical context is made up of the exhibits and their surroundings. The personal context includes the visitor' prior knowledge, experiences, skills, motivations and desires and the social context refers to the people that the visitor interacts with during the visit. Figure 2.1 below is a diagrammatic representation of the CML (Falk & Dierking, 2000).

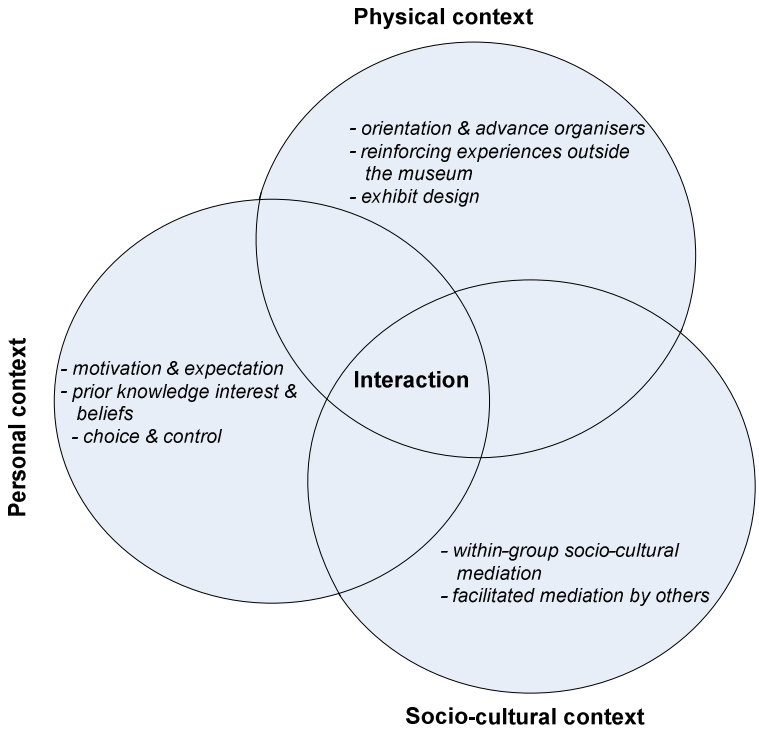


Figure 2.1: The Contextual Model of Learning (Falk and Dierking, 2000)

Falk and Dierking described the interaction between the three contexts in the following way: The personal context is formed and then is continuously modified and changed by the events of the physical context which are in turn mediated by the sociocultural context. Kisiel used the factors in the CML above to suggest characteristics of a worksheet that is likely to promote learning. Table 2.3 below compares characteristics suggested from the CML with characteristics in Kisiel's hypothesised worksheet.

Table 2.3: A comparison of Kisiel's hypothesised worksheet with worksheet characteristics based on the CML (After Kisiel, 2003)

Distinguishing characteristics	Suggested worksheet characteristics based on the Contextual Model of Learning	Kisiel's hypothesised worksheet has:
Task density	*The personal context (motivation, expectations and interest)*: Task density should be low enough to allow for exploration as well as time for orientation and novelty effects.	A lower task density: fewer questions and fewer exhibits that are examined by use of the worksheet.
Orientation cues	*The physical context (orientation and advance organiser)*: Worksheet must help visitors orient themselves in the museum and to organise the visit for more meaningful understanding.	Orientation cues incorporated e.g. maps, directional signs and location of exhibits.
Information source	*The physical context (Design)*: Worksheet must focus students on that which is unique to the informal setting and unavailable in the classroom.	Task that are based on objects and displays rather than text; the worksheet emphasises that which would be difficult to experience in the classroom.
Level of choice	*The personal context (choice and control, prior knowledge and interest)* Choice provides for a positive attitude and allows for recognition of individual prior knowledge and interest.	Some choice in what information is sought.
Cognitive level	*The personal context (prior knowledge):* A combination of higher and lower order questions accounts for differences in student experience and expertise.	Both lower and higher order questions.
Response format	*The socio-cultural context (within group social mediation)*: A variety of response modes addresses different learning styles and can promote social interaction.	A variety of response formats (oral, pictorial, written and unwritten).
Classroom connection	*The physical context; Reinforcing experiences*: Making connections to prior knowledge makes the museum experience more meaningful.	Post-visit activities to promote discussion and lead to additional activities.

The comparison in Table 2.3 shows that the worksheet that was hypothesised by Kisiel fulfils most of the recommendations of the CML.

Kisiel compared the survey agenda and the concept agenda worksheets with the worksheet he had hypothesised and concluded that the concept agenda worksheet, in terms of the Contextual Model of Learning, is more likely to create conditions that will promote learning during a museum visit. Some of the characteristics in the concept agenda worksheet have also been recommended by other researchers as characteristics that promote learning. Examples are low task density (McManus, 1985), choice and control (Griffin & Symington, 1997;

Mortensen & Smart, 2007) and tasks that address exhibits rather than labels (McManus, 1985; Mortensen & Smart, 2007).

Despite the conclusion that concept agenda worksheets are likely to promote learning compared with the survey agenda ones, a study by Kisiel (2006) showed that most of the teachers in his study favoured the survey agenda worksheet. Although Kisiel attributed this preference to differing perceptions of teachers as far as science field trips are concerned, their choice of the survey agenda worksheet may also be due to a lack of awareness of the kind of worksheet characteristics that are likely to promote learning during a museum field trip. It is possible that some museums in South Africa also use survey agenda worksheets out of ignorance of the kind of worksheets that can best promote learning. The literature that I have reviewed above therefore provides useful findings that may be used to confront and shape attitudes of both teachers and museum educators regarding what a useful worksheet might look like. Assisting museums and teachers to become more aware of the characteristics of an effective worksheet may help them to make better use of the museums.

2.2.6 Worksheet construction and use

The way a worksheet is constructed can reflect how it is used. If a teacher or museum educator wants to use the worksheet to help students to see and experience the entire museum, or to keep the learners 'busy' the worksheet will have more of the survey agenda worksheet characteristics where students will sample a little bit of everything with little time for personal exploration and observation. If the aim is to use the worksheet to focus students on a particular concept, the worksheet will contain fewer tasks that direct students to a few exhibits related to the concept of interest hence taking more of the form of a concept agenda worksheet. If a teacher wants to promote social interaction, the worksheet will have tasks that require group or team work and if a worksheet is used to extend the curriculum to the-out-of school environment, then there must be pre-visit and post-visit tasks that link the classroom curriculum to the visit experiences (Kisiel, 2003). Therefore, in addition to reflecting the kinds of learning experiences that are likely to result from its use, the way a worksheet is designed can also reflect how it is meant to be used. This means that by analysing the worksheet I can infer how the worksheet is meant to be used and also the learning experiences that are likely to result from its use.

2.3 Learning

In this section, I will discuss learning in schools first followed by the sort of learning that takes place in the museum.

2.3.1 Learning in schools

A survey of educational research literature shows that defining learning is a challenging task. Braund & Reiss (2004) said that "Trying to define learning is an impossible task" (p4) and Falk and Dierking (2000) also acknowledged the difficulty of trying to define learning by saying that "Defining learning is a tricky business" (p9). This is evidenced by the presence of many definitions in the literature. Some of the definitions are shaped by the theoretical inclinations of the individuals giving those definitions and others by the individual's intentions and the context into which the definition is given (Braund & Reiss, 2004). Faced with the same challenge, I decided to examine learning starting from the point of Falk and Dierking (2000) that "learning is simultaneously a process and a product" (p9).

Looking at learning as both a process and a product meant that I had to identify the products of learning, describe how these products are acquired, then combine the products and the process into a definition. Identifying the products of learning was not difficult. Products of learning include measurable outcomes such as knowledge, skills, understanding, awareness, values, ideas and feelings (Braund & Reiss, 2004). Defining the process of learning however was challenging. This was mainly because the definition will depend on the theoretical perspective one will be using. A look at three of the learning theories: cognitive constructivism (Piaget, 1964, 2003), socio-cultural constructivism (Vygotsyky, 1978) and situated cognition (Wenger, 1991) makes this point clear.

One who is inclined to cognitive constructivism (Piaget, 2003) will define the process of learning as construction of one's understanding and knowledge through experiencing things and reflecting on these experiences. In this case learning is an individual process. The perspective emphasises the importance of an individual's mind in which learning is said to occur. Learning is prompted by action which leads to re-organisation of internal structures. (Smith, DiSessa, & Roschelle, 1993). Previous knowledge is important as the learning process involves the building of more complex structures from simpler pre-existing ones. Hence learning is not absorption or copying of reality but rather reconstruction and

remodification of knowledge. Emphasis is placed on the activity of the learners themselves. In the classroom situation the teacher is therefore encouraged to create opportunities and provide activities that will enable learners to reconstruct or re-organise their internal structures or schema.

In the socio-cultural perspective (Vygotsky, 1978) learning is defined as internalisation of social interaction. Unlike the cognitive perspective, the socio-cultural theorist puts more emphasis on the social plane where ideas are met and discussed between people. Here learning is triggered by social exchanges such as gestures, words, talk, writing, visual images as well as action. Learning then occurs when these ideas are internalised (Mortimer & Scott, 2003; Wertsch, 1991). In the socio-cultural perspective emphasis is on the collective activities undertaken by adults and children or by children amongst themselves. The role of the adult is to direct and guide the children in activities, making corrections when needed and providing greater challenges when appropriate (Wertsch & Kanner, 1992). The child's peers contribute to acquisition of knowledge by exposing the child to other points of view and conflicting ideas that may encourage him to rethink or review his ideas. Vygotsky's theory makes clear the role of teachers in the learning process: assisting and guiding the learner, directing the activities of the learners by setting appropriate tasks, allowing learners to perform the tasks, giving support, assessing and giving feedback with the aim of pushing the learner to certain limits.

The situated perspective views learning as participation in a community of practice (Wenger, 1991). Collins (1988) as quoted by Brill (2001) defined situated learning more simply as 'learning knowledge and skills in contexts that reflect the way they will be used in real life'. The situated pespective looks at learning as a shared process. In this process, the acquisition of knowledge and skills is not done through isolated activities but through engaging, in partnership with others, in real life practices and scenarios (Brill, 2001). In a classroom situation, both the teacher and the learners could be regarded as participants in communities of practice as the learning process is continuous for both. The teacher and the learners are partners in the joint activity of learning. The teacher facilitates the learning process by creating conditions that approximate as much as possible the context in which the acquired knowledge and skills will be useful (Brown, Collins, & Duguid, 1989). The learner participates actively in the activities, contributing to decisions and observing others. The learner at some point may also assume the role of the facilitator during a learning episode.

This happens when the learner having acquired a skill, can also go through the process of how to acquire the same skill with fellow learners. One challenge that I see with the situated perspective is on how to balance the content coverage that is outlined in the syllabus through the use of authentic context-based activities. Although the classroom situation described above could be regarded as a community of practice others can disagree with it because the teacher though a participant is the facilitator of the learning process expected to create the necessary conditions for the acquisition of knowledge and skills by the learners.

A synthesis of the process of learning as seen through the three theories discussed above shows that all the three theories: cognitive constructivism, sociocultural constructivism and situated cognition consider the process of learning to involve active participation or engagement of the learner. In constructivism individuals are engaged as they actively construct knowledge and meaning through cognitive processes from personal experiences. In socio-cultural theory, a learner gets engaged as ideas are discussed and rehearsed on the social plane and participation in communities of practice engages the learners as they take part together with their teachers in the given activities. Activities where individuals are encouraged to think, talk, write and manipulate physical tools (all of which result in learner engagement) are implied in all three theories. Combining all the ideas discussed above, I can define learning in schools as:

> *A process of engagement, be it cognitive, physical or oral, with oneself or with others, which will ideally result in acquisition of knowledge, understanding, skills, awareness, ideas, values and feelings.*

2.3.2 Learning that takes place in museums

The learning that takes place in museums is complex and difficult to capture in a single definition. I have therefore discussed all the definitions that, put together, will give a clearer picture of the kind of learning that has been seen to occur in museums.

Learning in museums can be defined as a process whereby an individual takes part in the activities of a given community. The community in the museum environment includes museum educators, explainers, docents (a tour guide working in a museum) (Abu-Shumays & Leinhardt, 2002) and other visitors. The activities include viewing, discussing, commenting about the exhibits, critiquing what the individuals see or interacting with the exhibits (Abu-

Shumays & Leinhardt, 2002). In this regard, asking a question, answering a question, commenting on or explaining an exhibit, even reading text aloud to others can be taken as indicators that learning is occuring. Sharples (2000) quoted by Johnson (2005) defined learning as a joint activity of a group. The definition of learning by Sharples is similar to the one above by Abu-Shumays & Leinhardt in that group activities can also include discussing, commenting and explaining the exhibits and the exhibition. Hawkey (2004) defines learning as "a process of active engagement with experience". Engagement, according to Fienberg & Leinhardt (2002) refers to the degree of involvement of the museum visitor, which may be physical or oral. Oral involvement entail group activity, social interaction or presence in the vicinity of other individuals that the visitor can converse with. Allen, in her study, defined learning narrowly as the "discussion of the exhibits and the exhibition, and its topic area" (2002, p. 262). What stands out in all the definitions of learning above is active participation or active engagement of a learner. Basing on this synthesis of learning, I have put together a definition of museum learning that is appropriate to my intention in this study. My intention is to find out if worksheets facilitate learning during museum visits by analysing learner conversations as they go through the museum answering worksheet questions. I therefore propose my definition of learning in museums simply as:

Engagement of a learner with exhibits, the exhibition and the museum community as a whole.

The definition of learning above therefore covers my intentions as tasks in a worksheet may create opportunities for learners to engage with the actual exhibit or the exhibition. Engagement maybe in different forms: through talk when a learner comments about, explains, asks or answers a question about an exhibit. Engagement may also be physical when learners interact hands-on with the exhibits. Learners may also get engaged by reading label text. Worksheet tasks may also encourage learners to engage with the museum community (educators, docents, volunteers) as they go about their tour completing worksheets.

In most of the activities that bring about engagement, language or talk is the vehicle by which the activities are accomplished (Abu-Shumays & Leinhardt, 2002). This means that language can be used as evidence of engagement which is learning. Allen (2002) developed a framework or scheme of learner talk or language that can be used as evidence of learning.

This framework is discussed in detail later in chapter three as it was used in phase 2 of the study to point out evidence of learning in worksheet elicited learner conversations.

It is evident in this discussion that the aspect of active engagement of the learner stands out in both, the definition of learning that occurs in schools and that which occurs in museums. This means that if meaningful engagement is promoted in schools and during museum visits, then the learning that takes place in both is likely to be similar in type and quality.

2.3.3 Can one measure learning?

If learning is both a process and a product then it can be measured by either measuring the products of learning or by observing the process of learning as it unfolds. Some of the techniques that have been used to measure the products of learning include questionnaires and pencil and paper tests (Ash, 2002). The various forms of engagement: commenting, explaining, asking and answering questions, holding and manipulation of exhibits have been taken to reflect the process of learning. Conversations provide a glimpse into ways humans build knowledge and understanding and also demonstrate the role of talk in creating shared meaning between individuals. Furthermore, much of the way humans make sense of the world is through social interaction with others: "Humans are social animals, and much of what they learn is mediated through conversation, gestures, emotions, the observation of others..." (Falk and Dierking, 2000, p.38). Therefore, analysing video recordings, field observations and audiotaped conversations can provide insights into the learning process that takes place in a museum (Rennie, Feher, Dierking, & Falk, 2003).

2.4 The theoretical frameworks

This section of my literature review presents the theoretical frameworks for my study. The frameworks that were chosen are those that attempt to explain learning in out-of-school settings. The Contextual Model of Learning (Falk and Dierking, 2000) was chosen as a framework in the development of the worksheet analysing instrument and in the analysis of worksheets. Vygotsky's socio-cultural theory of learning (Vygotsky, 1978) was chosen to guide the collection and analysis of data in the second phase of my study. The socio-cultural theory was chosen on the basis that learning in museum has been shown to be social in nature (Allen, 2002). The CML within two of its contextual domains: the physical and the personal contexts, incorporates two important components of Ausubel's theory of meaningful learning,

that of advance organisers and prior knowledge (Novak, 1977). Ausubel's theory of meaningful learning was therefore also incorporated into my theoretical frameworks.

2.4.1 The contextual model of learning

As explained earlier in section 2.2.4 and shown in Fig 2.1, the CML (Falk and Dierking, 2000) suggests that learning in museums is influenced by eight factors within three different but overlapping contexts. These three contexts and seven of the eight factors within them have a direct bearing on phase 1 of my research which is investigating the appropriateness of museum worksheets as instruments for facilitating learning during museum visits. The CML was therefore used to guide my worksheet analysis. Table 2.4 below presents an explanation of how each of the seven factors provided a framework for examining the worksheets. Since a worksheet is meant to facilitate learning during museum visits and the three contextual domains in the CML all interact to contribute to the learner's museum experience, I presume that if a worksheet design disregards any one of the seven features, then its effectiveness in facilitating learning will be lessened.

Table 2.4: Detailed explanations of the features of Falk and Dierking's Contextual Model of Learning (Kisiel, 2003, Falk and Dierking, 2000; **Novak, 1977)

The physical context	
Feature	**Explanation**
Orientation and advance organiser**	Learning is more likely to occur when visitors are familiar with their surroundings and with the expected behaviour. An effective worksheet must therefore incorporate orientation cues and advance organisers to facilitate learning.
Reinforcing experiences outside the museum	Events and situations that occur before and after the museum field trip can influence what is learnt from the museum experience. An effective worksheet must incorporate pre- and post- visit activities that promote a discussion about the visit.
The social context	
Within-group sociocultural mediation	Museums are suited for social learning as visitors in groups utilise each other for making meaning of exhibits. An effective worksheet must include tasks that promote social interaction.
Facilitated mediation by others	Museum staff and others if utilised can impact individual learning
The personal (mental) context	
Motivation and expectation	The reasons for a field trip and what people expect to see during the field trip affect their museum experience. An effective worksheet must therefore have a task density that is low so that the learners can complete the worksheet and still have time to pursue that which will satisfy their own motivations and expectations for the fieldtrip.
Prior knowledge, interest and beliefs	Museum visitors' existing knowledge and interest have a profound effect on their participation during a museum field trip. An effective worksheet must incorporate tasks that allow students some choice in what information is sought, tasks that are open-ended and have low site specificity in order to cater for individual learners' prior knowledge and interest. Open-ended tasks will cater for learners' prior knowledge in the sense that they (learners) can use their prior knowledge to come up with reasonable answers to the tasks
Choice and control	Learning is made more meaningful if learners are in control of their learning and are able to choose that which is more interesting. Choice also provides for a positive attitude and allows for recognition of individual prior knowledge and interest. An effective worksheet should therefore have a low task density to allow learners time for free exploration.

2.4.2 The theory of meaningful learning

Ausubel's theory is about the importance of prior knowledge in learning. He says "*the most important single factor influencing learning is what the learner already knows"* (Novak, 1977, p. 455). The theory postulates that meaningful learning occurs when the learner's appropriate existing knowledge interacts with the new learning. The theory is made up of

seven components. These components are meaningful learning (key component in Ausubel's theory), subsumption, obliterative subsumption, progressive differentiation, super ordinate learning, integrative reconciliation and advance organisers. The components that are of interest to my study are meaningful learning, subsumption, and advance organisers. These components are important because they focus on learning, an important aspect in my study. These three components will be discussed in detail.

Meaningful learning occurs when new knowledge interacts with existing relevant concepts. It is not a simple addition of new knowledge to existing concepts. The learner makes a conscious effort to relate new knowledge in a substantive and logical way to relevant existing concepts or propositions in cognitive structure (Novak, 1977; West & Fensham, 1974). The extent or degree of meaningful learning therefore depends on the nature of the learner's prior knowledge and how it interacts with the new knowledge. When meaningful learning is occurring, new knowledge is assimilated into existing relevant concepts. This assimilation alters the form of both the anchoring concept and the new knowledge. The anchoring concepts refer to the prior knowledge that can provide the interactions for meaningful learning. Ausubel called these anchoring concepts **subsumers** (West & Fensham, 1974). The process of meaningful learning results in subsumption of new knowledge. A subsumer therefore is any concept, principle or generalising idea that the learner already knows that can provide association or anchorage for the various components of the new knowledge (ibid). Knowledge which can be associated with an existing concept is accepted in the schema and subsumed to enlarge and strengthen the concept (meaningful learning). Knowledge which cannot be associated with prior knowledge (non-subsumable knowledge) is according to Novak (1977) learned independently or rote-learned. This implies that for meaningful learning to occur during a museum field trip learners must have the relevant subsumers otherwise there will be need for some pre-visit preparation that will provide learners with advance organisers.

Advance organiser is a term that is used to describe any verbal, written or visual presentation, presented to the learner before the detailed new knowledge. It can be a single word, a title or a picture, anything that can enable the learner to easily link new knowledge to existing relevant concepts in the schema by providing an alternative set of anchors or links, if the learner does not possess appropriate subsumers, or if they are inadequately developed or inadequately alerted to play their part in the new learning (Novak, 1977; West & Fensham,

1974). Subsumers and advance organisers are active elements in the way existing knowledge facilitates new learning. According to the theory, meaningful learning can occur by both use of relevant subsumers in the prior knowledge and use of advance organisers. If irrelevant subsumers are used by a learner, a likely outcome would be misconceptions about the new learning (West & Fensham, 1974). Worksheets can serve the role of advance organisers by providing learners with information about the visit and the exhibits. The worksheets should help learners to link new knowledge to prior conceptions.

2.4.3 The socio-cultural theory

Vygotsky's socio-cultural theory says that learning is internalisation of social interaction. Talk underpins the learning process which involves a passage from social contexts to individual understanding (Mortimer & Scott, 2003). The theory focuses on learning as a process rather than a product, a joint activity of a group rather than the activity of one person (Allen, 2002). Ideas are brought into the open for public sharing in such a way that group members build on each other's knowledge and understanding (Fienberg & Leinhardt, 2002). During the discussions, people use a range of modes of communication such as talk, writing, gestures, visual images and action to explain their ideas to others (Wertsch, 1991). Learning then occurs when the ideas are internalised.

Looking at museum learning through a socio-cultural 'lens' is appropriate because, a teacher/museum guide working with students or students working in groups constitutes the social plane and museum staff presentations, video footages or audio clips constitute the social events. As ideas are discussed during the social events, each learner is engaged as he/she reflects on and makes individual sense of what is being communicated. The gestures, words, pictures and exhibits used in the social exchanges provide the very tools required for engagement and learning occurs when the social tools are internalised (Vygotsky, 1978).

The socio-cultural lens is also appropriate when one considers that conversations are a typical component of most museum learning. Learners in museums are people who are in conversation with the exhibits on display and with each other (Stainton, 2002). In a museum, people spend most of their time in conversation, asking questions, answering questions and gesturing (Hein, 1998). As learners interact through discussion of what they know from previous experiences, what they see, hear and read, these discussions provide opportunities for people to reinforce past experiences and to develop a shared understanding among

members of a group. Such group interactions, where discussions of experiences and knowledge are present can promote learning (Mortensen & Smart, 2007). Worksheets can incorporate social learning by being multiuser – that is having tasks that require participation by several individuals and by utilizing museum exhibits that allow for easy access of groups of learners (Mortensen & Smart, 2007).

In his theory Vygotsky proposed that children do not come with nothing to the social plane. They bring personal contributions at their own level. This personal contribution can be prior knowledge, interest and motivation (Davydov, 1995). These are some of the factors mentioned in Falk and Dierking's Contextual Model of learning within the personal context as factors that affect learning in museums (Falk & Dierking, 2000) and the aspect of prior knowledge is what forms the basis of Ausubel's theory. The three frameworks are therefore interlinked. Teachers and museum educators must engage learners in such a way that they develop further the child's personal contribution. Some of the strategies that are used to achieve learner engagement during a visit are giving students tasks to do, discussing exhibits with them and asking them questions. If worksheets are used, in order for them to promote learning as purported by the socio-cultural theory, the theory of meaningful learning and the CML, the worksheets must contain tasks that promote social interaction and also cater for learners' prior knowledge, interest and motivation.

My study makes use of the three frameworks to analyse and evaluate worksheets for appropriateness as instruments for facilitating learning and the extent to which the worksheets can facilitate the learning process during a museum field trip.

2.5 Conclusion

In this chapter, I have discussed worksheets in schools and worksheets in museums. I have also discussed learning in schools and in museums. The discussion on worksheets in schools shows that the use of worksheets has both advantages and disadvantages. However, despite the fact that their use presents some drawbacks, researchers agree that the use of worksheets in schools brings a necessary variety to the teaching and learning process. The discussion on the use of worksheets in museums shows that there is disagreement among researchers on the usefulness of worksheets during museum field trips some saying that they are useful and others that they are problematic. A critical analysis of the cited literature reveals that the researchers who are in favour of worksheets do acknowledge that their usefulness depends on

how the worksheets are designed and utilised. Those researchers who are against worksheets seem to blame the tool (the worksheet) instead of poor workmanship (wrong use of worksheets) as their conclusions are based on how the worksheets have been used by both teachers/museum educators and students only without considering that the way a worksheet is designed can also negatively impact on the museum experience. In my study therefore, I looked at both the design and use of worksheets with the aim of finding out if worksheets can facilitate learning.

Chapter three

Research design and Methodology

3.5 Introduction

This chapter covers a discussion of my research design, and the methods that I used to select study sites, participants, and to collect data. I also discuss the instruments that I used, the piloting of instruments, the ethics, and also reliability and validity issues. The discussion is accompanied by a review of the literature pertinent to the research aspects of my methodology.

3.6 Methodology

This study analyses the worksheets that are used at various museums in the Gauteng province of South Africa for appropriateness as instruments for facilitating learning and to determine the extent to which the worksheets that are used at Oppenheimer Life Sciences Museum (OLSM) promote learning during a museum field trip.

The following questions were investigated:

1. How appropriate are the worksheets used at various museums in Gauteng as instruments for facilitating learning during museum visits?

2. How are worksheets used by school groups during the tour of a biology exhibition at the OLSM?

3. To what extent are the worksheets at the OLSM effective in facilitating learning during a school visit?

My research work was done in two phases. Phase one was analysis of worksheets and phase two was a case study.

3.6.1 Research design

This research falls under the qualitative, interpretive paradigm. I chose the qualitative, interpretative paradigm as it suited what I intended to do: describing and interpreting social phenomena directly from its natural setting. There are two main paradigms that have

influenced educational research in the recent past: the quantitative (or positivist) and the qualitative (or interpretative) paradigms (Opie, 2004; Burton, Brundrett, & Jones, 2008). The two paradigms represent opposing worldviews with regards to ontology and epistemology (Burton et al., 2008). The positivist paradigm emphasises an objective approach to studying social phenomena. It focuses on observation, measurement and prediction as a means of understanding human behaviour. Positivists view knowledge as generated from observation and experiment (Dash, 2005). On the other hand, the interpretative paradigm stresses a subjective approach to studying social phenomena. It concentrates on describing and interpreting evidence to bring about meaning. The paradigm supports the belief that reality is constructed by subjective perceptions and predictions cannot be made. In the interpretative paradigm researchers need to immerse themselves into the data and search for what is important (Burton et al., 2008).

3.2.2 Quantitative versus qualitative

Each of the two paradigms discussed above focuses on either of the two main research approaches: quantitative and qualitative. The quantitative and qualitative approaches are often associated with the positivist and the interpretive paradigms respectively. However there is an overlap as educational researchers have tended to frequently use both approaches (Opie, 2004). Quantitative involves determining amounts of characteristics on display whilst qualitative involves describing the characteristics of events or people. Quantitative data therefore provides evidence of the scale or relative importance of a problem whereas qualitative data attempts to offer an explanation or interpretation (Burton et al., 2008). Unlike the quantitative approach in which the researcher manipulates the study setting, the qualitative approach is a discovery oriented approach where no prior controls or limitations are placed on the research settings or outcomes. The data that is collected is directly from the natural environment or setting where the phenomenon is being studied (Patton, 1990). Burton et al. (2008) suggests that a combination of both quantitative and qualitative approaches in research could significantly strengthen arguments as numerical data will give immediate point of impact to the reader whilst the qualitative evidence give meaning to the numbers thereby enriching the interpretation and analysis.

3.2.3 Phase one of the study: a descriptive, quantitative and qualitative approach

The aim of this phase was to analyse worksheets that are used at museums during museum visits and evaluate their effectiveness as instruments for facilitating learning. A combination of descriptive quantitative and qualitative approaches was used to analyse the worksheets. Descriptive research is research that involves describing exactly and accurately the facts and characteristics of the subjects of investigation with the aim of making an evidenced commentary of the current situation (Isaac & Michael, 1981; Burton et al., 2008). My approach to phase 1 was descriptive in the sense that it involved describing exactly and accurately the characteristics of the worksheets that were chosen for the study. It was also quantitative and qualitative because there was measurement of the amounts of characteristics displayed by the worksheets followed by an explanation of what the measurements meant. Twenty-three worksheets were analysed. The research instrument that I used to analyse the worksheets and how I obtained and selected the worksheets are described in later sections of this chapter.

3.2.4 Phase two of the study: A collective case study

The aim of this phase was to provide information on how worksheets are used by groups of learners during a museum visit and determine the extent to which the worksheets are effective in facilitating learning during a museum visit. Allen's study (2002) showed that it was possible to capture moment-by-moment learning by visitors through the recording and analysis of visitor conversations as they move through the museum. The use and effectiveness of worksheets during museum fieldtrips is surrounded by controversy. I realised that capturing the moment-by-moment events of worksheet use in reality would make the events speak for themselves on how worksheets are used and the extent of their effectiveness in facilitating learning rather than me the researcher interpreting or judging the events. In order to find out as much as possible about the use of worksheets during museum visits and hence get a more complete picture of worksheet use, I focussed on a number of cases. I therefore chose a case study approach which required an in-depth study of a real social activity in a real situation with real people (Opie, 2004). This made my approach a case study type called 'collective case studies' whereby a number of individual studies are carried out to gain a fuller picture (Stake, 1994 in Cohen, Manion, & Morrison, 2000). My collective case

studies involved 11 groups of learners (cases). How I selected the eleven groups and the case study site, the instruments that I used for gathering data are all described in a later section.

3.7 The research instrument for phase one: The worksheet analysing instrument

Figure 3.1 below shows the worksheet analysing instrument. This is followed by a description of how I developed the instrument.

The worksheet analysing instrument					
Characteristics of worksheets (categories)	**Sub-categories**		**Frequency**		**Comments**
1. Task density	**(1a)** Number of tasks in the worksheet	Time/question (T/Q)			
	(1b) Number of displays to be visited to complete the worksheet	Time/display			
2. Orientation cues	**(2a)** Pre-visit orientation tasks				
	(2b) During visit orientation tasks				
	(2c) Is there a map or directions in the worksheet				
3. Information source	**(3a)** Tasks requiring information from text/labels				
	(3b) Tasks requiring information from objects				
	(3c) Tasks requiring information from audio-visual presentations				
	(3d) Information requiring information from the teacher, museum educator or tour guide				
	(3e) Tasks requiring prior knowledge				
	(3f) Tasks requiring information from practical activities				
4. Level of choice	**(4a)** Tasks with 1 correct answer only (no choice)				
	(4b) Tasks with 2 or more correct answers (some choice)				
5. Cognitive level	**(5a)** Lower order tasks (knowledge)				
	(5b) Medium order tasks (knowledge and application)				
	(5c) Higher order tasks (analysis, synthesis and evaluation)				
6. Response format	**(6a)** Tasks requiring oral answers only				
	(6b) Tasks requiring oral and written answers				
	(**6c)** Tasks requiring pictorial presentation for answers				
	(6d) Tasks requiring action only, no verbal answers				
	(6e) Tasks requiring answers in form of written text only				
	(7a) Open-ended tasks				

The worksheet analysing instrument			
7. Question format	**(7b)** Closed –ended tasks		
8. Classroom connection	**(8a)** Tasks connecting to classroom topics		
	(8b) Tasks with no connection to classroom topics		
9. Social interaction	**(9a)** Tasks requiring students to work in pairs or groups		
	(9b) Tasks requiring teachers/tour guides to work with students		
	(9c) Tasks requiring students to work individually		
10. Site specificity	**(10a)** High		
	(10b) Low		

Fig 3.1: The worksheet analysing instrument.

I developed the worksheet analysing instrument using the ten worksheet characteristics that I described in chapter two namely: task density, orientation cues, information source, level of choice, cognitive level, response format, question format, classroom connection, social interaction and site specificity. These characteristics are listed in column one of the instrument as categories. The development of the instrument was informed by literature, my own personal experiences as a museum visitor and inductively from a preliminary examination of the nineteen worksheets that I analysed. I took each of the ten characteristics above to represent a category and therefore the instrument had ten categories. The ten categories were coded 1-10 as shown in Fig 3.1 above. I then identified the various forms of each category using literature where possible and took these forms to be the subcategories of the various characteristics. For example, category 1 task density was described by Kisiel (2003) as having two forms: number of tasks in a worksheet and number of halls to be visited in order to complete the worksheets. I replaced halls with displays after an observation that the museums in my study did not have halls but rather display areas on the same floor or area. I then took the two forms; number of tasks and number of displays to represent the two subcategories for the category task density. For the category information source, Kisiel (2003) had identified two forms of information sources: object and label text. However, I also identified three other sources from my own museum experiences as a museum goer during a visit to the Walter Sisulu Botanical garden with a group of teachers. We were given worksheets to complete. The worksheet questions focussed on the importance of biodiversity. The tour of the garden did not provide any information from the objects in the garden or text. We however managed to answer the worksheet questions using prior knowledge, information

from our tour guide and from a video presentation that we were shown. I therefore considered prior knowledge, audio/visual presentations and the teacher/museum educator/tour guides as possible sources of information and hence also subcategories to the category, information source. During a preliminary examination of worksheets from one of the museums, I discovered that some of the tasks in the worksheets required information from practical activities, hence practical activities was also added to the category information source as a subcategory. This process was repeated for all the categories. Each category was assigned a code and the corresponding subcategories for each particular category were also coded. The codes for the categories were numerical and those for the subcategories alphanumerical (the subcategories were assigned the same number as their category number plus a letter to differentiate between the various subcategories). For example, the characteristic task density was assigned the number (1) and its two subcategories, number of tasks and number of displays to be visited were then coded (1a) and (1b) respectively. The identification of all possible forms of each category and the subsequent numbering of the identified subcategories resulted in the development of the instrument shown in Fig 3.1 above.

It is important to note that the category cognitive level was divided into three subcategories namely lower order: knowledge, medium order: comprehension and application and higher order: analysis, synthesis and evaluation. This categorisation is a simplification of Bloom's taxonomy (Bloom et al, 1956). This simplification was adopted using ideas from Green and Rollnick (2007) which suggest that comprehension and application (Bloom's levels II and III respectively) are more or less comparable in terms of cognitive demand and that analysis, synthesis and evaluation (Bloom's levels IV, V, and VI respectively) are regarded as collectively embracing higher order thinking abilities.

3.4 The research instruments for phase two – A collective case study

Phase two of my research involved audio-recording conversations of 11 groups of learners as they moved through the museum. In her research, Allen (2002) made it very clear that recording of extended conversations of visitors in a museum environment was a very challenging task due to the massive amount of ambient noise. To overcome this challenge, my supervisor provided me with high quality cordless and portable digital audio recorders which I then used to collect the data. The devices were used in conjunction with small detachable microphones to improve the quality of the recordings. In addition to the recorded

conversations I also made a backup of notes from my observation of the groups. These notes 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 for example whether they were using worksheets or not, whether they were completing them or just discussing the questions.

3.5 Improving the quality of the research

In order to improve the quality of this research there was need to look into the issues of trustworthiness. To quantitative researchers, trustworthiness refers to the issues of validity and reliability. In qualitative research, trustworthy research means that the research should be credible, dependable and confirmable. These concepts are however said to be extensions or adaptations of the concepts of validity and reliability (Scaife, 2004). Validity can be defined as the degree to which a research instrument measures what it purports to measure. In qualitative research it refers to the meaningfulness, honesty and rightness or correctness of the claims made based on the scope of the collected data (Cohen et al, 2000). I used a number of strategies to improve the trustworthiness of the research instruments.

3.5.1 Validation of the worksheet analysing instrument

The validity of the worksheet analysing instrument was checked through face validation. This involves using an expert in a specific field of study to check if the instrument measures what it is meant to measure. I gave the instrument to experts (an expert in informal education, an academic who is an experienced life sciences lecturer at Wits School of Animal Plant and Environmental Sciences, a museum educator, and a group of ten Life Sciences teachers) to check whether the instrument categories were relevant and if they catered for all the features of a worksheet. The experts were also asked to find out if the wording for the various sub-categories were not ambiguous. These experts suggested a number of changes which were considered and some of them incorporated into the instrument. Below are the suggested changes that were incorporated into the instrument:

- A third sub-category (2c) was added to category 2 - Is there a map or directions in the worksheet?
- The wording of sub-categories 4a and 4b for the category ‘level of choice’ were said to be vague. The sub-categories were therefore reworded as follows –4a **Tasks with one**

possible answer was changed to **Tasks with one correct answer**. 4b **Tasks with 2 or more possible answers** was changed to **Tasks with 2 or more correct answers**.

- The word *verbal* was substituted with the word *oral* in sub-categories 6a and 6b. This change was a result of a suggestion that text can also be described as verbal but these sub-categories refer to something expressed in spoken form only.
- Sub-category 6c was changed from **Tasks requiring non-verbal and written answers** to **Tasks requiring pictorial presentation only**.
- Sub-category 6d was changed from **Tasks requiring non-verbal and unwritten** to **Tasks requiring action only no verbal answers** e.g. search, observe.
- A fifth sub-category (6e) – **Tasks requiring written answers only** was added to category 6.
- A third sub-category to category 9 was added (9c) – **Tasks requiring students to work alone**.

3.5.2 Reliability of the worksheet analysing instrument

Reliability of an instrument or a data-gathering procedure is defined by Scaife (2004) as 'the extent to which a data-gathering process produces similar results in similar conditions' p. 68. The test-retest procedure or 'triangulation by researchers' was used to judge the reliability of my worksheet instrument. This procedure involved an independent application of the data-gathering procedure to the same subjects by three different researchers (Scaife, 2004). I therefore, analysed three worksheets using the instrument and recorded the results. I then sent the three worksheets and the instrument to two other people who also analysed the worksheets using the same instrument. The two people were a PhD fellow and a biology lecturer in the University of the Witwatersrand's division of Maths and Science Education. I then compared these two people's results with mine. The results were the same for all the categories except for categories three (information source) and five (cognitive level) of tasks. The category information source was difficult as it required familiarity with the exhibits. I had to describe the exhibits to them then discuss and agree on the source of information for each task. For category five there was disagreement on the cognitive level of a number of tasks. We discussed this discrepancy and identified one main cause of the disagreement: that for some of the tasks, if the museum visit is done after the learners have been taught the topic that is covered by the tasks, then the tasks would be at knowledge level. However, if is their

first encounter with the topic, the tasks would be at a higher level. An example of such a task is:

A wetland is land which is flooded with water most of the time. Give one good reason why we should look after our wetlands and not destroy them.

If the learners have learnt about wetlands before the visit, they would simply recall the points from the lessons. If, however, their visit is before learning about the topic then they will have to examine and analyse the wetland features to find out what it has that would be important to warrant our protection. This discussion highlights and hence supports the argument of Green and Rollnick (2007) that for one to easily allocate questions to cognitive levels calls for familiarity with the teaching situation. In our case, therefore, in order for us to agree on the cognitive level of the worksheet tasks, we needed to know the kind of knowledge learners bring to the museums. To overcome this problem, I decided to find out from the museums what their rationale was for constructing the worksheets. One curator didn't know as they were using worksheets that had been prepared by a museum educator who had since left the institution. The other three people at the other three museums that I managed to contact (two museum educators and a curator) said that their focus was on whether the learner would be able to answer the question using information in the museum (exhibits, presentations, text labels etcetera) meaning that the assumption would be that they are encountering the information for the first time. With this information, I decided to assume that the learners would not have covered the topic in the classroom before the museum visit.

3.5.3 Improving the quality of phase two research instrument

One way of improving the validity of research instruments is to carry out a pilot study (Sanders and Cramer, 1992). A pilot study is a study that is done to try to uncover and solve any problems that may be inherent in the study methods before full implementation (Hitchcock and Hughes (1989) in Cohen et al, 2000). Piloting of my phase two research tool was done on the first day of the 2008 edition of the Yebo Gogga exhibition (see section 3.7.2). The pilot study involved five grade six learners from a public school, two girls and three boys. Prior arrangements had been made with their parents and consent forms signed. The purpose of the pilot study was to test the audio recorders that were to be used to record the learner conversations and to try and detect any problems that could arise during the main study. The recorders were put into the learners' pockets or under the uniform out of the

learners' sight. Hiding the recorders from the learners' sight was done to try and make the learners 'forget' that they were being recorded so as not to affect the nature of their conversation and their behaviour as well, which is a concern among museum professionals when data gathering involves audio-recording visitors (Allen, 2002). Small microphones were then connected to the audio recorders and pinned to the collar area of the learner so as to be near their mouths. The microphones were used to improve audio quality of the recording and to capture the learner conversations even in cases where the ambient noise was huge and the learners were talking in low tones (Allen, 2002). I did not give the learners any instructions as to how they should move through the museum. They were given the freedom to move as they liked. The recording was done for one hour only as I assumed that one hour was long enough to enable me to uncover any possible problems. I did not transcribe the entire conversations. Instead, I played back all the five recordings making some notes.

3.5.4 Results of the pilot study

Initially the learners moved together as one group, and then they split into two groups: one group of two boys and the other group of two girls and one boy. During playback I discovered that during the period when they were moving together as one group, there were many instances where they had almost separated but they kept on asking each other whether or not they weren't supposed to move as one group? They eventually split however. I also discovered that one recorder captured the conversation for the whole group. So when I played back the five recordings, it was like listening to the same conversation five times.

The pilot study showed that these learners did not go through the museum individually. They moved in groups and in conversation confirming the observations of McManus (1985). The study also showed that one recorder was enough to record the conversation of a group of 2-5 learners. Therefore, in the actual study, individual learners were given the recorders. The assumption was that the learner with the recorder will eventually come together with others to form a group. In addition, the pilot study also showed that when learners were put into designated groups, there was a tendency to keep on reminding each other that they were supposed to move in a group. This constant reminder had the potential to make the learners more conscious of the recording that was taking place and hence control or influence what they would talk about. Hence a decision was taken not to form groups but rather to give the recorders to individual learners and allow them to form their own groups. Allowing learners

to self-select their group has also been shown to promote social cohesion (McManus, 1985). The observation that one recorder was enough for a group made it possible for me to record the conversations of more than one group at the same time. However, I could only observe one group at a time. During playback I also discovered that one recorder accidentally switched off for the greater part of the recording time. Fortunately, the high quality audio-recorders had a function which when set would prevent the recorder from accidentally switching off. This meant that there was no need for me or for the learners to constantly check if the recorder was still on, an observation by Allen (2002) which could make learners to remain more conscious of the recorders. The background noise did not seriously affect the recording of the learners' conversations.

3.6 Data collection – Phase one

3.6.1 Collection of worksheets

My initial intention was to collect worksheets from around the country (South Africa). I searched the internet and created a data base of natural science related museums in the country with both the physical and the email addresses and the telephone numbers. I emailed letters (See Appendix B) requesting for worksheets and for permission to analyse them to all the museums that could be reached through email. One museum responded immediately sending me five scanned worksheets. It was this batch of worksheets which made me realise that an accurate analysis of the worksheets would require familiarity with the museum setup and the actual exhibits. This led me to narrow my sampling from covering the whole country to the Gauteng province where I would be able to visit the museums. I emailed 15 museums in Gauteng. Three of these institutions said they were research institutions and hence do not produce any worksheets. Five of the museums did not respond to my emails and when I called them, they said that although they did get school groups visiting them ocassionally then, having school groups visiting was not their main thrust hence they did not produce any worksheets for learners. Two museums simply said they do not produce any worksheets for learners. Four museums responded favourably including the one that had sent me some scanned worksheets and invited me to visit them and get the worksheets. I could not get through to the last museum by email or telephone and hence it was left out of the study. A total of 53 worksheets were collected from four museums in Gauteng. The details of the

museums and the number of worksheets that were collected from each museum are shown in table 3.1 below.

Table 3.1: Details of museums and collected worksheets

Institution*	Total number of worksheets made available	Number of worksheets for each phase			
		Foundation (grades 0-3)	Intermediate (grades 4-6)	Senior (grades 7-9)	FET** (grades 10-12)
Museum Z (A zoological garden)	19	6	11	2	Nil
Museum B (A botanical garden)	17	2	5	3	7
Museum E (An environmental centre)	4	nil	4	nil	Nil
Museum A (History of medicine)	13	nil	13	nil	Nil
Total number of worksheets	53	8	33	5	7

*Actual names of museums not used to maintain confidentiality, ****FET**-Further Education and Training Band.

When I was collecting these worksheets, I did not have a predetermined system on how to sample the worksheets as I had no idea of how many each museum had. Hence, the worksheet collection was random. At museums Z and B, the educators who attended to me simply pulled out the worksheets from a number of drawers where they were kept and gave them to me. At museum E the curator gave me all four sets of worksheets which they used. The museum A curator gave me all 13 sets of worksheets that she said they have developed for use at the museum.

Table 3.1 shows that only two of the four museums (Z and B) produce worksheets for foundation phase and senior phase learners. All four museums produce worksheets for intermediate phase. Only one of the four museums (B) produces worksheets for Further Education and Training band. The intermediate phase worksheets which are common to all the four museums were therefore chosen for analysis. The other reason for choosing intermediate phase worksheets was an observation that intermediate phase learners visit museums most. This reason was given by museums E and A curators for producing intermediate phase worksheets only and Lelliott's (2009) study also supported this observation.

The focus of phase one of this research was to analyse the worksheets that are for use during museum visits i.e. when learners are at the museum. However, the intermediate phase worksheets that I had chosen for analysis had a mixture of pre-visit, during-visit, post-visit

and general worksheets. Therefore, the worksheets needed to be categorised. The following five categories were chosen: **pre-visit**, **during-visit**, **post-visit**, **general** and **other**. These categories are explained in Table 3.2 below.

Table 3.2: Definitions of worksheet categories

Category	Definition
Pre-visit	Worksheets that are meant for use by learners at school in preparation for the museum visit.
During-visit	Worksheets that are meant for use by learners at the museum when they visit.
Post-visit	Worksheets that are meant for use by learners back at school after the museum visit.
General	Worksheets which, though meant for use at the museum during the museum visit can be completed by the learner without the learner having to visit the museum.
Other	Worksheets that cannot fit in any one of the other four categories.

The five categories above were used to categorise the intermediate phase worksheets. The results of the categorisation are shown in Table 3.3 below.

Table 3.3: Results of the categorisation of intermediate phase worksheets.

Name of museum	Pre-visit	During-visit	Post-visit	General	Other	Total
Z	1	3	3	4	0	11
B	0	2	0	2	1	5
E	0	4	0	0	0	4
A	0	13	0	0	0	13
Total	**1**	**22**	**3**	**6**	**1**	**33**

Table 3.3 above shows that there were worksheets in each category (see Appendix A for an example of a worksheet from each category). The pre-visit, the during-visit and the post-visit worksheets are all from one museum and when I went through them, I could see that they build on each other. The pre-visit worksheet prepares learners to see rhinos. The during-visit worksheet deals with the learner who is looking at the rhinos. The tasks in this worksheet help the learner to learn about the life and characteristics of the rhino. The post-visit worksheet helps the learners to consolidate what they would have learnt at the museum. The pre-visit and post-visit worksheets were left out of the analysis process as they fell outside the

focus of the research, which is the analysis of during-visit museum worksheets. The 'general' worksheets, though meant for use during the museum visit were also excluded from the analysis. The reason for excluding them was the fact that a learner does not need to visit a museum in order to complete them, which makes these worksheets unsuitable for use as during-visit museum worksheets. The general worksheets were considered unsuitable for use at the museum because I felt that if learners could complete the worksheets without having to leave the classroom, why waste their valuable museum time by asking them to do something they can do at school. Museums are meant to be places where learners are exposed to that which they cannot find in the classroom. The worksheet under the category 'other' had two sections, a pre-visit and a during-visit section. I therefore, could not fit it into any of the other categories and so created the 'other' category. Although the whole worksheet did not fit into the during-visit category, the during-visit section did and as it is used by learners at the museum when they visit. The during-visit section of the worksheet was therefore analysed. It is also important to note here that I appreciated the idea of combining pre-visit and during-visit tasks into one worksheet as this may help learners to prepare for the museum visit if they decide to familiarise themselves with the worksheet tasks. A total of 22 during-visit worksheets and one worksheet in the 'other' category were analysed.

3.6.2 Analysis of the worksheets: Description of the process

The worksheet analysing instrument was administered in the following manner: I went through one worksheet at a time until I had gone through all the worksheets that I analysed. During the analysis, I focused on one category at a time. I started with category 1, task density, went through the worksheet marking each task or question with the codes for task density. If one looks at worksheet A1 (Fig 3.2) below, there are 8 tasks and all are marked with the code 1a. Where I encountered multipart questions, I coded them as separate questions, if there was clearly a different task or idea introduced. For example task 3 has 2 parts. Part 1 requires a learner to describe how the doctors are dressed and part 2 requires the learner to identify the risks involved. The two tasks demand different information from the learner hence they were counted as two separate tasks (task 3 and task 4). I would then move on to the next category and would analyse all the worksheet tasks for that particular category again marking every task with the appropriate code. I would repeat the process with each category until I had examined every worksheet task for all the categories.

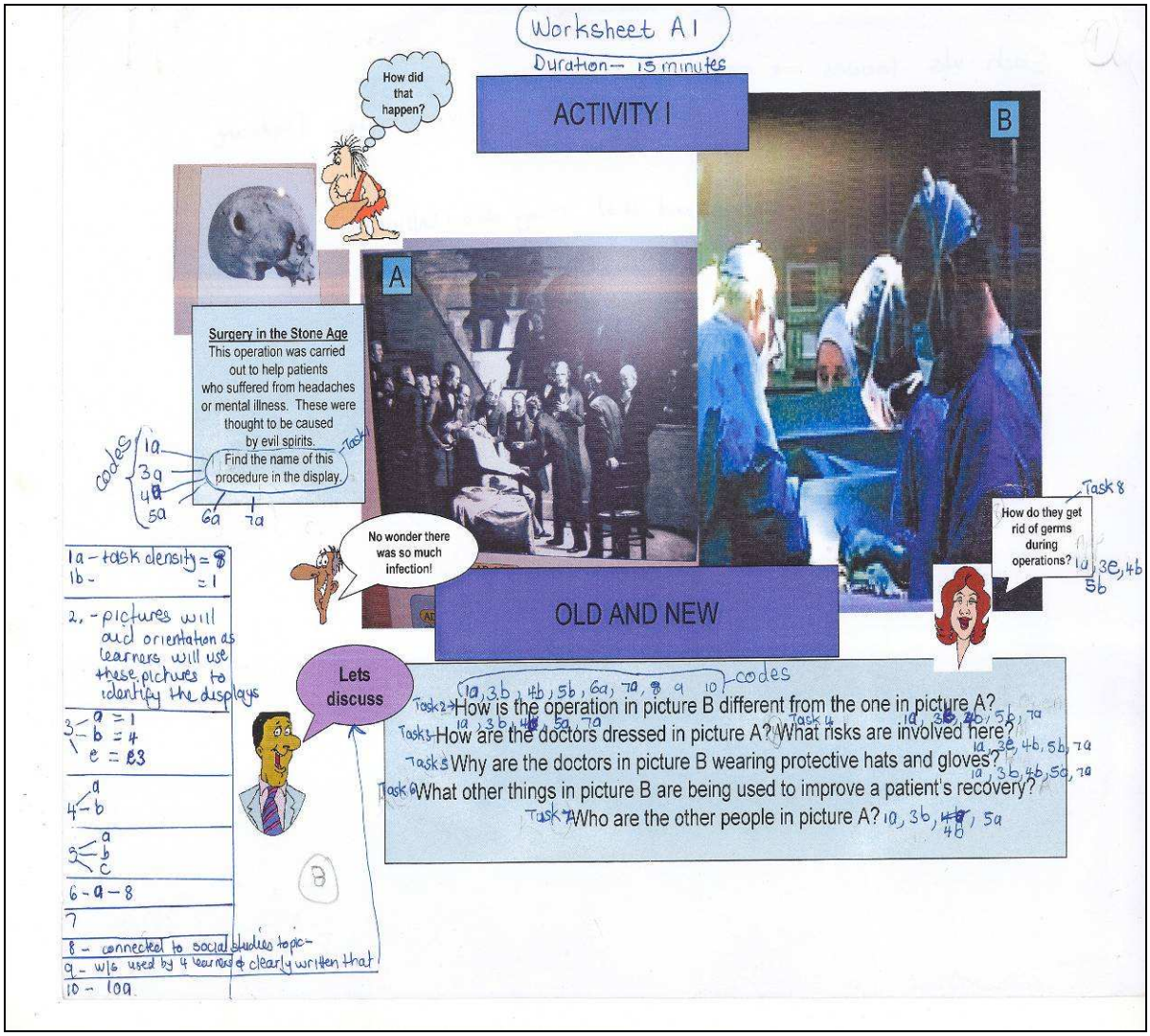


Fig 3.2: An example of an analysed worksheet

At the end of the analysis, the worksheet would look like worksheet A1 in Fig 3.2 with every task marked with the codes 1-10. Where a code is missing (for example code 2 is missing from the tasks in worksheet A1) it may mean that the features of that characteristic are missing or cannot be quantified. In such a case, explanatory notes would be added under the column labelled comments. For category number 8 which looks at the connection of worksheet tasks to the classroom topics, I first listed all the topics that were covered in the worksheets then used the Revised National Curriculum Statement (NCS) document to determine if the tasks were aligned to the classroom. I also sought the help of an experienced primary school Natural Science teacher who helped me to establish the topics that were aligned to the school curriculum. Three of the museums had also told me when I was collecting the worksheets that they aligned their worksheets to the school curriculum to make

them relevant to the visiting learners and their teachers. It was from this teacher that I learnt that the topics about the history of medicine that are covered in the worksheets from Museum A fall under Social Sciences not Natural Sciences. The results for the analysis of each worksheet were then summarised using the worksheet analysing instrument template as shown below for worksheet A1.

Results from analysis of worksheet A1					
Characteristics (categories)	**Sub-categories**		**Frequency**		**Comments**
1. Task density	**(1a)** Number of tasks in the worksheet	Time/question (T/Q) (min)	8	1.9	
	(1b) Number of displays to be visited to complete the worksheet	Time/display (min)	1	15	
2. Orientation cues	**(2a)** Pre-visit orientation tasks		-		Worksheet has pictures that learners can use to identify the display and the objects.
	(2b) During visit orientation tasks		-		
	(2c) Is there a map or directions in the worksheet		-		
3. Information source	**(3a)** Tasks requiring information from text/labels		0		
	(3b) Tasks requiring information from objects		7		
	(3c) Tasks requiring information from audio-visual presentations		0		
	(3d) Information requiring information from the teacher, museum educator or guide		0		
	(3e) Tasks requiring general knowledge		1		
	(3f) Tasks requiring information from practical activities		0		
4. Level of choice	**(4a)** Tasks with 1 correct answers only (no choice)		3		
	(4b) Tasks with 2 or more correct answers (some choice)		5		
5. Cognitive level	**(5a)** Lower order tasks (knowledge)		4		
	(5b) Middle order tasks (knowledge and application)		4		
	(5c) Higher order tasks (analysis, synthesis and evaluation)		0		
6. Response format	**(6a)** Tasks requiring oral answers only		8		
	(6b) Tasks requiring oral and written answers		0		
	(**6c)** Tasks requiring pictorial presentation for answers		0		
	(6d) Tasks requiring action only, no verbal answers		0		
	(6e) Tasks requiring answers in form of written text only		0		
	(7a) Open-ended tasks		0		

Results from analysis of worksheet A1			
Characteristics (categories)	**Sub-categories**	**Frequency**	**Comments**
7. Question format	**(7b)** Closed –ended tasks	8	
8. Classroom connection	**(8a)** Tasks connecting to classroom topics	8	
	(8b) Tasks with no connection to classroom topics	0	
9. Social interaction	**(9a)** Tasks requiring students to work in pairs or groups	8	
	(9b) Tasks requiring teachers/tour guides to work with students	The museum educator can help by facilitating the discussion	
	(9c) Tasks requiring students to work individually	0	
10. Site specificity	**(10a)** High	High	
	(10b) Low	0	

Fig 3.3: Template showing how worksheets were analysed and how the results for each worksheet were recorded

The raw numerical data from the analysis of the worksheets from each museum were then combined and summarised in a single table (see Appendix C).

As can be seen in the above summary of results for worksheet A1, the analysis produced data which was in numerical form. The analysis and discussion of results were therefore combined with qualitative explanations in chapter 4 to make the numerical data more meaningful and to try and paint a clearer picture of the properties and dimensions of the worksheet that were embedded in the numerical data.

3.7 Data collection, phase two: Worksheet in use – a collective case study

The second phase of this study was carried out at OLSM. The aim of this phase of the study was to determine the extent to which the worksheets that are used at OLSM promote learning during a museum field trip. This phase involved recording the conversations of student groups as they went about their museum visit, hence a qualitative approach was used. I first of all analysed the whole set of worksheets that had been prepared for the exhibition and evaluated their appropriateness as instruments for facilitating learning during the exhibition (See table 5.1 in chapter 5). I then observed and recorded the conversations of learners as they went about their tour of the museum. The audio-recorded conversations were supported by my own observation notes.

3.7.1 Museum selection

I chose OLSM for the second phase of the study for two main reasons. The first reason was that the museum is conveniently located at the University of the Witwatersrand where I was working part-time. The location of the museum was an advantage to me as I could and did familiarise myself with the exhibition by attending the planning meetings between the curator, the service students who were going to exhibit and the other exhibitors from outside the university. This helped me to know in advance the exhibits that would be on display and how the exhibition would be organised. Familiarising with the exhibition was important as I intended to do my own transcription and according to Allen 'familiarity with the exhibition is a key requirement for good transcription' (2002, p272). The second reason was that the museum holds a temporary four-day annual life sciences-related exhibition in September or October. One of the challenges that Allen in her 2002 study faced was that they had to wait for a long period (daily for twenty days) to get appropriate participants. With a limited time for data collection, using this four-day exhibition was going to be advantageous as it meant that I was not going to need long periods of time to get enough and appropriate participants (at least 8 groups, two from each phase: foundation, intermediate, senior and FET). The exhibition is called *Yebo Gogga Yebo Amablomo*. I sent letters to the OLSM curator (Appendix B) requesting for permission to carry out my research at the museum and to analyse their worksheets. The permission was granted.

3.7.2 Overview of the Yebo Gogga exhibition

Yebo Gogga Yebo Amablomo is a temporary exhibition that is organised by the OLSM curator and undergraduate students at the School of Animal Plant and Environmental Science (APES), Faculty of Science in the University of the Witwatersrand in collaboration with several institutions. It focuses on themes that relate to 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 arthropods, 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 is aligned towards a specific theme. In 2006 the theme was on health and disease and the title of the exhibition was *Umuthi*. In 2007 the theme was about partnership between humans and nature and it was called '*Ubuntu in nature, it's all about partnerships'*. The 2008 edition of the exhibition (the year when I collected my data) was held from the 27th to the 30th of September. The main

theme of the exhibition was '*Defence'* and the title was '*Defender – Bugs, Plants and Animals strategise defence'*. The goal of the exhibition was to show the public how plants and animals defend or protect themselves against their enemies; their survival strategies. Some of the organisms' defence mechanisms are obvious while others are not and the public was being invited to come and experience these mechanisms for themselves. The other theme which was reflected in many exhibits was about the harm that we humans cause to the environment. For example how we destroy wetlands, pollute the environment and indiscriminately kill wild animals using snares.

The exhibition had more than thirty exhibits. Table 3.4 describes twenty of those exhibits. The twenty exhibits are the ones on which the worksheets questions were based.

Table 3.4: 2008 Yebo Gogga exhibits

Exhibit	Exhibit title in the worksheets
Recycling	Make haste reduce waste
Earthworms	Underground defenders*
Cockroaches	SA Roachman
Melville kopjes	Defending our heritage*
Rand water	Defenders of water, our most precious resource*
Dung beetle	Saving biodiversity for future generations
The Walter Sisulu garden	Green defenders for all*
Bees	Bee-ing social
Fossils	War and peace in the distant past
Arthropods	Arthropods arsenal*
Reptiles	Scale up your defences*
Mosquitoes	The moz squad
Drosophila	Drosophila
Seed dispersal	Seed dispersal
Locusts	Locusts
Owls	Urban wildlife warriors
Birds	Defenders of the skies*
wetlands	We are the defenders*
Plants	Defending the kraal*
Arachnids- spiders and scorpions	Awesome arachnids – The aggressive defenders*

*Titles that highlighted the theme of the exhibition

Nine of the exhibits were given titles that would constantly remind learners of the theme of the exhibition. These titles are marked by an asterisk in table 3.4 above. However, the titles were only indicated in the worksheets not at the exhibit tables. Each exhibit table was assigned an explainer who was there to explain the exhibit and to help with the answering of

the worksheet questions. The explainers could be the students, the exhibitors or volunteers. These people were taking turns to man the exhibits.

3.7.3 OLSM worksheets

Worksheets at the museum are generated by undergraduate students in the School of APES. The students get questions from the exhibitors and then compile them into booklets. The worksheet questions are contributed by the exhibitors who are people of different backgrounds not necessarily educators and may affect the quality of the questions. The worksheets/booklets are prepared for all the four phases in the school hierarchy structure. It is the extent of effectiveness of these worksheets in facilitating learning that I wished to investigate in phase two of my study.

3.7.4 The research sample

Unlike in previous years, only 11 schools (8 primary and 3 high schools) ten of which were private schools and one public booked to attend the 2008 edition of the Yebo Gogga exhibition. The main reason for the low turnout was because the exhibition was being held when all public schools had closed for the third term school holiday. All the schools that booked for the exhibition were therefore considered for the case study. School Heads of booked schools were contacted via e-mail to ask for their permission to involve their students in my study. (see letter to principals in Appendix B) Seven schools (All private schools) granted this permission. Information sheets ensuring confidentiality and disclosing all aspects of my research as well as consent forms (Appendix B) were then sent to these schools for learners' consent (and parental consent) in the case of the learners under the age of fourteen[8] to read and sign if they were willing to participate in my study.

3.7.5 Recording of conversations and observation of school groups

For each school whose learner conversations were recorded, the following steps were followed. I approached the teachers and introduced myself. The teachers chose one learner or two (depending on the availability of the recorders) from among those whose consent forms had been signed. I switched the recorder on, set it on the non-switching off mode, then put it in the learners' pockets or under the uniform out of the learners' sight. I connected a

[8] The age of consent as approved by the University's ethics clearance committee

microphone to the recorder and pinned it to the collar area near the mouth of the learner. I then moved away and followed the learner at a distance. I observed each learner or group unobtrusively throughout the recording and made detailed field notes. To make my tracking of learners more inconspicuous I put on a green T-shirt which was the exhibition shirt put on by the explainers, the exhibitors, the tour guides and museum helpers (students who were helping out at the exhibition). This made me look like one of the many green-shirted people who were moving around in the exhibition area. One school arrived with a group that had been already chosen for me. The learners in the group had been chosen by the teacher and told that they would be moving together through the museum as a group. I did not ask the teacher for the criterion that she had used to choose the three learners for fear of offending her. I made sure to express my appreciation and gratitude to all participants for participating in my study. In total 11 group conversations were recorded. An overview of these groups is shown below.

Table 3.5: An overview of my sample for phase two

Phase	Number of groups	Grade
Foundation	2	1 and 3
Intermediate	5	2 grade 4s, 1grade 5 and 2 grade 6s
Senior	3	1 grade 7 and 2 grade 8s
FET	1	Grade 10

The table shows that I managed to get at least one group for each phase, so that every phase was represented. The recording and observation of school groups was done and completed during the 4-day exhibition period.

3.7.6 Worksheet use

Worksheets were given to all learners by museum helpers at the entrance of the museum just before the tour of the museum. The museum helpers did not compel learners to use the worksheets. Completion of the worksheets was therefore entirely up to the teacher and/or the learners. Each school group was assigned a tour guide who would take them through the museum. One full class formed a school group. Therefore the sizes of the school groups ranged from about twenty to thirty learners. The school groups were scheduled to spend only thirty minutes in the museum as the organisers wanted to accommodate as many school groups as possible during the normal school hours (between 9 am and 2 pm) as this was the

time most schools preferred to visit the museum (according to the organisers). Thirty minutes is however far too little for any meaningful learning to occur. This is because learning involves linking new ideas with old, assimilating and integrating our experiences into new ways of understanding, thinking and acting. As such, this requires time for reflecting and therefore takes time (Rennie & Johnston, 2004). Luckily for the school groups, the organisers were not monitoring the time that each group was actually spending in the museum. Hence, in the end, although school groups were scheduled to spend only thirty minutes in the museum, they all ended up spending at least an hour there though this resulted in the exhibition becoming overcrowded.

3.7.7 Transcription of conversations

In my study, conversations were considered to be vehicles for the social construction of knowledge. I first played back all the recorded conversations and made some qualitative comments before doing the transcriptions. I did this to get an overview of the conversations. I then used my observation notes to describe each group's conduct of the museum tour stating whether the worksheet was used and how it was used. The descriptions provided just enough data to inform the reader about the groups' overall activities and movement through the museum. Table 5.2 in chapter 5 is a summary of the overview. The playback was followed by the transcription. I did the transcription of the conversations myself because research findings, (Allen, 2002) have shown that familiarity with the exhibition produces more accurate transcriptions as it makes it easier for the transcriber to hear what the visitors would be saying. Not all the recorded conversations were transcribed in their entirity. In one case, I picked out the more striking features as the conversation was routine: asking the worksheet question, getting an answer and writing it in the worksheet. In another case the groups (two) filled the worksheets in silence for the greater part of the museum tour. In yet another case (4 groups) the learners did not use worksheets and they moved as one big group of more than twenty learners. For these groups only representative conversations or sections thereof were transcribed. The main criterion that was used in choosing to transcribe whole conversations or sections of them was the use of worksheet. Qualitative descriptions were however made about every group including comments on why the conversation was not transcribed.

3.7.8 Data analysis

After transcribing, the conversations were qualitatively analysed for evidence of learning. The conversations varied from very short to lengthy ones. Data analysis in qualitative research means making sense of the collected data (Hitchcock, 1995). The analysis protocol was a group by group qualitative description of their tour of the exhibition starting with the Foundation phase groups to the FET group. My fundamental goal was to highlight how learners were using the worksheets and also to draw attention to evidence of learning in the transcribed conversations. My descriptions therefore brought to light these interesting issues: evidence of learning and how learners were using worksheets. Excerpts from conversations or whole conversations were used as supporting evidence. Indicators of learning (see table 3.6 below) were highlighted in the conversation transcripts to signify evidence of learning. Evidence of learning was not quantified as the aim of the study was just to find out if worksheets facilitated learning or not during museum field trips. I also decided to highlight the differences that were reflected in the conversations of those who used worksheets and those who did not as I had managed to capture rich conversations of both learners who were using worksheets and those who were not.

3.7.9 Evidence of learning

The coding scheme or framework for identifying evidence of learning in learner-talk by Allen (2002) was used to indicate evidence of learning in the analysed conversation transcripts.The framework has five categories and sixteen subcategories. These categories and subcategories are described in Table 3.6 below.

Table 3.6: Framework for identifying evidence of learning in learner-talk (Allen, 2002)

Category 1: Perceptual talk (talk that indicates an awareness of objects of the museum environment)	
Subcategories of perceptual talk	**Explanation**
Identification	Pointing out to an exhibit or an interesting feature of an exhibit e.g "Guys look at that bullfrog."*
Naming	Stating the name of an object e.g. "That's a chongololo." *
Feature	Pointing out some concrete aspect or property of the exhibit e.g. "Look at those ticks. Their fillers look like they are animated"*
Quotation	Drawing attention to exhibit text by reading aloud part of a label e.g "For throat infection, insect bites...' That's for throat infection"*
Category 2: Conceptual talk (cognitive interpretation of whatever was being attended to in the exhibit)	

Subcategories of conceptual talk	Explanation
Simple inference	Single interpretation of part of an exhibit e.g. "Look, it's working so hard to get to that" [Learner looking at a mosquito trying to cross a mosquito net barrier]*.
Complex inference	Drawing of some kind of inference about the exhibit element beyond correctly interpreting what has been explicitly displayed e.g. "Look, they hide from light" referring to earthworms disappearing under the soil.*
Prediction	A statement forecasting what is expected will happen or is about to happen. "That guy will get agitated" [Learner referring to a python].*
Metacognition	Reflection on one's own state of current or previous knowledge e.g. "Oh! I never knew that." [learner referring to the fact that birds are the only animals that have feathers]*.
Category 3: Connecting talk (any kind of talk that made explicit connections between an exhibit and previous experiences)	
Life connection	Story, personal association or likening of exhibit element to something familiar e.g. "That's the stuff about evolution. My mom is actually teaching about evolution" [learner referring to skeletons of a chimpanzee, human and the Taung child].*
Knowledge connection	Declaration of knowledge gained prior to visiting the exhibition e.g. "It's a… gaggle. We learnt this from…." Learner responding to a worksheet question that said "What do we call a group of wild geese in flight?"*
Inter-exhibit connection	Any kind of link between exhibit elements including the bringing of information gained at a previously visited exhibit to the discussion of the current exhibit e.g. "Yoh, Ok, so we can use earthworms like, to save the environment. Like, ok it says here something about waste – organic matter. How? I don't get that, I don't understand" [This is an interesting connection to the previous exhibit which was on recycling of nutrients in order to save the environment. At that exhibit learners had suggested use of organic matter as compost as an example of recycling that saves the environment]*
Category 4: Strategic talk (talk of how to use exhibits)	
Categories of strategic talk	**Explanation**
Use	Statements about how to use an exhibit e.g. "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. That means you have to put it in hot water or a bath or smell the steam in it not eat it." [Learner responding to a group member who wanted to chew the leaves of herb on display].*
Metaperformance	An expression of evaluation of one's own or partner's performance, action or abilities e.g. "I don't think I did a very good job of it."**
Category 5: Affective talk (all expressions of feeling including pleasure, displeasure, surprise or intrigue)	
Subcategories of affective talk	**Explanation**
Pleasure	Expression of positive feelings or appreciation of aspects of an exhibit e.g. "cool, beautiful, wonderful, laughter."**
Displeasure	Expression of negative feelings or dislike towards aspects of an exhibit e.g. "That's disgusting" [learner looking at a handful of earthworms held by an exhibitor]*
Intrigue	Expression of fascination or surprise e.g "500 million cases, Wow!", Oh! Oh! Oh! Read this, all 80-90% of cases occur in South Africa" [Learners reading text about malaria cases in the world]. *

*Examples from my present study. ** Examples from Allen (2002)

3.8 Conclusion

In this chapter I have described my research design and how I collected the data. The descriptions were detailed to provide the reader with a full account of how I carried out my study.

Chapter 4

Analysis of worksheets

4.1 Introduction

This chapter presents the results and the discussion of phase 1 of my project which was the analysis of worksheets. The aim of this phase of the project was to analyse the worksheets that are used at various museums in Gauteng province, South Africa for appropriateness as instruments for facilitating learning during museum field trips. The research question that I was trying to answer is:

How appropriate are the worksheets that are used at various museums in Gauteng as instruments for facilitating learning during museum visits?

Firstly is the description of the different types of worksheets that were analysed. This is followed by the analysis of the worksheets and discussion of the results.

4.2 Description of the analysed worksheets

Twenty three intermediate, during-visit worksheets were analysed. How these worksheets were selected was described earlier in chapter 3 section 3.6.1. A look at the 23 worksheets (see Appendix A) showed that the worksheets could be grouped into three categories namely: **structured**, **find me** and **role-play** worksheets. **Structured** worksheets were those that consisted of a series of tutorial type questions or tasks for learners to do. Learners would be expected to answer these questions using whatever information obtained from the exhibits, the text in displays or the museum educators. **Find me** worksheets were worksheets with drawings and/or pictures of some of the exhibits that are found in the museum. Learners would be required to locate these exhibits in the museum. The **role-play** worksheet depicted a scenario that learners were expected to role play. The number of worksheets that fell into each of these categories is shown in Table 4.1 below. The worksheets were coded for easy reference in the discussions that followed the analysis. The codes are alphanumerical. The letter differentiates the museum from which the worksheet was obtained and the number differentiates between the worksheets from the same museum. For example worksheets from museum Z were coded Z1, Z2 and Z3. Worksheets from museum B were coded B1, B2, and so on. Of the 23 during-visit worksheets 19 were structured, 3 were find me and one worksheet was a role play.

Table 4.1: Categorisation of during-visit intermediate phase worksheets

Name of museum	Number of during-visit intermediate phase w/s*	Type of worksheet		
		Structured	Find me	Role-play
Z	3	3 (Z1+ Z2 + Z3)	0	0
B	4	3 (B1 + B2 + B3)	1 (B4)	0
E	3	2 (E1 + E2)	1 (E3)	0
A	13	11 (A1-A11)	1 (A12)	1 (A13)
Total	23	19	3	1

4.3 Analysis of 'find me' worksheets

As explained earlier 'find me' worksheets consist of pictures, drawings or clues (short descriptions) of exhibits that are found in the museum. Three find me worksheets were among the 23 worksheets. The description of these three worksheets is given below.

4.3.1 Find me worksheet B4

Worksheet B4 contained pictures and drawings of animals and plants that are found in a wetland ecosystem located in the museum. The task is for learners to use the pictures and drawings in the worksheet to try and find (or identify) the actual organisms. It focuses learners on finding and hence knowing the plants and animals that are found in that particular wetland ecosystem. The worksheet has a hidden structure in the sense that for learners who are not familiar with the required plants and animals, for them to be able to identify the organisms, they must know the features of the organisms that are easily identifiable and distinctive of those organisms. Therefore, there is a lot to learn in order to be able to correctly identify the organisms. However, there is need for mediation from the teacher or the museum educator for these learning opportunities to be effectively utilised.

4.3.2 Find me worksheet E3

Worksheet E3 is made up of drawings of some of the exhibits that are found at museum E. At the bottom of each exhibit drawing is the name of the exhibit. However, the names have some missing letters. Attached to the worksheet is another sheet with some clues in the form of short sentences describing the exhibits shown in the worksheet. Learners are required to use

the clues to locate the exhibits and to fill in the missing letters when they find the exhibits. The filling in of the missing letters will act as proof that the learners have located the exhibits or display areas described in the worksheet.

4.3.3 Find me worksheet A12

A12 contains pictures of a variety of exhibits that are found in the museum. The pictures in A12 are of some of the exhibits from which the structured worksheets that are used at that museum are based. Worksheet A12 is the one learners are given first, according to the museum A curator. Use of A12 orientates learners to the museum displays and exhibits.

4.3.4 Deductions from the analysis of find me worksheets

The analysis of find me worksheets shows that the worksheets play similar roles. They:

- Encourage exploration of the whole museum or the exhibition area by learners as they search for the exhibits shown in the worksheet.
- Serve the role of orientating learners to the museum environment before they start working on structured worksheets.
- Help learners to be aware of the location of exhibits before they embark on completing the more demanding structured worksheets.
- May encourage learners to try and observe the displays/ exhibits more carefully in their search.
- Are not too demanding mentally and therefore learners are likely to enjoy completing the task.

Find me worksheets if used properly and at the right time (beginning of the museum exploration) serve a very important role of orientating students and promoting social interaction. Orientation is one aspect of the physical context of the CML (Falk & Dierking, 2000) which if not considered, may negatively impact on the museum experience. Hence providing some means of orienting learners is likely to impact positively on their museum experience. According to Bowker (2000), children need time to look at exhibits before they can work out or answer the questions. Children also need to wander around the museum first in order to familiarise themselves with the museum environment and the location of the

exhibits. This reduces the novelty effect which has been shown to impact negatively on learning (Price & Hein, 1991).

4.4 The role-play worksheet A13

The role-play worksheet is based on an exhibit depicting a healing scene by a traditional healer (A sangoma). Learners are expected to act out the scene. There should be a sangoma and patients with a variety of ailments who come to consult the sangoma. The sangoma should know the herbs to give to his/her patients. If the role playing is done properly, it can be an insight for the children into the world of traditional healers. Apart from bringing variety to the museum experience, it is likely to give a lasting impression to the learners as it will immerse them into the social situation thereby transforming the information about traditional healing to experience (Blatner, 2002). Effective role playing however requires time which may not be available during the tour of the museum. Effective role playing also requires expert mediation (ibid).

4.5 Analyses and discussion of the structured worksheets

Structured worksheets are made up of many different types of questions focusing on one or more exhibits. A total of nineteen structured worksheets: 3 from museum Z, 3 from museum B, 2 from museum E and eleven from museum A were analysed. Each of the nineteen worksheets was analysed for the following ten characteristics: task density, orientation cues, information source, level of choice, cognitive level, response format, question format, classroom connection, social interaction and site specificity using the tool that I designed and described in chapter 3 section 3.3. The analysis procedure was described in section 3.6.2 of chapter 3. Summaries of the raw data for each museum are shown in Appendix C. Each table in Appendix C is a summary of the results of the analysis of worksheets from each museum. Below is a presentation of the same results but combined for all the worksheets from the four museums. The results and discussion are presented one worksheet characteristic at a time in the following order: first is the results and discussion of task density, followed by orientation cues, then information source, level of choice, cognitive level, response format, question format, classroom connection, social interaction and lastly site specificity. For each characteristic, I started by briefly explaining what it is about. Then in the form of a table, a bar graph or a detailed description, I presented the results and the discussion.

4.5.1 Task density

Task density refers to the number of questions on the worksheet and the number of displays that the learners are expected to visit in order to complete the worksheet. Task density and duration of the tour, excluding lunch breaks are used to determine the time (in minutes) that is available per question (T/Q) and per display (T/D). Low T/Q indicates that there is very little time available to answer each question and vice-versa and low T/D indicates that little time is given for each display. Table 4.2 below shows task densities of all the worksheets that were analysed.

Table 4.2: Task densities of the analysed worksheets

Museum	Worksheet	Time given to complete the w/s (min)	NOQ	NOD	T/Q	T/D
Z	Z1	Depends on individual teachers	6	1	-	-
	Z2	Depends on individual teachers	7	1	-	-
	Z3	Depends on individual teachers	8	1	-	-
B	B1	The time they will spend on each exhibit area will depend on the teacher or tour guide. Each group however is scheduled to spend 3 hours to tour and to complete worksheets.	10	1	-	-
	B2		8	1	-	-
	B3		6	1		
E	E1	30	16	6	1.9	5
	E2	30	11	1	2.7	30
A	A1	15	8	1	1.9	15
	A2	15	8	I	1.9	15
	A3	15	3	I	5	15
	A4	15	4	I	3.8	15
	A5	15	16	I	0.9	15
	A6	15	6	I	2.5	15
	A7	15	4	I	3.8	15
	A8	15	4	I	3.8	15
	A9	15	12	I	1.3	15
	A10	15	3	I	5	15
	A11	15	7	I	2.1	15

NOQ-Number of questions, NOD-Number of displays, T/Q-Time per question (min), T/D-Time per display (min)

Table 4.2 shows that task density (number of questions in the worksheet) varies significantly from one worksheet to another. Task density ranges from a lowest of 3 questions per worksheet to a highest of sixteen. At face value, task density appears to be low; however, the

time that is given to learners to complete the worksheets is very little which then translates to too little time per question. Table 4.2 also shows that T/Q ranges from as low as 0.9 minutes (worksheet A5) to a high of only 5 minutes. On average, the time that is made available to do each task in most of the worksheets is on the lower side, about 2 minutes. This feature (low T/Q) does not support learning. This is because learning is an activity which requires adequate time for the learners to actively engage with the exhibits and with each other. There is therefore not enough time for completion of worksheets and for discussing with each other if learners are to examine the exhibits and/ or read the text in order to answer the questions.

It has also been reported in the literature on museum learning that high task density negatively impacts on the learners' museum experience as the visiting time will all be spent trying to complete the worksheet (Mortenson & Smart, 2007). There will not be time for learners to freely explore the museum and to look at the exhibits of their choice. This is one possible reason why some learners then resort to copying from each other so as to complete the worksheet and be able to explore the museum. Learning in museums is made more meaningful when learners are given a measure of control of their learning and are able to pursue that which is more interesting to them (Mortenson & Smart, 2007). Low task density offers an opportunity to learners to complete the worksheet and pursue their own interests thus taking care of the learners' personal context (Falk & Dierking, 2000). In terms of task density therefore, most of the worksheets that were analysed are less likely to support learning.

T/Q was difficult to determine for museums Z and B worksheets. This is because the two museums cover a wide geographical area. Learners who visit museum Z spend a maximum time of three hours there and may complete more than one worksheet. The number of exhibit areas they visit and the time they spend in each area is determined by individual teachers and the accompanying museum educator. At museum Z, each visiting group spends the first 45 minutes listening to a presentation by the museum educators. After that, the school groups are free to explore the museum. The exhibit areas visited and the time spent in each area will again be up to the individual teachers.

4.5.2 Orientation cues

Orientation cues refer to those features of a worksheet that guide students through the museum to find the location of displays, exhibits and halls that the worksheet tasks pertain to.

The cues may include wayfinding systems such as maps and directional signs or 'advance organisers' such as pictures of exhibits and captions. Table 4.3 summarises the type of orientation cues that were identified in each worksheet.

Table 4.3: Orientation cues present in the analysed worksheets.

Museum	Worksheet	Types of orientation cues	Comments
Z	Z1	None	A map of the zoo is given to the leader of the visiting school
	Z2	None	
	Z3	None	
B	B1	None	A tour guide accompanies every group of 20 learners.
	B2	None	
	B3	Pre-visit tasks	
E	E1	None	The worksheet comprises questions only. The tasks are not marked in any way to indicate the displays or exhibits they pertain to
	E2	Introductory text	There is an introductory passage with some information on one of the concepts the worksheet is focusing on.
A	A1	Pictures and captions	Each worksheet focuses on one display only. The pictures of the exhibits in the display are all included in the worksheet together with captions (a short description or title accompanying the pictures)
	A2	Pictures and captions	
	A3	Pictures and captions	
	A4	Pictures and captions	
	A5	Pictures and captions	
	A6	Pictures and captions	
	A7	Pictures and captions	
	A8	Pictures and captions	
	A9	Pictures and captions	
	A10	Pictures and captions	
	A11	Pictures and captions	

Worksheets from museum Z do not have any orientation cues. However, every visiting school group is given a map of the zoo to help them to negotiate their way around and to locate the exhibits of their choice. Providing a map showing directions and location of exhibits as is done by museum Z is also an effective way of orientating visitors as it helps them to easily locate exhibits of their choice and hence facilitate learning. However, providing just one map for the whole group is likely to be a hindrance to free-choice learning by learners. Therefore, instead of providing just one map for the whole visiting group, more maps should be made available as learners may prefer to move around on their own. The map is necessary to facilitate their movement through the museum and location of the exhibits. The assumption however is that learners will be able to read the map.

Worksheets B1 and B2 do not have any form of orientation cues. B3 has some pre-visit tasks which may help to orientate learners if schools were to access the worksheet before the visit. The pre-visit tasks help learners to become aware of what museum B is all about and what it offers. Although museum B worksheets do not have any orientation cues in terms routes and

location of exhibits, the museum caters for orientation by providing learners in groups of twenty, a museum educator who tour guides them.

Worksheet E1 does not have any orientation cues. It is made up of sixteen questions covering 6 displays. There are no headings or captions to indicate the displays or the exhibits that are covered by each of the sixteen questions. This is likely to hinder the learning process as learners will not only find it difficult to locate the displays but will also struggle to connect the questions to the appropriate displays and exhibits. When a worksheet lacks any form of orientation cues, this is likely to negatively affect the learning process as a lot of the time is lost trying to locate the exhibits and to make sense of what is required by the tasks.

Worksheet E2 has some orientation cues in the form of written text – a short introductory passage with information on some of the concepts that are covered in the worksheet tasks. Although the information may provide the necessary orientation to learners, written text may not appeal to them mainly because learners visit museums to look at exhibits and hence reading large 'chunks' of text will be undesirable as it will entail additional work especially for those who are not competent readers.

All the worksheets from museum A have some orientation cues in the form of exhibit pictures and captions. Exhibit pictures and captions that are utilised in museum A worksheets are likely to facilitate learning by helping students to recall from prior knowledge the concepts being covered in the worksheet. By providing learners with advance information, about the exhibits, the pictures and the captions serve the role of advance organisers (Ausubel, 1968) which will enable the learners to link new knowledge to existing relevant concepts that the learners possess (West & Fensham, 1974). Furthermore, the pictures enable learners to quickly locate the displays and the exhibits referenced in the worksheets. Quick location of exhibits ensures that more time is spent engaging with the tasks rather than looking for the exhibits. Museum A worksheets in terms of the characteristic orientation cues caters for both the physical and the personal context of the learners which is likely to facilitate learning.

Orientation cues address the physical context of the CML which covers the museum exhibits and its surroundings. According to Falk & Dierking (2000) learning is likely to occur when visitors are familiar with the exhibits and the surroundings. In terms of orientation cues therefore, the results show that museum A worksheets are likely to promote some measure of

learning with their pictures and captions. A lack of appropriate orientation cues in worksheets from museum E is likely to hinder the learning process. Learners who visit museums Z and B will be confined to what the guide or the educator chooses to show them. The learners won't be able to freely explore the museums to look at the exhibits of their choice as they won't know where to find them. This can also dampen their enthusiasm and hinder the learning process.

4.5.3 Information source

Information source refers to where the learner should get the information for completing the worksheet tasks. The information can be found by reading labels (text), by observing objects (object), from tour guides and the teacher, by doing a practical activity (PA), from audio-visual presentation or from prior or general knowledge (PK).

An example of a text-dependent task is:

Why do you think a gemsbok cucumber is sought after by humans and animals in the desert?

The gemsbok cucumber is not shown in the display window. What is available is the picture of the cucumber and some text in the text panel. In this case, the learner has to read the text in order to answer the question. An example of an object-dependent task is:

Look at the object on display on the museum floor

1. *What do you think it was used for?*
2. *Why are there windows on the sides?*
3. *Where can it be opened?*

In this case a learner has to study the exhibit and try to derive the answers from it. An example of a practical task (PA) is:

Take a piece of paper from the box. Roll it into a tube. Place it by your ear and listen to your partner's chest or back through the other end. What can you hear? Try to describe the various sounds. Now take the stethoscope from the box. Place the ear pieces into your ears and place the end piece against your partner's back or chest. What do you hear now? Are the sounds clearer?

The learner has to do the practical task in order to answer the questions. An example of a prior knowledge question is:

What does SANBI stand for?

SANBI is an abbreviation for **S**outh **A**frican **N**ational **B**iodiversity **I**nstitute. This question requires prior knowledge from learners. If learners do not know the answer, they will have to ask their teachers or museum educators. Figure 4.1 below shows the source of information for each of the tasks in museums Z, B, and E worksheets) and Figure 4.2 shows the source of information for each of the tasks in museum A worksheets. This pattern, where data from museums Z, B and E is plotted together and data from museum A worksheets is plotted separately will be used in subsequent sections. This pattern is used because museum A worksheets are many (11) whilst worksheets from the other three museums combined together are only eight and can fit together in one figure.

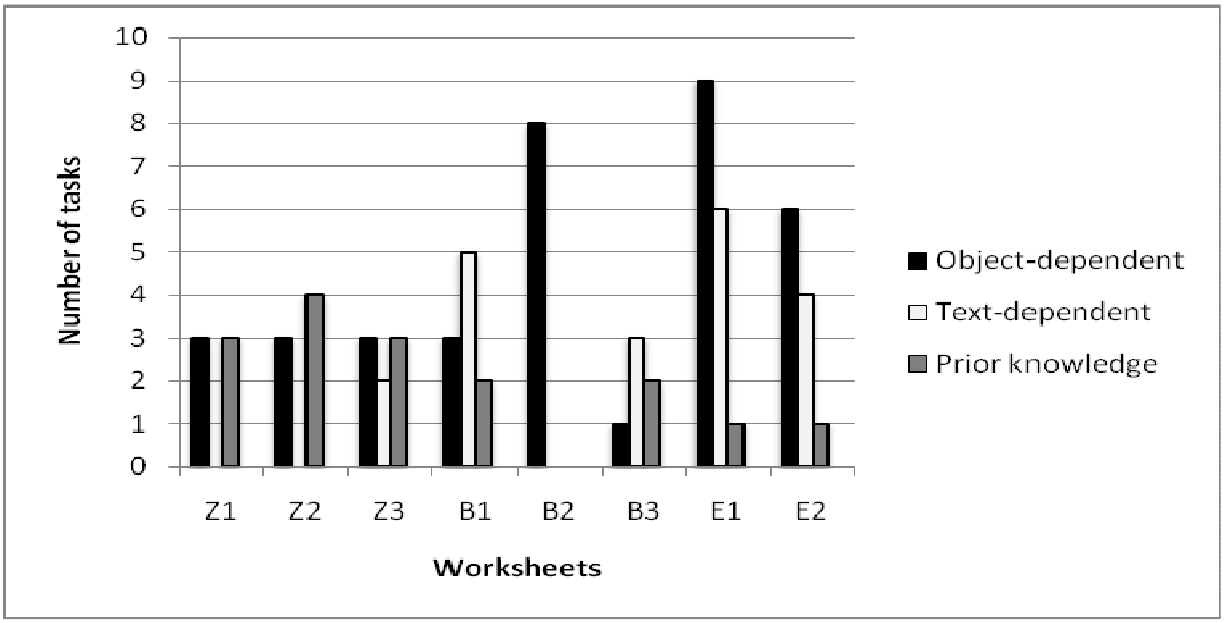


Figure 4.1 : Sources of information for tasks in museum Z, museum B, and museum E worksheets.

Figure 4.1 shows that:

- Z1 and Z3 have an equal number of object-dependent and prior knowledge tasks.
- Z2 has prior knowledge tasks (four) and object-dependent task (three).
- Only one of the three museum Z worksheets (Z3) has some text-dependent tasks.
- Two museum B worksheets (B1 and B3) have slightly more text-dependent than object-dependent tasks. They also contain some prior knowledge tasks.

- B2 contains object-dependent tasks only.
- Both E1and E2 worksheets have more object-dependent tasks than text-dependent ones. In addition, E1 and E2 have one task apiece requiring prior knowledge.
- All the worksheets from the three museums have no tasks requiring practical activities.

The summary of the data presented above shows that the three museums (Z, B and E) contain a fairly high number of object-dependent tasks.



Figure 4.2: Sources of information for the tasks in worksheets from museum A

Figure 4.2 shows that:

- Two of the eleven worksheets have object-dependent tasks only (A7 and A10).
- A8 has practical and text dependent tasks only. No object-dependent tasks. It is possible for a learner to answer the text dependent question from prior knowledge if the learners would have covered the topic prior to visiting the museum. In that case the learner will not need to read the text.
- A1, A2, A5, A6 and A9 have more object-dependent than text or prior knowledge dependent tasks.

- Only two worksheets (A3 and A11) have more text-dependent than object-dependent tasks.

This summary shows that most of the tasks in museum A worksheets are object-dependent.

In terms of the characteristic 'information source' therefore, all the museums, especially Museum A worksheets are likely to support learning. This is because of the presence of many object-dependent tasks in the worksheets, a feature which conforms to the requirements of a worksheet that is likely to promote learning as recommended in the literature. According to Kisiel (2003), object dependent responses provide students with that which would be difficult to experience in class. Focusing learners on objects rather than text is therefore likely to promote learning as learners will be motivated to engage with something new. Object-dependent tasks also promote personal construction of knowledge by offering students an opportunity to observe, think deeply and derive their answers from the objects (Smith, DiSessa, & Roschelle, 1993; Mortensen & Smart, 2007). Allen (2002) observed that object-dependent responses elicited a higher diversity of learning-related conversations than text-dependent responses. School groups that were studied by Mortensen and Smart (2007) solved more object-dependent tasks compared with text-dependent ones thereby supporting the observations that worksheets that utilise objects rather than text are likely to support learning.

In addition to having a high number of object-dependent tasks which provide learners with opportunities to experience concrete objects, worksheets A8 and A9 also incorporate some practical activities. Practical activities are very important because most of the intermediate phase learners are at the level of concrete operations which require that learners be exposed to concrete objects before they can progress to the next stage (Piaget, 2003). The practical activities therefore provide the learners with opportunities for them to observe and engage with real concrete objects from which they can then move on to abstract information.

It is also important to note that 5 worksheets from museum A and all the worksheets from the other museums (except one worksheet; B1) contained some tasks that required prior knowledge in addition to object and text dependent tasks. This is a very useful combination which addresses the learner's personal context giving the learners a chance to share personal experiences or prior knowledge about the exhibit in question (Falk & Dierking, 2000). The object-dependent tasks in the worksheets will focus learners on the exhibits which may then stimulate the learner's memory to retrieve the personal experiences or prior knowledge.

4.5.4 Level of choice

Level of choice indicates the number of correct answers available to a task. Level of choice ranges from **no choice** where there is only one correct answer to **some choice** when there are several correct answers or options for a response. An example of a **no choice** task is:

What do we call plants that have been exploited and are no longer available?[9]

This task has only one answer, which is extinct, therefore the task does not offer any choices.

An example of a task which offers **some choice** is:

Plants living in this dry, sandy place have to find ways to stop water loss from their leaves. Name one way plants do this.[10]

Plants in the desert exhibit many ways of reducing water loss. This means that a learner has a number of correct responses to choose from. This question therefore, offers **some choice**.

Figures 4.3 and 4.4 show the levels of choice that are offered by the tasks in the worksheets that were analysed.



Figure 4.3 : Level of choice that is offered by the tasks in museum Z, B and E worksheets.

[9] Question 7, Worksheet B1, Appendix A

[10] Question 1c, Worksheet E1, Appendix A

Figure 4.3 above shows that:

- Z1 has more no choice tasks than tasks that offer some choice (4 out of 6). Z2 and Z3 contain no choice tasks only.
- Museum B worksheets contain some tasks that offer some choice. The worksheets are however dominated by no choice tasks.
- Although both E1 and E2 have more no choice than some choice tasks, the number of tasks that offer learners some choice are fairly high.



Figure 4.4 : Level of choice that is offered by the tasks in museum A worksheets.

Figure 4.4 shows that:

- Worksheet A8 contain no choice tasks only.
- Worksheets A4 and A5 contain an equal number of no choice and some choice tasks.
- Worksheets A1 and A6 have more some choice than no choice tasks.
- The rest of the worksheets (A2, A3, A7, A9, A10 and A11) have more no choice tasks than some choice tasks.

Fifteen of the nineteen worksheets are dominated by no choice tasks. No choice tasks may work for learners who are used to finding a single correct answer. However, research has shown that offering learners some choice cultivates a positive attitude towards the museum experience as the learner is likely to recall or remember some of the correct answers. Offering

some choice to learners also takes into account individuals' prior knowledge and level of competence (Falk & Dierking, 2000; Kisiel, 2003). Therefore, as far as level of choice is concerned, these worksheets are less likely to support learning.

4.5.5 Cognitive level

Cognitive level refers to the six levels of questioning as described by Bloom's taxonomy: knowledge, comprehension, application, analysis, synthesis and evaluation (Kisiel, 2003). For the purposes of this study, the cognitive levels were simplified into three levels or subcategories. These three subcategories were described in section 3.3 and are shown in Table 4.4 below.

Table 4.4: A description of the simplified Bloom's taxonomy of cognitive levels

Category	Subcategory	Cognitive level	Description
Cognitive level	**Lower order**	**Knowledge (K)**	Requires simple recall of facts or information
	Medium order	**Comprehension (C)**	Requires an understanding of facts that will enable an individual to process information
		Application (Ap)	Requires one to use acquired knowledge in new situations
	Higher order	**Analysis (An)**	Requires the ability to recognise hidden meanings in given information
		Synthesis (S)	Requires an individual to relate knowledge from several areas
		Evaluation (E)	Requires an individual to examine, compare and make decisions based on reasoned arguments

A useful worksheet is one that incorporates questions at different levels especially comprehension and application as it accounts for differences in student experiences and expertise (Mortensen & Smart, 2007). As explained in chapter 3, deciding on the cognitive level of the worksheet tasks was not easy and after a discussion with a number of people (see section 3.5.2) I decided to assume that the learners would be encountering the information for the first time.

Table 4.5: Cognitive levels of worksheets tasks

	Z			B			E		A										
SC	**Z1**	**Z2**	**Z3**	**B1**	**B2**	**B3**	**E1**	**E2**	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**	**A11**
LO	3	6	6	9	6	6	9	4	4	6	2	3	9	4	3	3	12	2	4
MO	3	1		1	1		1	6	4	2	1	1	7	2	1	1		1	3
HO					1		6	1											

SC- Subcategory, **LO**- Lower order, **MO**- Medium order, **HO**- Higher order

Table 4.9 shows that most of the tasks in the worksheets are lower order and medium order tasks. Only eight tasks are at a higher order level, worksheets B1-1task, E1-6 and E2-1. Although lower order, knowledge level questions promote factual recall of information, I think for a museum visit it is acceptable to have more of these lower order questions and a few higher order ones. This is because during a museum visit, learners want to not only learn but also enjoy. So lower order question will afford participation by both weak and strong learners and a few higher order questions will then cater for those strong learners who enjoy doing more challenging tasks that demand more in-depth thinking. According to Green and Rollnick (2007), higher order tasks are not suitable for use in time-limited situations like examinations due to the fact that such tasks require time. This observation by Rollnick and Green can also be extended to museums as completion of a worksheet during fieldtrips, though not a timed test, has time restrictions. Inclusion of many higher order questions in a worksheet is therefore likely to require more time for learners to complete the worksheets which may result in all of the museum visiting time being taken up by the completion of the worksheet thereby depriving the learners of time for free exploration.

4.5.6 Response format

Response format describes how a learner is directed to respond. The worksheet may direct learners to write (note down), draw (pictorial presentation), state orally (say out loud) and, discuss (oral), touch or do a practical activity (action). Figures 4.5 and 4.6 show the response formats requested in the worksheets.



Figure 4.5: Response formats requested in the worksheets from museums Z, B and E



Figure 4.6: Response formats requested in the worksheets from museum A

Figure 4.5 shows that worksheets from museums Z, B and E are dominated by the written format. They however also contain a few questions that require learners to draw. Figure 4.6 shows that oral answers in the form of discussions dominate museum A worksheets. Three of the eleven worksheets also contain some action through practical activities. The actions in worksheet A8 are followed by some written work and in A9 the actions are followed by some oral discussions.

The written format which is dominant in worksheets from museums Z, B and E has its own merits and demerits. It accounts for the completion of the worksheet by the learners. The

written format can also provide feedback to the teachers after the the visit if they decide to look at the completed worksheets. This will ensure that individual learners get the necessary feedback after visit. This is very important as it is most unlikely that oral group discussions will provide the necessary feedback to individual learners in the group during the visit, given the limitations of time and the sizes of groups. With the written format, an educator has a chance after the visit to go through the learners' work and assess their understanding and pick out any misunderstandings and misconceptions that may have arisen during the visit. The question however is how many educators if any, will take the opportunity to go through their learners' worksheets with the aim of reviewing the learners' understanding and consolidating the teaching and learning opportunities that are offered by the museum visits?

Inclusion of some tasks that require learners to draw, as in worksheets Z1 (1 task), B2 (2 tasks), E1 (3 tasks) and E2 (2 tasks), is a welcome feature as it introduces variety to the worksheets. In addition, drawing also encourages learners to observe and examine exhibits more deeply (Durbin, 1999). Furthermore, learners are likely to have different learning styles, therefore, one response format may not address the different learning styles that learners prefer. An effective worksheet should therefore include a variety of response formats: oral, pictorial, action and written. Worksheets A8 and A9 also introduce variety by directing students to do some hands-on practical activities followed by writing and oral discussion respectively. Given the shortage of classroom resources that many schools in this country are facing (DOE, 2001), tasks that require learners to do some activities will help students to experience those objects, something which may not be available in their classroom.

Oral answers offer opportunities for immediate feedback and are easier to give than writing or drawing. However, learners benefit from giving oral answers only if there is a knowledgeable educator to listen to the answers and give the necessary feedback. This is not the case most of the time as the museum curator is the museum educator and can only be with one group of learners at a time.

Although an effective worksheet should incorporate a variety of response formats in order to promote learning, I am aware of the fact that the logistics in museums may not favour certain response formats. For example, the written format requires a learner to have some space in order to write without any hindrances. Therefore, for a museum with space limitations,

writing down answers may not be an option. In such a case, the suitable response format will be limited to oral. The other limitation for the written format is the need for a supporting structure to write on. One museum has overcome this problem by providing learners with clip boards. Where it is possible however, a variety of reponse formats should be incoporated in the worksheets.

4.5.7 Question format

Question format focuses on whether the tasks in the worksheet are open-ended or closed-ended. Open-ended questions are the type of questions that offer learners a chance to speak freely and to share more than just facts whilst closed-ended questions require simple and brief responses. Open-ended questions also require complex thinking and yield multiple solutions. Below are examples of open-ended and closed-ended questions. Open-ended question:

1. *Give one reason why you think the ocean is important to humans*

The question above is open to many suggestions from learners.

Closed-ended question:

1. *What do we call this kind of surgery*?

For this question, every learner has to come up with the same answer.



Figure 4.7: The number of open-ended and closed-ended questions in each worksheet

Figure 4.7 above shows that most of the tasks in museum Z's three worksheets are closed-ended with some open-ended tasks only in worksheet Z1. All museum B worksheets,

although dominated by closed-ended questions also have some open-ended task. Museum E worksheets contain some open-ended tasks with worksheet E2 containing more open-ended tasks than closed-ended ones. Figure 4.8 below, shows that five of the eleven museum A worksheets, though they have more closed-ended tasks (except for A11 which has an equal number of both), contain some open-ended tasks too. The rest of the worksheets have only closed-ended questions.

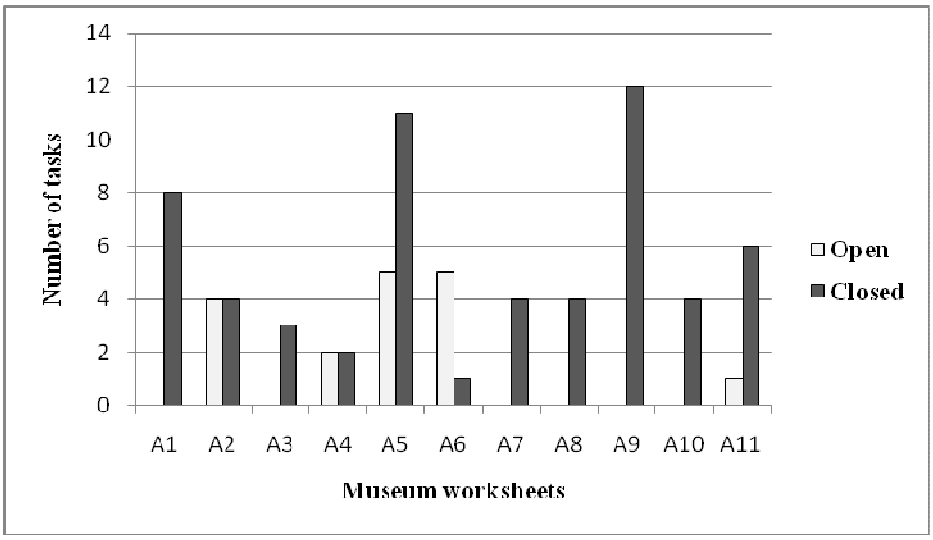


Figure 4.8: The number of open-ended and closed-ended questions in each worksheet

Closed-ended questions can be answered quickly which means more time for free exploration. Previous studies that have looked at the importance of proper questioning have noted that open-ended questions promote children's creative thought, problem-solving skills and cognitive growth (Herman, Morris, & Taylor, 1987). A worksheet that facilitates learning should therefore, have a mixture of both open-ended and closed ended questions as is the case in most of the worksheets.

4.5.8 Classroom connection

Classroom connection is a feature that looks at the extent to which worksheet tasks are connected to the topics that are in the curriculum. Connecting worksheet tasks to what the learners cover in class has been shown to promote learning as the knowledge that learners take to the museum (prior knowledge) is "an important determinant of what they learn during their visit" (Bowker, 2002, p.132). Through connections to prior knowledge and memory, museum experiences are made more meaningful (Kisiel, 2003). When worksheet tasks connect to classroom topics, the worksheet can be used after the visit to engage learners in

discussions regarding their museum experiences which can lead to additional activities and hence contributing further to the learning experiences. All the worksheets cover topics that are in the National Curriculum. These topics include conservation, biodiversity, biomes of Southern Africa and the history of medicine.

While the topics mentioned above are in the intermediate phase syllabus, they are very broad topics and the teachers have the liberty to choose the sections of the topic that they wish to cover with their learners. For example, with the topic conservation, a teacher may choose to look at either conservation of wetlands, of the rhinos or of the African elephant. With the history of medicine, a teacher may choose to do the history of smallpox or tuberculosis or dentistry (Natural science teacher, personal communication). As a result, when learners visit a museum they may encounter information that may not be directly connected to what they would have covered or would cover in class. This information is one other reason why in the section on cognitive level, I decided to assume that the learners would be encountering the information for the first time.

The way museum A worksheets are done caters for the diversity of topics that different teachers may cover. The museum has prepared a separate worksheet for each topic on the history of medicine. So when teachers arrive at the museum, they can simply choose worksheets covering the topics they are interested in and leave out the rest. Museum E could do the same by preparing a separate worksheet for each biome instead of combining all biomes into one worksheet. Museums Z and B said they do prepare worksheets for schools covering specific concepts if schools indicate their requirements well in advance of the visit.

4.5.9 Social interaction

Museums are ideal venues for social learning as visitors (in groups) interact with each other in the process of making meaning of exhibits (Falk & Dierking, 2000). A useful worksheet should therefore include tasks that promote social interaction. Only the worksheets from museum A promote social interaction as they make it clear that learners work in pairs, discuss in groups or discuss with the museum educator. The rest of the worksheets are silent about the interaction that should take place. In phase 2 of my study, I observed that learners show hesitancy to discuss worksheet tasks when it is not stated that they can discuss. At one point learners had to anxiously ask their teacher for permission to discuss the worksheet tasks (Personal observation). Worksheets therefore must clearly indicate whether or not learners

can discuss worksheet tasks. Worksheets from museums Z, B, and E fall short as far as the characteristic social interaction is concerned.

A worksheet that calls for group discussions is likely to facilitate learning as talk has been shown to play an important role in creating meaning between individuals (Mortimer & Scott, 2003). Therefore, as learners interact with each other or museum educators interact with learners during discussions, the learners help each other and museum educators help the learners to make sense of the worksheet tasks or to find answers to the worksheet questions (Mortenson & Smart, 2007). Facilitation by museum educators also promotes learning by keeping learners focused on the museum content (Griffin & Symington, 1997). By facilitating group discussions, museum educators also reduce the learners' workload and speed up the completion of the worksheet as they have more knowledge about the exhibits than the learners themselves. This gives the learners some time to pursue their own interests, an observation that has been shown to promote a positive museum experience (Mortenson & Smart, 2007).

Group discussions that are facilitated by museum educators, though desirable, are not always feasible for a number of reasons. Firstly, enough or knowledgeable chaperones or museum educators are not always available to cater for the large number of learners that are characteristic of many school visits in South Africa (Lelliott, 2009). Secondly, group sizes should be small if group discussions are to be effective in facilitating learning. Unfortunately, research (Bowker, 2002) and personal observations show that group sizes are in many cases too large to give each learner a chance to participate in the discussions thereby negatively impacting on the learning process . Lastly, the way some displays and exhibits are arranged in the museum (the physical context) does not allow access by groups.

4.5.10 Site specificity

Site specificity indicates the extent to which learner tasks in a worksheet are based on a specific exhibit. Low site specificity means that a task is not limited to a particular site or display but can be accomplished in a larger area and high site specificity means a task can only be accomplished at a specific display. Low site specificity allows students to have a choice as to where and when they can complete the task. On the other hand high site specificity quickly focuses learners on the task to be completed (Kisiel, 2003).

All the worksheets except E2 are highly site specific. The worksheets focus on a specific exhibit or display in the museum. Worksheet E2 on the other hand has low site specificity. The first question of worksheet E2 asks learners to sketch an ecosystem. The rest of the tasks in the worksheet require the learner to do them in relation to the ecosystem sketched. The worksheet (E2) therefore has very low site specificity in the sense that the question does not specify the type of ecosystem to be sketched. The learners have the freedom to choose ecosystems from the ones in the displays or of their own choice as long as the ecosystems are found in South Africa. McManus (1985) recommended that worksheets should reflect low site specificity so that learners can have a choice as to where and when to apply the tasks. This is however contrary to Kisiel (2003) who thinks that a worksheet should have high site specificity so as to facilitate orientation. From phase 2 of my study, I observed that high site specificity helped learners with orientation as they knew exactly what to look for and where thereby supporting Kisiel's recommendation. High site specificity also helped learners to quickly focus on the tasks at hand. Learners did not waste time walking aimlessly up and down the museum floors. I cannot however comment about the effect of low site specificity as all the worksheet tasks in phase 2 had high site specificity.

4.6 Conclusion

The analysis of the worksheets from the four museums in Gauteng shows that museums produce a variety of worksheets that they use to try and facilitate learning during museum field trips. These were classified as role play, find me and structured. The majority of worksheets are however the structured type. Structured worksheets display a variety of features. Some of these features are likely to facilitate learning and some are likely to hinder it. The features in the structured worksheets that are likely to facilitate learning during field trips are the presence of many object-dependent tasks, presence of many lower order and medium order tasks and few higher order ones, presence of both open-ended and closed-ended tasks, presence of tasks that connect to curriculum topics and tasks with high site specificity. The features likely to hinder the museum learning process are high task density, lack of orientation cues, and dominance of no choice tasks, dominance of the written format and of tasks that do not promote social interaction. Overall, the analysis shows that there is no ideal worksheet. All the worksheets possess some features that are likely to facilitate learning and some that are not. This means that the extent of effectiveness of these worksheets is likely to differ with some worksheets likely to facilitate learning more than others.

Chapter 5

Qualitative analysis and discussion of learner conversations

5.1 Introduction

In this chapter I analyse and discuss the results of phase 2 of the study. The aim of this phase was to determine the extent to which the worksheets that are used at the Oppenheimer Life Sciences Museum promote learning during a museum field trip. The research questions were:

- How are worksheets used by school groups during a biology exhibition at the OLSM?
- To what extent are the worksheets at the OLSM effective in facilitating learning during a school visit?

Firstly, I analyse the worksheets that had been prepared for the Yebo Gogga exhibition to highlight their design features and briefly comment on their appropriateness as instruments for facilitating learning during the exhibition. Secondly, I give an overview of each group's movements and behaviour as they toured the exhibition. Thirdly I narrate and analyse the conversations of the groups. Analysis is in terms of how the worksheets were used by the groups, highlighting evidence of learning in the conversations. Lastly, I discuss the results of the analysis.

5.2 Analysis of the 2008 Yebo Gogga worksheet

5.2.1 The worksheet analysis process

The analysis was done using the worksheet analysing instrument described in section 3.3 and was used in chapter 4 for analysing worksheets. I followed the process of worksheet analysis that I described in section 3.6.1. Four worksheets are prepared for use during the Yebo Gogga exhibition: one foundation, one intermediate, one senior and one FET. I analysed all the four worksheets as I was going to observe learner groups from each of the four phases. The results of the analysis are shown in table 5.1. below.

Table 5.1: Results of worksheet analysis

Worksheet characteristic		Foundation	Intermediate	Senior	FET
Task density		Too high- learners had to visit 20 displays and answer 36 questions in 30 minutes	Too high- learners had to visit 20 displays and answer 43 questions in 30 minutes	Too high- learners had to visit 20 displays and answer 50 questions in 30 minutes	Too high- learners had to visit 20 displays and answer 44 questions in 30 minutes
Orientation cues		None?	none	none	none
Information source		The worksheets had very few object dependent questions. Text, prior knowledge and/or explainers were the sources of information for the majority of questions.			
Level of choice		Many tasks (31 out of 36) in the foundation phase worksheet were no choice tasks	Both no choice (27) and some choice (16) tasks featured in the worksheet	Both no choice (32) and some choice (18) tasks featured in the worksheet	Both no choice (27) and some choice (17) tasks featured in the worksheet
Cognitive level		30 tasks were at knowledge level. The other 6 were comprehension.	39 tasks were at knowledge level and 4 were comprehension	43 were knowledge tasks and 7 comprehension	30 knowledge tasks, 13 comprehension and one analysis
Response format		Written-35, Pictorial-1	All 43 are written	All 50 are written	Written: all 44
Question format	**Closed**	35	38	47	38
	Open	1	5	3	6
Classroom connection		The topics covered in the worksheets connect to environmental education and biology			
Social interaction		Silent	Silent	Silent	silent
Site specicity		High	High	High	High

5.2.2 Discussion of the results

Task density

The results show that task density was very high in all the four worksheets and high task density has been shown to negatively impact on learning. In terms of task density, all the worksheets had the structure of a survey agenda worksheet whereby the worksheet has many tasks requiring a visit to many displays. A learner is expected to sample a little bit of everything. Survey agenda worksheets are less likely to support learning.

Orientation cues

There were no orientation cues in all four worksheets and this can negatively impact on learning (see section 2.2.3). However, to cater for orientation the organisers had tour guides in place to guide each school group through the museum. Observations show that learners have a tendency to break into self-selected smaller groups (McManus, 1985) and move through the museum on their own, therefore although tour guides were provided, absence of orientation cues is still likely to negatively affect those small groups.

Information source

There were very few object-dependent tasks. Most of the tasks were text-dependent. This is likely to impact negatively on the learning experience as the reason for going to the museum in the first place is to learn from real objects. The setting of the exhibition was however such that, each exhibit had an explainer, therefore answers could also be obtained from these explainers. If explainers can explain the exhibits effectively to learners, the interaction can facilitate learning (Lehman & Lehman, 1984). Learners could also make use of their prior knowledge to do the tasks as I later observed during the analysis of learner conversations. At the malaria stand learners were expected to watch a video from which they would get answers to one of the tasks. Watching the video proved very unpopular in the overcrowded conditions as I later observed.

Level of choice

Most of the tasks in the Foundation phase worksheet offered no choice. Research suggests that having many no choice tasks in a worksheet can negatively affect the learner's museum experience by restricting the learner to specific facts and concepts (Kisiel, 2003). However, I am of the opinion that having more no choice tasks in a foundation phase worksheet is appropriate as having a whole range of correct answers may confuse the young learners. The intermediate, senior and FET worksheets had a high number of tasks that offered learners both no choice and those that offered some choice. Offering students some choice impacts positively on their museum experience as they are likely to get some of the answers.

Cognitive level

The majority of tasks in all the worksheets were at knowledge level. However, Senior and FET worksheets also contained a considerable number of tasks that required comprehension. Having more lower order (Knowledge) level questions in a museum worksheet especially for young foundation and intermediate phase learners is appropriate. I say this because research has shown that young learners below the age of ten struggle to use worksheets (McManus, 1985). Including many medium and higher order tasks that are cognitively more demanding in their worksheets is likely to impact negatively on their learning as they will not only struggle with the management of worksheets but also the answering of worksheet tasks. Lower order task are therefore likely to enable them to complete the worksheet and hence contribute to a positive museum experience. Increasing the number of comprehension tasks in the senior and FET worksheets is a positive feature. Senior and FET learners are more mature

and are taught at a higher level than lower classes. Comprehension tasks will test their understanding and if the tasks are challenging, this may encourage them to observe and interact with the exhibits more in their search for answers. Absence of higher order tasks is the worksheets is not problematic. This is because higher order questions require time which is limited during museum field trips.

Response format

All tasks in all worksheets except for one task in the Foundation phase worksheets required written answers. The worksheets offered no variety and hence did not expose learners to the many different skills that would encourage observation of exhibits and hence learning. Therefore as far as response format is concerned, the worksheets were unlikely to support learning.

Question format

All worksheets had both closed-ended and open-ended questions. The open-ended questions were however very few. Open-ended questions require independent thinking and hence more stretching in terms of time (Durbin, 1999). Therefore, for an exhibition like the Yebo gogga which limits visiting time, having a few open-ended and more closed-ended tasks is likely to be more appropriate. Many open-ended questions would have meant the need for more time which was not available to school groups at this particular exhibition.

Classroom connection, social interaction and site specificity

The worksheet topics were connected to the school curriculum mainly environmental education and biology. This is likely to facilitate learning as learners can make use of their prior knowledge to tackle the worksheet tasks. The teacher can also revisit the worksheet tasks in post-visit discussions. The worksheets were silent about social interaction and one would be inclined to say that they did not support social interaction. The worksheet tasks had high site specificity. The worksheet tasks were based on specific exhibits that were on display. High site specificity was likely to benefit learners as this would quickly focus them on tasks to be completed.

5.2.3 Conclusion of the analysis of the 2008 Yebo gogga exhibition worksheets

The analysis of the four worksheets shows that the worksheets had the following features that were likely to facilitate learning: presence of both no choice and some choice tasks, many

lower and medium level tasks (knowledge and comprehension), more closed-ended and less open-ended tasks, connection to classroom topics and high site specificity. The worksheets also contained features that were likely to impact negatively on the museum experience namely high task density, absence of orientation cues, too many text-dependent tasks, tasks requiring answers in the written format only and lack of tasks promoting social interaction. It is important to mention here that the Yebo Gogga worksheets are designed by service students who are undergraduate students in the school of Animal, Plant and Environmental Science. These students have little or no educational background about worksheets and therefore can hardly be expected to know much about preparation of worksheets.

5.3 Analysis of conversations

5.3.1 An overview of the groups

As described in chapter 3, seven schools participated in this study. From these schools, conversations of ten learner groups were recorded. An eleventh conversation was recorded from two grade 1 girls from the same school who were in the company of an adult. Details of the groups are shown in table 5.2. These details are given to inform the reader of the overall activities and movement of the groups during the tour.

Table 5.2: An overview of the groups' tour of the exhibition

Group name	Gender	Phase	Grade	Group size	Instructions given to groups by their teachers	Observations
A	Girls	F	1	2*	none	Struggled to use the worksheet
B	Boys	F	3	~25	"When we get to a station, you will listen to what the person at each station would say. I will then tell you when to fill in the worksheet"	Did not get into small groups. Moved through the museum as one big group and had problems with the completion of the worksheet which was then abandoned.
C	2 boys 1 girl	I	4	3	"Do not complete the worksheets now. We will do that back at school. Just write brief notes."	Worksheet questions referred to at one exhibit only. The rest of the time it was a general discussion and exploration of the exhibits
D	Girls	I	4	4	"You have fifty minutes to look at the exhibits. We will meet here at 11:50"	The girls filled in the worksheet in silence. Group not observed
E	Girls	I	5	1	none	No group formed. Worksheet filled in silence by the learner with the recorder
F	2boys, 1girl	I	6	3	"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 group systematically moved through the museum from one exhibit to the next filling in their worksheets
G	Girls	I	6	Big group, actual figure unknown	none	Worksheet not used.
H	Girls	S	7	3	"Fill in the worksheets. You have two hours"	The group moved through the museum using the worksheet to choose exhibits to go to and filling in their worksheets. Group not observed
I	Boys	S	8	3	None	Worksheet not used.
J	Boys	S	8	2	None	Worksheet used
K	2girls, 1 boy	FET	10	3	None	The group systematically moved through the museum from one exhibit to the next filling in their worksheets

*Not a school group but just a little girl and her friend from the same school accompanied by an adult. Consent for the two girls was requested and granted at the museum. **F** – Foundation, **I** – Intermediate, **S** – Senior, **FET** – Further Education and Training band.

5.3.2 Analysis of conversations

In this section I present the results of the analysis of conversations and a discussion of the findings. I present the data that I collected in form of a narration; describing and recounting the events that took place as learners were touring the Yebo Gogga exhibition. The narration is supported by excerpts from learner conversations. After the narration of each group's tour,

I provide qualitative comments pertaining to the findings described. After the narration of all the groups' tour I discuss the findings.

I will use the following **Key** in this section**:**

- **WSQ**- worksheet question
- **E**- explainer
- **L**- learner
- **[*italics*]**- Italics in square brackets will indicate evidence of learning
- **[comments]-** Comments in square brackets are researcher's comments.

Group A (two grade one girls and an adult)

Group A was made up of two grade one girls (Girl 1 and Girl 2). For the analysis of the conversation of this group, I picked out the more striking features that highlight the overall observations from this group. The girls were given worksheets (workbooks) at the entrance to the museum. They however had no clue what the worksheets were or what they were for.

Girl 1: What is this for?

E: It's a workbook?

Girl 1: What must I do with it?

Dad: It contains some questions about the things we are going to see and you must answer the questions.

Girl 1: [flipping through the pages] All of them?

Dad: If you want to

Girl 1: [getting excited] I want to.

Girl 1 got very excited and was eager to complete the worksheet. She was at the beginning, not very sure how to go about it as reflected in the excerpt below. The excerpt also shows that this girl depended heavily on her dad to fill in the answers as she could not spell out most of the words in the given answers. She therefore kept on asking her dad to spell the words for her.

Girl 1: Dad should I ask the question?

E: What do you want to ask? Do you want one [meaning an earthworm]?

Girl 1: No I want to ask, 'How do earthworms improve our soil?" [WSQ]

E: You tell her [referring to a boy who was also at the same station]

Dad: [Her dad however gave her part of the answer.] They make holes in the soil.

Girl 1: They make holes in the soil [girl verbally repeats the answer]. Where should I write? [Dad shows her where to write]

Girl 1: How do you spell hole? [Dad spells the word hole for her].

Girl 2 on the other hand looked overwhelmed by the museum environment. She was not participating in the discussions that girl 1 was involved in as she was busy looking at people and the many different things which were all around her. She would however eventually copy the answers from girl 1. Girl 1 was so eager to complete the worksheet that she no longer wanted to visit and see those exhibits that did not have any worksheet questions. The only thing she was interested in when she got to the exhibit displays was the answer. At one display, the explainer knew that the answer to the worksheet question would be difficult for the little girl to comprehend and wanted to explain. The girl however, insisted that she wanted the answer only.

Girl 1: How big is the largest dung beetle? [WSQ]

E: Do you know what a dung beetle is or what it does?

Girl 1: No

E: Let me show you

Girl 1: But all I want to know is how big it is

E: Approximately 5 cm

Girl 1: How do you write that? [Dad wrote 5cm on a piece of paper and both girls copied]

The worksheet asked for the size of a dung beetle. The concept of size is a difficult concept even for older learners (Smith, Carey, & Wiser, 1985). In this case, the concept was even more challenging as the dung beetle is three dimensional and irregular and hence difficult to state its size. It is highly unlikely that the little girl had the understanding of the concept of size in terms of the given measurements and the explainer knew it. Unfortunately, that was the question in the worksheet and the girl's concern was to complete the worksheet. This observation highlights the importance of framing the worksheet questions according to the age or developmental levels of the pupils concerned if they are to effectively facilitate the learning process. This is in agreement with Borak & Marek (1991) cited in Rennie & McClafferty (1995) who said that most effective interaction of children with exhibits occurs when the thought processes required to understand the exhibit match with that of the children.

The group visited thirteen stations. At twelve of the thirteen stations, the sequence of events was the same i.e. the girl would, with the help of her Dad, read the question to the explainer. The explainer would give her the answer. Girl 1 would write the answer with the help of her dad, and then girl 2 would copy from her. However, in one case at the recycle stand, the explainer managed to capture the girls' attention by asking them to do an actual activity. At this stand, the girls were required to name the colours of the four recycle bins that were on display. They were able to do this and you could see their faces beaming. The explainer then gave girl 1 an empty coke can and girl 2 a crumpled piece of paper and asked them to place these waste materials into appropriate bins according to the picture and text labels on the four recycle bins. At this stand, the girls were able to get the answers for themselves and they were also given a chance to interact with the exhibits. Both girls were able to place the waste materials into correct boxes. A sense of having achieved something was written all over their faces. The exhibitor then explained why different types of waste material were put in separate bins. Unlike at other stands, the exhibitor had succeeded in capturing their attention. The girls listened attentively to what the exhibitor was explaining. Up to now girl 2 was typically just following the father and her friend, but at this exhibit she also got involved. The tasks at this exhibit were at the level of the two girls.

A total of twenty questions were answered. When the father announced that it was time to go home, girl 1 looked exhausted and was almost in tears complaining that the questions were just too many, that's why she could not finish answering them.

Comments: The worksheet was utilised and the following observations noted. Firstly, the two learners did not know what worksheets were and what they were for. Secondly, giving the worksheets to these girls robbed them of true and broader observations as they were now over-concerned with answering and completing the worksheet so much that there was no engagement with anything else. Lastly, the fact that the adults had to read out the tasks in the worksheets and to spell out the answers for the learners meant that the use of a worksheet may not have been suitable for grade 1 learners. If museum educators and teachers want learners to complete worksheets during museum visits, it is of crucial importance that they prepare learners beforehand or at the museum so that they know how to use worksheets and also know where and when they should use them. Research has shown that preparing learners for the field trip can greatly improve their learning during the trip (Kisiel, 2006). Providing learners with a background on how to use museum worksheets as part of the preparation can

also improve the likelihood of learning. Durbin (1999) suggested that a worksheet should provide boxes for drawing or dotted lines for written answers to make the worksheet user friendly for children with little experience of using worksheets.

Group B (approximately 25 grade three boys)

As in the case of grade 1 learners in Group A above, the learners in group B were handicapped by their inability to spell word answers and to write without anything firm to write on. The educator accompanying the learners explained to them that they needed to listen to the explainer first and write only when told to do so. The group was big, over twenty learners. The learners did not break into small groups because being very young, they were under strict instruction that everyone was to keep with the group. They went to 'Defending our heritage' stand first. At this stand, the children were required to draw an Iron Age tool that women used to use. After the explainer had explained and shown them the tool, the worksheet required them to draw the tool. Their teacher announced that it was now time for them to draw the tool. The learners started to complain to their teacher that they could not draw the tool because they didn't have anything to use as support base on which to put their worksheets as they were drawing. Others complained that they did not know how to draw the diagram. The situation became so chaotic that the educator accompanying the learners had no choice but abandon the use and completion of the worksheet.

Comments: The completion of the worksheet was abruptly abandoned as it was putting both the teacher and the learners under a lot of stress. Worksheet use was abandoned because the teacher was not prepared for the problems that arose but most importantly because the group was too big for one person to manage. The adult in group A above managed to sustain the completion of the worksheet until the end of the tour despite facing the same problems because he had to deal with two children only. The group B teacher had to deal with over twenty learners. According to McManus (1985), the size of the group for children up to ten years old should be limited to 4 to 6 learners. Bowker (2002) also suggested more or less the same figure: an adult to child ratio of 1 to 2 or at worst 1 to 4. Small groups are ideal whether you are using the worksheet or not. This is because, when in small groups, learners get more involved in their learning in terms of having more room to ask questions, to receive answers and to do hands-on activities (Price and Hein, 1991). This ideal situation is however difficult to achieve especially in countries like South Africa where huge numbers of learners are

brought to museums by schools during field trips (Lelliott, 2009) and also a background of few trained staff at the museums. What can however be achieved for foundation phase learners is the designing of suitable worksheets: worksheets with among other desirable features a manageable number of tasks that do not require written responses. Minimising tasks requiring written responses is crucial as the written response format that was required for completion of the worksheets in this study was the major cause of the problems that were observed.

Group C (two boys and one girl in grade four)

The three members of this group did not come together naturally like the other groups. They were teacher-selected and asked to move together as a group. The group was not completing the worksheet. Their teacher had instructed them that they were to just write short notes that would help them to complete the worksheet when they get back to school. However the group was moving briskly from exhibit to exhibit, glancing at displays without engaging with the exhibits. Their conversation as they went through the first two exhibits reflects this.

Exhibit 1 (fossils display)

L1: Pa-a-a-le – I can't read that

E: Palaeontology- she is going to tell you all about it. [A museum explainer referring to his colleague]

The learners did not however wait for the explainer to explain the exhibit to them. The learners briskly moved on to the next exhibit. At the next exhibit the exchange was just as brief as at the first one and there wasn't much engagement.

Exhibit 2 (arthropod display)

L1: Chongololo, chongololo [*Naming*] [A chongololo is a millipede]

L2: What's a chongololo? [*Asking a question*]

Note here that L1 saw a familiar organism and said its name aloud. Naming or identifying is evidence of learning (Allen, 2002). Even asking a question (L2) is evidence that learning is taking place (Borun, 2002). Therefore, even though learners were moving briskly without paying particular attention to any exhibits, I can still say some learning was still taking place. However, the learning process was rather incomplete as evidenced by what Gilbert and Priest (1997) described as premature closure of the conversation. L2 never got an answer to his question or a chance to have a look at the millipede that L1 had seen on display. This reflects

the superficial nature or the limited effectiveness of informal tour of exhibits without some form of mediation. However, an interesting observation is that the naming of the millipede by L1 did stick into L3's mind. This is evidenced by what L3 said in the excerpt below. This conversation occurred when the group was passing the arthropod display again and L3 saw the millipede that L1 had referred to earlier:

L3: That's a chongololi.

L1: Chongololo not chongololi. (L1 corrects L3).

This excerpt shows that L3 had internalised the 'talk' that L1 had done earlier. Although the talk was brief it had facilitated learning. The group moved on and when the learners got to the 'Green defenders for all' exhibit which was a display of indigenous plants, the following exchange occurred:

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 [*quotation*].

L2: That means you have to put it in hot water or a bath or smell the steam in it not eat it [*use, explanation*].

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? [This question indicates that the worksheet is the cause or source of this conversation]

L2: Did you read that. [Pointing to the text label]

L1: Let's figure it out later.

L2: No. Now. [L2 and L3 insisted that the text was to be read then started to read the text in silence]

L3: Ok, can I read this?

L1: [L1 budged and read the text aloud] 'For throat infection, insect bites...' [*Quotation*] That's for throat infection [*commenting, use*].

In this excerpt, one member of the group realised that they were not writing any notes or engaging with the exhibits. She therefore decided to remind others about it. The reminder seems to have worked as it made the trio to explore and interact with the exhibit more. This observation highlights an important role that worksheets play. The reminder that they were expected to complete the worksheet back at school was enough to force the learners to explore the exhibits at a much deeper level than when they just freely explore the museum on their own without any form of guidance or mediation. Learning occurred at this exhibit: commenting on, reading explanatory text aloud and explaining the exhibit (Borun, 2002).

It is also important to note here that some kind of disagreement was occurring in terms of whether to take down notes or not. The same kind of disagreement was to be seen again later. This group, being a teacher-selected group and the only one in which some disagreements were observed I suspect that the disagreement was likely due to these learners not being used to working together. Learners should therefore be allowed to move in groups that they are used to work in at school or in self-selected groups to promote social cohesion (McManus, 1985) and hence reduces the tension that may negatively impact on the museum learning experience.

When the group moved on to the next exhibit, which was titled 'the Moz squad' and was dealing with mosquitoes and malaria, they met their teacher who reminded them that although she had said that they would do the worksheets back at school, they were supposed to ask the explainers the worksheet questions then write some notes or just fill in one word that would remind them of the answers. This resulted in the group spending more time at this exhibit. The conversation reflects an extended and more meaningful engagement with the exhibit.

L1: What is Malaria? [WSQ directed to Tr].

Tr: Ask the man in the green shirt. [The man in the green shirt was the museum explainer]

L1: [to the explainer at the stand] what's Malaria?

E: Malaria is a disease that is caused by mosquito bites. Yah. [Note here that this answer that was given by the explainer is incorrect]

L1: Yah, cool. '500 million cases' [Q*uotation*]. Wow! [S*urprise*] [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.

L2: Oh! Oh! Oh! Read this [*intrigue]*, 'all 80-90% of cases occur in South Africa' [Q*uotation*]. [i.e. malaria cases]

L1: Africa, not South Africa. [L1 corrects L2]

E: Guys are you getting your answers.

L (all): Yes

L1: What does that say? [*Asking a question*][L1 pointing to a label in the displayed text]

E: Plasmodium.

L1: What does that mean? [A*sking a question*]

E: It's a parasite that causes malaria.

L1: Ok, Ok.

E: Symptoms of malaria? [WSQ]

L1: It's what happens to you when you get malaria-that's symptoms [*answering a question*]

L2: [searches for the symptoms in the text on display]

L1: Its not there, it's not there. I read through it.

E: You can watch the video to get the answers.

L1: I don't want to listen to the video.

L3: You have to.

L1: I don't have to.

L3: So how are you going to get the answer?

L1: Now we have to, because she wants to. [Referring to L3]

L1: Mosquitoes. Check it out; check it out [*Naming*]. [Focus moves away from the text to the video]

L2: Look, it's working so hard to get to that [*Identification*].

L1: The rest are dead except that one [*Identification*].

L2: Check how cool this looks [*pleasure*]. [L2 was now looking under the microscope. His focus had moved from watching the video to the mounted microscope. So watching the video came to a premature stop and malaria symptoms were not identified]

L1: What is supposed to be there? [*Asking a question*]

E: Malaria [wrong answer again or rather incomplete answer as it was supposed to be malaria parasite]

L1: Alec, does it look cool? Let me see. [L1 looks under the microscope] It's a dried worm, lots of little worms [*Identification*] [L1 was referring to the plasmodium parasites on a slide under the microscope]. You have to look a little close then will see the eyes. It looks cool [*Pleasure*].

In this conversation the tension and disagreement resurfaced again with learner 3 wanting to watch the video in order to get the symptoms of malaria and learner 1 wanting to move on. This conversation which was linked to the use of the worksheet was relatively long and it shows some engagement with both the exhibit and the text. The fact that there was some significant engagement with the exhibit by the learners after their teacher reiterated that learners were to refer to worksheet questions in their interaction with the exhibits and the museum explainers shows that the use of the worksheet promoted engagement of learners with the exhibits and hence learning. The observation also highlights the importance of the teacher's role in enhancing the museum learning experience. The premature move from video watching to the microscope incident supports the observation by the teachers in Kisiel study (2003) that it is unlikely that learning would occur without worksheets. To them, worksheet use helps to keep learners focussed and on task.

The group visited many more exhibits but stopped referring to the worksheet questions or to write any notes after this exhibit. There was some conversation with the explainers at the various stands that the group visited. However most of the conversations were very brief and

lacked depth compared with the two previous ones. The conversations had one prominent feature in common: aesthetic appreciation of exhibits punctuated by phrases like: 'that's cool', 'awesome', 'that's disgusting'. (See appendix D for these conversations).

Comments: There are very interesting differences between the conversations that occurred when learners in Group C were referring to worksheet questions and when they were not. These differences are listed below.

- The group's conversation at an exhibit was longer when the source of conversations was the worksheet. More time was spent when the worksheet was in use.
- As they were searching for answers to the worksheet questions, learners were able to see some other important features of the exhibit e.g. the fact that 80-90% of all malaria cases occur in Africa which stunned them. The learners interacted in depth with both the objects and the text as they searched for answers to the worksheet question.
- Aesthetic appreciation of the exhibits was more prominent when worksheets were not in use.

The observations summarised above show that as far as Group C is concerned, there was more engagement with the exhibits when learners were using the worksheet. When they were not using worksheets, learners focussed on the general and broader observation at the expense of more salient features of the exhibit. Arguably, when learners are not using worksheets, there is likelihood that they may not know what to look for in an exhibit. Therefore, although it is desirable to allow learners to look at the exhibits of their own choice in a free choice environment like a museum, a worksheet may be necessary to then direct and guide them to the salient features of the exhibits. A balancing act may be to prepare worksheets that have fewer questions, high site specificity, with questions that focus students on observation of objects rather than label reading (Kisiel, 2003). Fewer questions will enable learners to complete the worksheet and to also explore the museum freely.

Group D (four grade four girls) This group was not observed.

The group toured the museum concurrently with group E and they spent very little time in the museum)This group moved in silence, directing their questions to the people at the tables and

completing their worksheets in silence. The greater part of the recorded conversations was therefore taken up by the exhibitors explaining issues pertaining to their exhibits. I later discovered that the reason why there were very little discussions among group members was because they thought they were not allowed to discuss the worksheet questions. I deduced this because towards the end of the recording one learner said this:

L: I lied. She (their teacher) said we can discuss the worksheet questions. [Apparently, this learner had earlier said to her friends that they were not allowed to discuss the WSQ].

Not much was however discussed after this as the learners were nearing the end of their tour of the museum.

Comments: The worksheet facilitated learning in the sense that there was some interaction between learners and exhibitors. This was evidenced when learners asked worksheet questions and exhibitors explained their exhibitions. The conversation was not transcribed as there was nothing more beyond the reading of the question and the exhibitors' explanations and also because the exhibitors' voices were very faint most likely because the two learners with the recorders may have been standing at a distance from the exhibitor most of the time. The learners filled in the worksheet in silence for the greater part of the tour deriving their answers from the exhibitors' explanations.

Group E (Grade five. The learner with the recorder did not form or join a group)

Only one learner, the learner with the recorder (L1) was completing the worksheet and she did this in silence. Two girls approached her for a chat. What they said could not be captured. It seems however that the two girls wanted to chat about something else that had nothing to do with the worksheet. This was derived from the observation that L1 declined to join in the conversation declaring that she wanted to answer the worksheet questions. This is what L1 said: *"I want to answer these questions seriously*". From this statement it seems L1 felt that the two girls were disturbing her. L1 then moved to the back of the whole group from where they were standing, listening to the explainers and filling in the worksheet in silence. No group was formed. The only recording captured therefore, was that of the exhibitors explaining the exhibits. According to Tulley and Lucas (1991) introverted experiences like this one shown by L1 where a learner watches and listens to other people can bring about learning. The observation that L1 was filling in her worksheet, deriving answers from what

the exhibitors were explaining shows that she was cognitively engaged and therefore learning. Meanwhile the educator accompanying the learners was referring to the worksheet after every exhibit visited choosing the exhibits that she wanted her learners to visit next.

Comments: The worksheet was utilised by both the teacher and the learners. The worksheet was guiding the movement and the choice of exhibits because the teacher used the worksheet to choose the exhibits to visit. The learners used the worksheet questions to initiate the discussions between them and the explainers at the stands. For the rest of the tour, the learner with the recorder was completing the worksheet in silence. For this reason, the conversation was not transcribed.

Group F (Grade six; two boys and a girl)

The educator accompanying these learners told them that they were expected to fill in the worksheet. She however made it clear that they should not be 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 tasks in the worksheet. This group on reaching an exhibit would initiate the discussion by asking the explainer the worksheet question. In the majority of cases the response from the explainer was not confined to the answer to the worksheet question but was more detailed. This in turn resulted in learners participating more by asking their own questions and in some cases interacting with the actual exhibits. The conversations that were held at the recycle and earthworm stands highlight this observation. These conversations were transcribed in their entirety.

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]

L1: Because to save the environment [*answering a question*]

E: How do you save the environment by recycling? [E probes the learner further]

L1: Because, like if you don't; ok its 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 dump gets too full?

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? 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 [*Answering a question*]

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)

E: But it's what you have just told me. What is organic rubbish? Come here I will show you? [The explainer shows the learners the following materials saying out loud the name of each one of them: Cooked food, Carrots, Leaves. So what can you do with all of that?

L2: Compost [*Answering a question*]

L1: But, I mean, like, ok can I ask a question? It's like everything can't be made into compost. What happens to things like chemicals from factories and all that? [A very good follow-up question from the learner]

E: That's the problem that everybody is trying to solve. I am glad that you asked that question? At this moment, this country has no policy. A policy is like a rule. There is no rule with regards to where factories can put the waste they produce. So what can we do as children? Go to the government and say to them that they should find ways of getting rid of this rubbish, maybe make some rules about these people who produce them. Do you know what happens to these wastes when they flow into the river?

Ls: No.

E: They get into our tap water. Do you want to drink that water?

Ls: Oh no, no ways

E: Precisely. So they must stop dumping stuff as it all ends up in the river.

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).

This conversation was long and everything that was said revolved around waste materials and recycling thereby linking the whole conversation back to the worksheet question. The conversation that followed this one was also long and the learners were interacting with the exhibits and the exhibitor asking a lot of questions. The second conversation occurred at the earthworm exhibit and is shown below.

Earthworm exhibit

L3: This question says: How do earthworms improve our soil (WSQ)

L1: That's where we are going now. Hullo. Can we ask you a few questions? How do earthworms improve our soil? (WSQ)

E: Do you know what earthworms do when they go along

L(s): No [*Answering a question*]

E: No. Have you ever seen earthworms before?

L(s): Yah.

E: You know earthworms?

L(s): Yah.

Tr: Let me see [The earthworms were under the soil and could not be seen]

E: [Lifts up a handful of soil with earthworms]

L: Oooh its disgusting [*Displeasure*]

E: What's disgusting about it?

L: It's just that – [sentence not completed]

E: [The exhibitor continues] As they go along they make tunnels in the soil

L1: [in low voice] -Burrow in soil leaving tunnels [*Knowledge connection*]

E: [continues to explain] that makes air available to the soil

L1: So how long do they live? [*Asking a question*]

MS: 2 years

L1, L2: 2 years? [*Metacognition*]

L1: Why such a short period of time when they have five hearts? [Laughter] [*Asking a question and identification*]

L2: Five hearts – where does it say? [L2 responds to L1 by asking a question. L1 points to the displayed text]

E: Because they are so small -----*laughs*

E: How many questions do you have to answer?

L1, L2 Many

E: But you see what an earthworm does. He makes this, droppings [showing them to the learner]. We also call them castings. This now is

L1: Manure [*Knowledge connection*]

E: And when you mix this with the soil, the soil gets very fertile. The soil gets very rich.

L3: And what does it eat? [*Asking a question*]

E: Anything that used to be alive that's no longer. So any kind of plant material, manure, leaves

L2: All the answers are there [pointing to the displayed text]

E: ---This blue one not South African. It comes from Australia----

L1: Yoh, Ok, so we can use earthworms like, to save the environment. Like, ok it says here something about waste – organic matter. How? I don't get that, I don't understand [This is an interesting connection to the previous exhibit which was on recycling of nutrients in order to save the environment. At that exhibit learners had suggested use of organic matter as compost as an example of recycling that saves the environment] [*Inter-exhibit connection*]

E: You know what we normally get from the kitchen, maybe the potatoes get peeled, carrots etc. Instead of throwing that away or burning it, we use earthworms. So it's no longer rubbish.

Tr: Oh they hide. Why do they hide [laughter] [Note here that the teacher chips in to highlight what he had observed: an earthworm disappearing into the soil thereby pointing out to learners an important characteristic of earthworms that learners seemed to have missed]

E: They hide from light

L1: Can I touch one? ooh nice. [Laughter and screams of excitement] [*Pleasure*] *Do* they die if there is light? [*Asking a question*]

E: If you expose them to light for about 30 min, they do----

L1: Why? Is it because it is used to darkness? [*Asking a question*]

E: [*Explanation inaudible*]

L1: Ok, thank you.

L3: Let's see the blue one again [Learner stretches his hand to have the earthworm put into his hand]

L1: Where did you get it from? [*Asking a question*]

E: Australia

L1: Australia? Blue? How come it's blue? [Learner's question reflects some active involvement with the exhibit].

E: Australians are funny. That's why they have blue earthworms. [Laughter]

Tr: How big is the biggest worm?

E: 2m

L1: 2m? [*Intrigue*] I wanna touch one again can I? [*Pleasure*]

L2: Can you put one in my hand again?

L1: No not that one [screams excitedly as a big worm is put into his hand]*)* --- oooh so cute. [*Pleasure]*. [Learner examines the earthworm] Does it have eyes? [*Asking a question*]

E: No. Doesn't have eyes.

L1: So how does it go through the sand? [Interesting connection to the explainer's previous explanation]

E: It feels with its skin. Everything is according to the skin. It breathes through the skin.

L1: So it's like a snake? But no a snake has eyes. [Learner corrects himself]

E: Snakes have eyes. Yes snakes have eyes. It does not feed on anything that is alive. That's one difference with the snake. Some feed on the soil. Some feed on organic matter; which is like anything that used to be alive.

L1: Ok, Thank you

This was a very long conversation. Every utterance was about earthworms thus reflecting back to the WSQ as the source of conversation. There are many indicators of learning in both conversations. The learners were relaxed and the conversation shows that they were enjoying themselves, not over-concerned with the completion of the worksheet. This relaxed and unhurried interaction with the exhibit and the explainer displayed by the learners was likely to be a result of what the teacher had said at the beginning of the museum tour; that although the learners were expected to fill in the worksheets, they were not to be over-concerned with the completion of the worksheet:

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 scenario above reflects the role of the teacher as central in determining the type of museum experience that the learners will have. Learners continued with their tour, systematically moving from one exhibit to the next filling in their worksheets. On reaching those exhibits which did not have any WSQ pertaining to them, they did not skip them; they explored them too.

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. [Free exploration taking place even before completion of the worksheet]

L3: Is this real [Now pointing to 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]

Here the group can be seen exploring even the exhibits that were not asked about in the worksheet. The group had now separated from the rest of the class. I attribute this free exploration to the way the teacher had handled the tour: making it clear to the learners that they had time to explore and that they should explore the exhibits freely completing the worksheets as they were going about the tour of the exhibition.

Group F teacher had also said that the learners were to listen to the explanation and the discussion first, then write their answers afterwards. Learners only referred to the text on display if they had missed the answer from the given explanations. Instructing learners to listen to explanations that were being given by the explainers is a very good approach as explanations are useful facilitators of conceptual development (Hohenstein & Tran, 2007). Explainers can also help learners use an exhibit and to understand the science behind it (Rix & McSorley, 1999). In some cases however, the explainers did not just explain. They would throw the question back to the learners and interact with them (e.g. at the recycle stand). The conversation that transpired at the bird stand also reflects this kind of interaction. It is important to note that although the stand was on birds, there were no birds or any other exhibits about birds on display.

L3: **Why are birds unique in the animal kingdom? (WSQ)**

E: You know. You guys gonna tell me that.

L3: What did they say?

L2: They said the first question you guys have to answer it yourselves.

L1: Yah; because they fly. No other animal flies. [Learner now suggesting answers to the WSQ]

E: What about bats

L1: Oh bats, aren't they birds? [*Asking a question*]

L3: They have different colours. They come in different colours. [L3 suggests another answer]

Tr: Why does it fly? How do they fly? (Teacher chips in to mediate the learning process*)*

L1: They have got wings, feathers; they have feathers [*Answering a question*].

Tr: Yah. Birds are the only organisms that have feathers.

L1: Oh! I never knew that [*metacognition*]

L2: They have feathers. Is it? [L2 confirms the answer]

L1: Yah [L1 affirms the answer]

L1: What do you call a group of wild geese in flight? (WSQ). [L1 reads aloud the next WSQ to the group]

L1: It's a… gaggle. We learnt this from – [*connection to prior knowledge*]

L3: What is it? [*Asking a question*]

L1: A gaggle. Its e-e-eh gaggle, gaggle like (*L1 tries to explain to others the term gaggle but fails).*

L2: What do we call it when birds fly away to warmer areas during winter? (WSQ) [L2 reads the third WSQ to the group]

L1: Migrate [*Answering the question*]

L2: Migration [*Answering the question*]

L1: Migrating

E: So you ask me when you know all the answers. [Laughter]

By throwing the challenge back to learners, the explainer managed to challenge the learners to take time to think and to come up with the answers. This also allowed the learners to participate more. The conversation episode above reflects the important role that explainers could play particularly when exhibits are not interactive as was the case at this display (Lehman & Lehman, 1984). The episode also shows that with good explainers, even a poorly constructed worksheet can bring about learning. The learners managed to answer all the questions correctly. The transcript shows that there was collaborative effort by the learners as they tried to come up with answers to the worksheet questions. It is important to note here that the three worksheet questions in the conversation excerpt above could be answered without having to go to the exhibit and the learners were able to answer the questions without much help from the exhibitors who were manning the stand. As a result, later on, for some questions of similar nature, Group F did not bother to visit the exhibits involved. They just answered the questions:

L1: Ok, ok guys. Wait, wait, let's just answer these. The green defenders for all [This was the title of the exhibit]

L2: What?

L1**:** **Why do plants have green leaves? (WSQ).** We don't have to see the plants to answer this.

L2: They never told us

L1: I know. So that they can attract food and sunlight from the sun [*Knowledge connection/explanation*]

L2: No not food just sunlight [L2 corrects L1, *connection to prior knowledge*]

L1: Yah. So that they can attract sunlight [L1 concurs].

L1: Where do plants get their energy from (WSQ)?

L2: The sun [*Answering a question*]

L1: Under the soil; the sun, the soil and water [L1 also contributes but the contribution is incorrect].

L3: Guys, soil? I don't believe soil is really---. [L1 interrupted L3 before she could say what she wanted to say].

L1: Yes, that's where they get their food from.

L3: I think its carbon dioxide.

L1: Yes but also roots, from underground; the sun, soil and water [L1 insists].

Comments: This conversation reflects learners who were building on each other's knowledge and understanding of the concept in question. Learners 1 and 3 had some incorrect ideas about the concept of photosynthesis. Unfortunately, when they were answering these questions, the learners were not at the exhibit to which these questions pertained and they had separated from the main group that was being led by the teacher. Therefore, these incorrect ideas could not be dealt with when they surfaced. This reflects one area where completion of a worksheet becomes very important. If the teacher collects the completed worksheets and goes through them, he/she will be able to pick up those incorrect ideas in the completed worksheets and deal with them. Furthermore, although the worksheet questions were not good museum worksheet questions in the sense that a learner didn't need to visit a museum to answer them, they still served a teaching/learning role as learners were able to express their understanding of the concept of photosynthesis thereby exposing the incorrect ideas they held. We can therefore in this regard say that the worksheet facilitated learning. This group fully utilised the worksheet.

Group G (over 30 grade six learners)

Group G moved as one big group of more than thirty learners. The learners did not split into small groups. The group did not use the worksheets. They focused on the explanations that were being given by the exhibitors at the stands. The learners were asking questions to the exhibitors here and there. The questions were about the exhibits but were not worksheet

questions as the learners were not using the worksheets. The learners who asked the questions were far away from the learners who had the recorders and from me so the questions were not captured by me or the recorders.

Group H (three grade seven girls, I was not able to observe this group)

This group, as in the case of group F used the worksheet to direct their movement through the museum. The teacher allowed the learners to freely explore the museum and to complete their worksheets at their own pace. However, unlike group F, this group did not always direct the worksheet questions to the exhibitors who were at the stands but rather discussed the questions amongst themselves and then filled in the worksheets individually. The group depended more on the text and the exhibit itself for their answers, not the exhibitors at the stands. Their discussions were guided by the worksheet question.

L: Let's go to the bees

L: Ok.

L There are so many bees [*Identification*].

L: Ok. What type of cells do the mites infect? (WSQ)

L: I don't know. Is it maybe this? [*Asking a question*]

L: No. That's the mites.

L: Guys. Let's look here [*Pointing out to some feature*]

L: I can't see.

L: Attackers. Look here. Look here, I found it. 'Honey bee attackers-verroa mites. The mites attack the body's drone cells' [*Quotation*].

L: Ok, then, **what is the name of the disease**? (**WSQ**)

L: The mites cause the disease -----not audible [*Answering a question*].

L: **Name two additional hosts (WSQ)**

L: Bumble bee and --- [inaudible]

L: So guys two additional hosts that mites are the main pest.

L: I think the bumble bee—it's here, it's here --- additional hosts. So it's a bumble bee and skyrol beetle [*Answering the question*].

Comments: The worksheet was fully utilised. The worksheet helped learners to know what exhibits were there and hence to choose the exhibits to go to. They worked collaboratively as a group reading out the worksheet questions and searching for answers in the displayed text. (see appendix D for another conversation).

Group I (two grade eight boys)

This group was not concentrating much on seeing the exhibits. The learner with the recorder (L1) would briefly talk about exhibits then switch over to something else that had nothing to do with the exhibition.

L1: What is this called? [*Asking a question*]

E: Rain spider

L1: Are you enjoying this journey?

L2: No. I wanna go. No joking, joking. I like this because

L1: Education is very delicate. [L1 interrupts L 2]

L2: I like golf

L1: I like bungee jumping

Comments: The worksheet was not used. The greater part of the conversation had nothing to do with the tour or the exhibits. The rest of the conversation was therefore not transcribed. The learner also talked about the recorder several times and his behaviour (continuously touching the recorder to make others aware that he was being audio recorded) showed that he did not 'forget' that he was being recorded for the greater part of the recording rendering the conversation less authentic. The teacher's attitude didn't help either. He seemed not concerned that the learners were not looking at or discussing the exhibits. At one point the teacher actually joined the conversation that the learners were having which had nothing to do with the exhibition. This observation supports the findings of Jarvis and Pell (2005) that the behaviour of adults accompanying children to museums is very influential in determining how children interact with the exhibits. If adults and children understand and share a learning focus, learning is promoted otherwise it is negatively affected. Pupils' attitudes also tend to mirror the teacher's (Price & Hein, 1991; Griffin & Symington, 1997). This means that if the teacher's attitude is positive and focussed, learning is likely to be promoted otherwise it is restricted.

Group J (two grade eight boys)

There were some discussion or rather short comments about worksheet questions here and there. Otherwise group members filled the worksheet in silence. **Comments:** The recording contains mainly the exhibitors' explanations. There were no sustained conversations from the group. The recording was therefore not transcribed.

Group K (two girls and one boy in grade ten)

Initially, the whole group moved systematically from one exhibit to another listening to the exhibitors' explanations and filling in the worksheet. However, after visiting about four exhibits, this group broke away from the class group. The group tended to fill in the answers using the displayed text meanwhile talking or commenting about something else not related to the worksheet question but related to the exhibit. They however discussed some of the worksheet questions and answers amongst themselves.

L2: I like these guys' name [She was referring to the name arthropods]

L1: It's cool

L2: In Australia you will see the geosciences thing in the Australia museum. It's so cool. Everything is interactive. It's like you touch everything. It's like they have a wall of insects this big, a wall of all different types of flies. You see the guy I worked for had some female albinos. They were so gorgeous. It's like they were pink or yellow. [*connection to prior knowledge*] [As this conversation was going on, learners were busy completing their worksheets,]

In cases where members did not know the answer, the whole group would focus on the worksheet question.

How do seeds disperse by means of animals? (WSQ)

L2: That's pretty cool

L3: Pretty boring stuff

L1: Ah well, what do we need to answer this one

L2: Like seed dispersal [laughter]

L3: How do seeds disperse by means of animals? [WSQ directed to the explainer]

E: I think they eat them and then digested or they pass through the gut and then they stick to their fur. Ok

L1: Serious? [Surprise]

E: Next one

L1: **What is the advantage of being able to pass through the digestive system of the animal? (WSQ)**

E: They spread out. Become nutrient active. They get spread wider. So they get all the nutrients they need. This dispersal is much wider I think. That's pretty much like it.

L1: Thank you [conversation closed]

Sometimes learners will freely explore. From the seed dispersal display, learners passed through the fossil display just looking around. The display had skulls of a modern human, a chimpanzee and the taung child, L3 said:

L3: And people say there is nothing like evolution, that's exactly like a human skull [*commenting and pointing to a feature*]

Comments: This group made full use of the worksheet. These learners unlike lower grade learners were able to complete the worksheet whilst discussing something else that would have been triggered by the exhibits. The worksheet helped learners to do some work whilst enjoying some social interaction.

5.4 Discussion of analysed conversations

As discussed in the literature review, there are conflicting opinions on the usefulness of worksheets during museum fieldtrips: some researchers say worksheets are useful as they promote learning, other researchers say that worksheets are problematic as they restrict learning and still others say there is no difference in the museum learning experience whether worksheets are used or not. The aim of phase 2 of this study was therefore to observe how worksheets were used by learners as they were touring a biology exhibition and to determine the extent of effectiveness of the worksheets in promoting learning during the learners' tour of the exhibition. The qualitative analysis of learners' conversations has revealed a number of interesting and useful observations about the way worksheets are used and also about their usefulness as instruments for facilitating learning during museum fieldtrips. These observations are discussed below.

Observation 1: Learners not knowing how to use worksheets

My first observation was that the grade 1 learner in group A did not know what the worksheet/ workbook was for and how it was supposed to be used. In a case like this, it is highly unlikely that the worksheet would be effectively utilised. It is therefore important for museum educators and teachers not to take for granted that the learners visiting the museum would know what worksheets are and how they are supposed to be used. Teachers or museum educators should clearly explain to learners how and when they should use the worksheet if the worksheet is to promote learning.

Observation 2: Younger learners (below ten years) struggling to complete their worksheets

My second observation was that the foundation phase learners struggled to complete the worksheets due to a number of reasons. The first reason was that some of the learners were unable to read the question on their own. The second reason was that the worksheet required written responses in the majority of tasks, which learners were not able to give as they did not

know how to spell the words. The third reason was that learners found it difficult to write without a firm support base to write on. The worksheet also contained too many tasks, most of which were too challenging for foundation phase learners. Because of the reasons outlined above, the completion of the worksheet ended up requiring a considerable amount of effort from both the learners and the adults that were accompanying them thereby denying both a chance to observe and enjoy other things about the exhibits that may have been more interesting. Given these observations, I would suggest that the use of worksheets may not be suitable for foundation phase learners. If the worksheet is nevertheless used, I would follow the recommendation by McManus (1985) that tasks requiring written responses be minimised in worksheets for use by children under the age of ten. I suggest that the oral and action responses that the exhibitors at the recycle stand were asking for would be more appropriate as learners' actions showed an understanding and enjoyment of the activity.

Observation 3: Quality and quantity of learner experiences different when worksheets are used and when they are not

The behaviour of learners and the amount of time that learners spent looking at exhibits when they were using and when they were not using worksheets differed. I observed this with group C. When the group was using the worksheet, they discussed and engaged more with the exhibits. At one point the group had to watch a video in order to answer the worksheet question on symptoms of malaria. The group also observed malaria parasites under the microscope. However, when the group was not using the worksheet they moved briskly and just glanced at exhibits without focusing at anything in particular. Brief comments on the aesthetics of the exhibits were also common when the group was not using worksheets. Since this was however only observed with just one group, it cannot be generalised. The observation however is in agreement with the findings of McManus (1985) and Jarvis and Pell (2002). McManus found that the quantity and quality of experiences that groups of learners go through when they use worksheets are different from the experiences that learners not using worksheets go through. McManus however attributed the longer time that is spent by worksheet users to management of the worksheet rather than in-depth exploration of the exhibit. Jarvis and Pell (2002) observed that when groups of learners were not using worksheets, passive touring occurred and the groups were unfocused. On the other hand, the two researchers (Jarvis and Pell, 2002) observed that when worksheets were used, focused

answering of worksheets occurred, even more when explainers explained and showed interest in the learners' work.

Observation 4: Worksheet as a guide

The activities of all the groups that used the worksheets were guided and controlled by the worksheet as groups would look through the worksheets and then choose the exhibits to visit. On reaching the various displays, learners would start by either asking the worksheet question to the explainers or exhibitors manning the exhibits or the learners would read the question to one another then search for answers. Group H was working on its own at most exhibits. The group did not direct the questions at exhibitors or explainers but rather discussed them amongst themselves, searching for answers in the displayed text where they could not get it from the exhibits. This not only helped the group to build on each other's knowledge but also encouraged them to work cooperatively with each other. The cooperative effort is reflected in the group's conversation at the bee exhibit (see p.105). This cooperative effort was made possible because the group had a common and clearly defined goal: finding answers to the worksheet tasks. The worksheet therefore played an important role of defining and directing the learning goal and the teacher's instructions that they could work as a group also encouraged cooperative effort towards the attainment of that goal. The worksheet in some cases however, also caused some learners (group H) to narrowly focus on answering the worksheet question at the expense of broader observations thereby missing out on other interesting features of the exhibition an observation that led Griffin and Symington (1997) to dismiss the usefulness of worksheets.

The worksheet was also very instrumental in initiating discussions about the exhibits beyond the worksheet questions. Learners in groups C and F asked many questions in addition to worksheet questions and according to Borun (2002) asking or answering a question about an exhibit is evidence that learning is occurring. The worksheets were also important in informing school groups about the kind of exhibits that were on display. The groups used the worksheets to choose the exhibits to visit. This way the worksheets promoted learning by guiding and directing the movement and participation of learners in the museum (McManus, 1985).

Observation 5: The teacher's role

The instructions that the teachers gave to their learners at the museum about the completion of the worksheet impacted a lot on how learners used the worksheet and how they went about their tour of the museum. For those groups where nothing was said, the worksheets were either not used or they were completed in silence. Some learners were not even sure whether they were allowed to discuss the worksheet questions or not (group D). Where the learners were given some instructions, the behaviour of the groups was different. Group C was told that they would complete the worksheets back at school. They were to write brief notes. The group did this only on two exhibits. Group F was told that they were to complete the worksheet. They were also told that they were not to be over anxious about doing the whole worksheet. They were to just fill it in as they were going through the museum and above all enjoy. It is with this group that long and rich conversations were observed. The group members would ask to touch the exhibits, ask their own questions and also join in whatever fun activities that were taking place at various stands and at the same time completing their worksheets. Throughout their tour of the museum, group F showed this hassle-free atmosphere.

Group H was also given explicit instructions that they had to complete the worksheet and that they had two hours to do it. However, unlike group F, the focus of group H was to complete the worksheets and nothing else. So they would look at the worksheets, choose the exhibit to visit, go to that exhibit, answer the questions and move on to the next exhibit. Group H did not engage with other exhibits outside the worksheet. Looking at the behaviour of the two groups (F and H), it can therefore be said that the instructions that were given to the learners at the beginning of the tour of the museum had some bearing on the way the groups went about the tour and the use of the worksheet. If this is the case, then the role of the teacher seems to be vital in determining the quality of the tour and learning that the learners experience. With proper instructions and guidance from the teacher, the worksheet can and has the potential to bring about a worthwhile learning experience. On the other hand, poor or no instructions can negatively impact on that potential.

Observation 6: The role of explainers

The way museum explainers interact with the learners impacts on the effectiveness of a worksheet. For example, when group F visited the Recycle stand, they went straight on to ask

the worksheet question to the explainer. The explainer instead of giving them the answers threw the question back to the learners:

E: You tell me. Why do we recycle?

The discussion that followed showed that the learners had a lot to contribute on the subject even going further to ask some intelligent questions on what can be done with those materials that cannot be recycled like chemicals from factories. If the explainer had just given answers to the learners, this fruitful discussion would not have taken place. The same observation was seen at the birds stand. The exhibitor challenged the learners to supply the answers to the first worksheet question on birds. All the learners then got involved in the discussion by bringing up their own suggestions to the possible answer. In this scenario I again see a situation where because of the way the explainer responded to the group, the learners were given a chance to explore their own thoughts on the task provided by the worksheet and to build on each other's knowledge through bringing out and sharing what they knew about the task. The important role of a teacher also featured here as she at one point in the conversation chipped in and threw some hints to her learners to help them arrive at the correct answer. When the learners had finished answering the entire three questions about the birds, the explainer then highlighted to the learners that they had actually directed the questions to her when they knew the answers. This seems to have motivated the learners as they, at the three exhibits that they went to next, the learners attempted to answer the questions first before asking the explainers. When explainers explain and show interest in learners who are touring a museum, this has an effect of motivating the learners to keep on task and to complete their worksheets (Jarvis & Pell, 2002).

5.5 Conclusion

In this phase of the study the analysis of conversations of all the groups that used the worksheet reflected meaningful and active participation by the learners. The analysis also showed that worksheets provide opportunities for engagement and social construction of knowledge. As such the use of the worksheets can be said to have facilitated learning. On the other hand however, the analysis has also revealed some loopholes or shortfalls in worksheet use: learners focusing on worksheet completion to the exclusion of everything else. In view of the above observations, the usefulness of worksheets as instruments for facilitating

learning cannot be dismissed. However, a constant critical appraisal is necessary to improve their effectiveness.

Chapter six

Conclusions and implications

6.1 Introduction

This chapter presents a summary of the findings and the conclusions from this study. Implications for stakeholders such as schools, teachers, museum educators and Yebo Gogga planners are also presented. The intention of this study was to answer the following questions:

1. How appropriate are the worksheets used at various museums in Gauteng as instruments for facilitating learning during museum visits?
2. How are worksheets used by school groups during a biology exhibition at the OLSM?
3. To what extent are the worksheets at the OLSM effective in facilitating learning during a school visit?

I conducted this study in two phases. In phase one I intended to answer question one and in phase two questions two and three. In order to answer these research questions I will first summarise the findings.

6.2 Findings from phase one of the study

In phase one of the study, I analysed twenty-three intermediate worksheets from four museums. The analysis revealed that museums prepare worksheets in a variety of forms: role-play (one museum), find me (three museums) and structured worksheets (all museums). 'Role play' worksheets have the potential to facilitate learning. However, the worksheets require time and expert mediation to be effective (Blatner, 2002) which may not be available during museum fieldtrips. Analysis of 'find me' worksheets shows that they are appropriate as instruments for facilitating learning during museum field trips. This is because the worksheets are easy to use, and encourage learners to explore the whole museum without demanding much mental effort from them. The worksheets also serve the role of orientating learners in a way that learners are likely to enjoy. The majority of the analysed worksheets were of the structured type.

Analysis of the structured worksheets showed that the worksheets exhibited some features that are likely to facilitate learning and some that are likely to hinder it. The features in the analysed worksheets which are likely to facilitate learning during museum visits are:

- Presence of tasks that focus learners on objects rather than text. The worksheets contained a reasonable number of tasks that would focus learners on objects although there were also many text-dependent tasks. Practical activities were also used. All the worksheets also contained some tasks that required the use of prior knowledge. Focussing learners on objects, and allowing them to do practical activities may motivate them to engage as real objects and practical activities provide learners with that which may not be available in their classrooms (Kisiel, 2003). Exposing learners to tasks that require the use of prior knowledge is likely to promote learning as an indiviual's prior knowledge is what shapes the new learning (Rennie & Johnston, 2004) and museum learning is more of "consolidation and reinforcement of previous understandings and perspectives" (Falk, 2004, p. S90). In this regard the worksheets are likely to facilitate learning.

- Many tasks that require knowledge and comprehension and a few that required higher level thinking. Higher order tasks require more time to answer than lower order tasks (Green & Rollnick, 2007). Museum visits are often constrained by lack of time. Therefore, having more lower level tasks in a museum worksheet is more appropriate as there may not be enough time available during museum visits to do many tasks that require higher level thinking.

- Presence of both closed-ended and open-ended tasks but with closed-ended tasks being more than open-ended. Closed-ended tasks require learners to look for specific information (Durbin, 1999) and as such need less time to complete as opposed to open-ended tasks that need more time as they entail extended contemplation and reflection by learners. More closed-ended questions in a worksheet is likely to facilitate learning as the completion of the worksheet will take less of the museum visiting time leaving some time for free-choice exploration. Learners are motivated to take the completion of the worksheet more seriously if they know that they can complete the worksheet and still have time afterwards to pursue that which interests

them. Closed-ended questions are also appropriate if the teacher requires learners to look for specific information.

- Tasks that connect to the classroom topics. All the topics that were covered in the worksheets are in the schools' intermediate phase curriculum. Connecting worksheet tasks to what is done in class before or after the museum visit has been shown to promote learning (Bowker, 2002; Griffin & Symington, 1997).

- Tasks with high site specificity. Majority of worksheets had tasks with high site specificity. High site specificity will help with orientation and will quickly focus learners on the tasks to be accomplished (Kisiel, 2003).

Outlined above are the features of the analysed worksheets that have the potential to make worksheets facilitate learning. The worksheets also have features that are likely to negatively affect the learners' museum learning experience. These features are discussed below and are accompanied by some recommendations on how to improve.

High task density. The analysed worksheets had high task density. High task density means that learners are expected to answer many questions in a short space of time. High task density is likely to negatively impact on learning as all the visiting time will be taken by the completion of the worksheet. Learners need time during museum visits for free exploration (Mortensen & Smart, 2007). In this case learners are likely to rush through the worksheet in order to get time to pursue their own interests. Furthermore, children are motivated to learn when they are provided with tasks that are manageable in number (Jarvis & Pell, 2005). To improve on task density there is therefore need to reduce the number of tasks in the worksheets and/or increase the time required to complete each worksheet.

Absence of orientation cues. Most of the analysed worksheets lacked orientation cues. Effective worksheets should be clear about where exhibits are and where information is to be found (Kisiel, 2003). Lack of adequate orientation cues in the worksheets is therefore likely to hinder the learning process. Worksheets should include some maps or directions, icons, photographs that will help facilitate the location of exhibits.

Presence of many 'no choice' tasks. The analysed worksheets were dominated by no choice tasks but it is when learners are offered some choice that positive attitudes are cultivated and learning is facilitated (Kisiel, 2003; Falk & Dierking, 2000). Presence of many no choice

tasks is likely to impact negatively on the learning process. This feature can be improved by including more tasks that offer learners some choice.

Presence of a limited variety of response formats. The worksheets from three museums were dominated by the written response format and from one museum by the oral response format. There were very few cases where learners are asked to use other formats like drawing and action. Museums should provide worksheets with a variety of response formats if they are to effectively facilitate learning. There are many other ways for learners to convey information than through oral and written word such as spotting similarities and differences, joining matching pairs and drawing (Durbin, 1999). All these formats should be used to bring variety when constructing effective worksheets.

Absence of tasks that promote social interaction. Worksheets from three of the four museums did not promote social interaction. Only worksheets from one museum gave explicit instructions that learners should discuss or work in pairs or groups. The rest of the worksheets were silent about social interaction yet learning in museums is social in nature (Allen, 2002) and according to Falk and Dierking (2000) most of the things that humans learn are mediated through social interaction. Learning in museums has also been seen to be constrained by activities that do not promote social interaction (Griffin, 2004). This feature can be improved by including instructions in the worksheets that promote social interaction such as ‘work in groups’, ‘work in pairs’, ‘discuss’ and so on.

To answer my first research question, my analysis of worksheets from the four Gauteng museums (in chapter 4) has shown that the worksheets are likely to support learning in so far as the following features are concerned: information source which is mainly object-dependent, cognitive levels of tasks which are mainly lower and medium order, presence of many closed-ended tasks and worksheet tasks that connect to classroom topics. The worksheets however, lacked some features that could likely support learning (orientation cues and tasks that promote social interaction) and contained some that were likely to constrain it (high task density, presence of a few tasks that offer learners some choice and dominance of the written response format). This finding suggests that the worksheets were not optimally designed to facilitate learning during museum field trips.

6.3 Findings from phase two of the study

Phase 2 of the study intended to answer questions two and three stated in section 6.1. Phase two of the study revealed a number of significant findings pertaining to worksheet use during museum fieldtrips. Some of these findings show that worksheets can support learning and others show that they can restrict it. However, since the findings are based on one case study, they cannot be a sound basis for generalisation. These findings are outlined below.

The **first finding** was that foundation phase learners struggled to complete the worksheets. Foundation phase learners could not use worksheets on their own without the help of the adults; firstly because the learners could not read the questions on their own. Secondly, the worksheet required written responses in the majority of tasks, of which learners were not able to give as they did not know how to spell the words. Thirdly, learners struggled to write without something firm to press on. The worksheet also contained too many tasks, most of which were too challenging for foundation phase learners. These findings are supported by McManus's observations who in her 1985 study found out that when children under the age of ten were using worksheets, most of the museum time was spent managing worksheets as some of the children could neither read nor write competently. This finding may therefore imply that the use of worksheets may not be suitable for foundation phase learners. If the worksheet is to be used, the number of learners per teacher should be manageable and the worksheets should have minimal writing tasks.

The **second finding** was that the behaviour of learners and the amount of time that they spent at exhibits differed depending on whether or not the learners were using worksheets. Learners engaged more with exhibits when they were answering worksheet tasks. When not using worksheets, learners moved briskly just glancing at exhibits without focussing at anything in particular thereby suggesting that when worksheets are not used and there is no other form of mediation, learning maybe superficial in nature. The observation is in agreement with the observations of Jarvis and Pell (2005) who found out that 'passive touring' and 'adventure playground type' of activities occurred when children's tour of the museum was not supported by some structured guidance or mediation. Rennie and McClafferty (1995) were also of the opinion that students need structured activities if learning is to be promoted.

The **third finding** was that the worksheet served an important role of guiding the learners and their teachers through the exhibition to the exhibits of their choice. According to

Mortensen and Smart (2007) the presence of many visual displays and aural stimuli in museums can overwhelm visitors thereby negatively affecting their museum experience. The Yebo Gogga exhibition in the case study had over forty exhibits located in different parts of the museum and the exhibition area was overcrowded for the greater part of the time. There was also no mechanism in place that teachers could use to find out about the exhibits on display. These unfavourable conditions, could impact negatively on the museum experience. The worksheets then became important in informing school groups about the kind of exhibits that were on display and to choose what exhibits to visit. The use of worksheets also helped learner groups to remain focussed even in the overcrowded conditions.

The **fourth finding** was that learners used worksheets in different ways and these different ways were dictated by the instructions that learners received from their teachers at the beginning of the museum tour. In one case 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. In another case, 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 therefore, the learners focused only on exhibits that pertained to worksheet tasks resulting in the exclusion of everything else. This observation showed that the role of the teacher is vital in determining the quality of the tour and learning that learners experience thereby agreeing with Jarvis & Pell (2005) that to motivate children to learn, teachers should make clear to their children what they should do. With proper instructions, a clear agenda, a clear indication of how to use the worksheets and time frame from the teacher, the worksheet can and has the potential to bring about a worthwhile learning experience. On the other hand, poor or no instructions can negatively impact on that potential as this leaves the learner without a clear purpose of the museum visit.

The **fifth finding** was that the use of worksheets encouraged group discussions. Although the worksheets that were used in the case study were silent about social interaction, learners still got into groups, discussed worksheet questions and worked together to complete their worksheets. This behaviour of learners shows that learning is social in nature (Allen, 2002). Talk plays an important role in creating meaning between individuals (Mortimer & Scott, 2003) and visitors in groups utilise each other for making meaning of exhibits (Falk &

Dierking, 2000). Teachers and museum educators can make use of this observation to promote cooperative effort among learners.

The **sixth finding** was that the completion of worksheets can expose incorrect ideas or misconceptions that are held by learners. When learners are completing worksheets, their answers reflect their thought processes. So if teachers can assess the completed worksheets, they are likely to pick out the misconceptions held by their students.

The **last finding** (seventh) was the presence of many indicators of learning in the worksheet initiated conversations. The indicators of learning included asking of questions related to worksheet tasks by learners, answering questions (which were mainly worksheet questions), talk by learners that connected to prior knowledge and was linked to worksheet tasks, inter-exhibit connection talk, quoting from text labels, commenting about the exhibits and metacognition. Answering of questions was the indicator of learning with the highest frequency. Learners would say out loud their answers as they worked collaboratively with each other to complete the worksheets. Since the conversations (from which the indicators of learning listed above were identified) were directly linked to the use of worksheets, one can say that the use of worksheets facilitated learning.

These findings help me to answer my second and third research questions. For the answer to research question two; 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 what their teachers said at the beginning of the tour suggesting that the teachers and/or chaperones play an important role in determining how worksheets are used by learners to support their learning.

To answer my third research question; the foundation phase worksheet did not facilitate learning as learners struggled to complete it. This was however not the same with the other worksheets. The intermediate phase, senior phase and FET worksheets, in spite of some shortfalls in the design that needed improvement, facilitated the learning process during the

tour of the Yebo Gogga exhibition as they compelled learners to engage with the exhibits and the exhibition.

6. 4 **Implications for stakeholders** (schools, teachers, museum educators, Yebo Gogga planners)

The findings that I have outlined above have some implications for schools, teachers, museums educators and Yebo Gogga planners. The implications are summarised below.

Teachers and museum educators should make sure that learners know what worksheets are for and how to use them before the tour of the museum. This follows the observation that the grade one learners who participated in this study did not know what worksheets were for and how they were supposed to be used. Preparing learners on how to use the worksheets is likely to create a positive museum experience. Research has shown that preparing learners for the field trip can greatly improve their learning during the trip (Kisiel, 2006). Providing learners with a background on how to use museum worksheets as part of the preparation can also improve the likelihood of learning.

Teachers, museum educators and Yebo Gogga planners should minimise the use of worksheets for foundation phase learners. If they choose to use them, they should make use of oral answers rather than written and should reduce the number of tasks. The size of Foundation phase groups per adult should also be small especially when learners are required to complete worksheets. This is because completion of worksheets is a very demanding task for young learners who then require a lot of help and guidance from the adults accompanying them. The adults can effectively help learners only if they have to deal with a few of them. This has implications for school administrators too who should make sure that they have allowed enough teachers to accompany learners when they are going on a field trip.

Worksheets encourage learners to work cooperatively with each other. Therefore, all those who get involved in preparing worksheets for use during museum visits (teachers, museum educators and Yebo Gogga planners) should take advantage of this positive attribute of worksheets and use them to encourage children to work together and to interact.

Informal tour of museums should be accompanied by some form of mediation either directly from the teacher or museum educators or through the use of worksheets. Freelance touring of

exhibits by learners without some form of mediation has been seen to lessen the potential effectiveness of museums as venues for facilitating learning.

Teachers should allow learners to choose their own groups during the museum tour. If learners find themselves among other learners that they are not used to work with, this may cause anxiety and apprehension which will impact negatively on the learner's museum experience. Furthermore, learners are likely to work cooperatively together if they understand each other and there is cohesion within the group. Learners should therefore be allowed to move in groups that they are used to work in at school or they should move in self-selected groups to promote social cohesion (McManus, 1985) and hence reduce the apprehension that may negatively impact on the museum learning experience.

Teachers should 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 whether to complete the worksheets or not, the time available for completing the worksheets and for tea and lunch breaks and shopping around in the gift shops. Giving learners a clear agenda and proper instructions has been seen to bring about a worthwhile museum learning experience (Jarvis & Pell, 2005).

Museum explainers can play a very important role of mediating and hence facilitating learning during museum tours. Explainers can help learners to make sense of the worksheet tasks or to find answers to the worksheet questions. The explainers can also help learners by keeping them focused on the museum content and facilitating group discussions. This can reduce the learners' workload and speed up the completion of the worksheets. Therefore in museums where explainers are available, teachers can make use of them. If possible teachers can briefly meet with the explainers before the tour and outline the purpose of the visit and where and how the explainers can help the learners during the museum tour. The teachers can also introduce explainers to the learners and make it clear that the explainers are there to help them during their tour of the museum. If explainers explain and show interest in the learners' work, focused answering of worksheet tasks is likely to occur (Jarvis and Pell, 2002). The Yebo Gogga exhibition planners should keep on providing explainers during their exhibition as the explainers play an important role of facilitating and mediating the learning process during school visits.

Sometimes learners have incorrect ideas about certain science concepts and these ideas come out as learners discuss worksheet questions in their small groups during the museum tour. If answers to worksheet tasks are simply discussed and not written down, the teacher misses an opportunity to pick out those incorrect ideas and to deal with them. Teachers are therefore encouraged to ask learners (especially senior and FET learners who are likely to split into small groups and move through the museum on their own) to provide written responses to some of the worksheet tasks. The written responses will provide teachers with the necessary feedback from the museum tour activities. Teachers are also encouraged to go through the worksheet responses with the learners or even mark them so as to assess learners' understanding and pick out any incorrect ideas or misconceptions that may have arisen or surfaced during the visit.

If teachers decide to take learners for educational tours, the teachers should be very clear about the learning focus during the tour and should share this learning focus with the learners in order for learning to be facilitated. This is important as the behaviour and attitudes of some teachers (two) in this study didn't help learners to learn. These teachers allowed learners to do whatever they wanted. The teachers didn't say anything to the learners at the start of the tour of the exhibition and as a result some learners chose to follow the tour guide who received them and they toured the exhibition, others followed the guided group from behind discussing other things that had nothing to do with the exhibition and others decided to complete the worksheets. Because of the teacher's attitude, which was negative and unfocussed, the conduct of the whole group was therefore chaotic and did not support learning.

6.5 A reflection on the research process

From phase one of the study, valuable information about the appropriateness of worksheets as instruments for facilitating learning was obtained from the analysis of worksheets. However there was an assumption that all the worksheets had been made for facilitating learning during museum field trips which may not be the case. There is a possibility of designing and using worksheets as a control mechanism rather than a teaching/ learning strategy. From phase two, other than the possibility of learners' behaviour being influenced by awareness of carrying the recorder, there were no other concerns arising from the audio-recording of learners' conversations.

The Yebbo Gogga exhibition is a temporary exhibition that is staged with the aim of raising the public's interest and awareness of insects, plants and animals, and their symbiotic relationships with people and also to raise school children's interest in biology. With this view of the exhibition in mind it is possible that teachers and learners visited the museum unprepared for a heavy task of completing worksheets hence very few groups used worksheets and the design of the worksheets was also to some extent inclined towards fascinating visitors more than facilitating learning. Moreover service learning students who are responsible for preparing worksheets are not trained educationists and hence are not likely to prepare worksheets with those features that are likely to facilitate learning.

6.6 Suggestions for future research

According to my knowledge, this kind of study has never been done in South Africa. The study (both phase 1 and phase 2) covered a small sample and hence the results cannot be generalised to all museums. It would therefore be important that the study be repeated at other museums that have different setups to see if similar findings will be obtained.

6.7 Concluding remarks

In this study I have presented in detail characteristics of a worksheet that one needs to consider when designing a museum worksheet that is likely to facilitate learning. I have also used the same worksheet characteristics to design an instrument that educators can use as a guide in constructing museum worksheets or as a checklist to assess the appropriateness of their worksheets. The study showed that worksheets at some museums in Gauteng have features that can facilitate learning. The worksheets also contain features that might make the worksheets restrict learning. Furthermore, the worksheets also lack some features that are necessary for facilitating learning in museums. The study has also shown that the use of worksheets during field trips facilitates learning and that the teacher plays a critical role in bringing out the potential effectiveness of worksheets as instruments for facilitating learning. It is my desire to promote this knowledge on worksheets by informing stakeholders (such as teachers and museum educators) through various means about the characteristics of an effective worksheet and the important role teachers can play to improve the effectiveness of worksheet use during museum field trips.

References

Abu-Shumays, M., & Leinhardt, G. (2002). Two docents in three museums: central and peripheral participation. In G. Leinhardt, K. Crowley, & K. Knutson, *Learning conversations in museums* (pp. 45-80). Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers.

Allen, S. (2002). Looking for learning in visitor talk: A methodological exploration. In G. Leinhardt, K. Crowley, & K. Karen, *Learning conversations in museums* (pp. 259-304). Mahwah, New Jersey: Lawrence Erlbaum Associates, Publishers.

Anderson, C., & Butts, D. (1980). A comparison of individualised and group instruction in a sixth-grade electricity unit. *Journal of Research in Science Teaching, 17*(2), 139-145.

Anderson, D., & Lucas, K. B. (1997). The effectiveness of orienting students to tne physical features of a science museum prior to visitation. *Research in Science Education, 27*(4), 485-495.

Ash, D. (2002). Negotiations of thematic conversations about biology. In G. Leinhardt, K. Crowley, & K. Knutson, *Learning conversations in museums* (pp. 357-400). Mahwah, New Jersey: Lawrence Erlbaum Associates Publishers.

Ausubel, D. (1968). The facilitation of meaningful verbal learning in the classroom. *Educational Psychologist, 12*, 162-178.

Blatner, A. (2002). *Roleplaying in education.* Retrieved July 15, 2009, from Science Education Resource Centre at Carleton College: www.blatner.com/adam/pdntbk/rlplayedu.htm

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives: Handbook 1. Cognitive domain.* New York: David McKay Company.

Borun, M. (2002). Object-based learning and family groups. In S. G. Paris, *Perspectives on object-centred learning in museums* (pp. 245-259). New Jersey: Lawrence Erlbaum Associates Inc Publishers.

Bowker, R. (2002). Evaluating teaching and learning strategies at the Eden project. *Evaluation and Research in Science Education, 16*(3), 123-135.

Braund, M., & Reiss, M. (2004). The nature of learning science outside the classrom. In M. Braund, & M. Reiss, *Learning science outside the classroom* (pp. 1-12). London: RoutledgeFalmer.

Brill, J. M. (2001). *E Book: Learning, Teaching, & Technology.* Retrieved March 3, 2007, from Situated Cognition - Ebook: http://www.coe.uga.edu/epltt/situatedcognition.htm

Brown, S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32-41.

Burton, N., Brundrett, M., & Jones, M. (2008). *Doing your educational research project.* London: Sage.

Clarke, D. (1999, June 5). *Learning domains or Bloom's taxonomy*. Retrieved April 22, 2009, from http:/www.skagitwatershed.org/~donclark/hrd/bloom.html#one

Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in Education.* London: RoutledgeFalmer.

Damonse, B. (2008). Science Centre Management-Can S.A. meet the Development Goals? *11th Annual SAASTEC Conference.* Johannesburg. Sci-Bono Discovery Centre.

Dash, N. K. (2005, June). *Online Research Methods Resource for teachers and trainers.* Retrieved June 22, 2009, from Research Methods: http://www.celt.mmu.ac.uk/researchmethods/Modules/Selection_of_methodology/index.php

Davydov, J. D. (1995). The influence of L. S. Vygotsky on Education:Theory , research and practice. *Educational Reseacher, 24*(3), 12-21.

DeWitt, J., & Osborne, J. (2007). Supporting teachers on science-focused school trips:Towards an integrated framework of theory and practice. *International Journal of Science Education, 29*(6), 685-710.

DOE. (2001). *Report on the school register of needs 2000 survey.* Pretoria: Government Publishers.

Dowdeswell. (1981). *Teaching and Learning Biology.* London: Heinemann Educational Books.

Durbin, G. (1999). Improving worksheets. In E. H. Greenhill, *The educational role of the museum* (pp. 92-98). London: Routledge.

Falk, J (2004). The Director's Cut: Toward an improved understanding of learning from museums. *Science Education, 88*(suppl 1), S83-S93.

Falk, J. H., & Dierking, L. D. (2000). *Learning from museums: Visitor experiences and the making of meaning.* Walnut Creek: Altamira press.

Fienberg, J., & Leinhardt, G. (2002). Looking through the glass: Reflections of identity in conversations at a history museum. In G. Leinhardt, K. Crowley, & K. Knutson, *Learning conversations in museums* (pp. 167-211). New Jersey: Lawrence Erlbaum associates publishers.

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

Griffin, J., & Symington, D. (1997). Moving from task-oriented to learning oriented strategies on school excursions to museums. *Science Education, 87,* 763-779.

Hawkey, R. (2004, September). *Learning with digital technologies in museum, science centres and galleries.* Retrieved April 12, 2009, from Future Lab innovation in education: http://www.futurelab.org.uk/resources/documents/lit_reviews/Museums_Gallaries_Review.pdf

Hein, G. E. (1998). *Learning in the Museum.* London: Routledge.

Herman, J. L., Morris, L. L., & Taylor, C. (1987). *Evaluator's handbook.* Newbury Park: Sage.

Hitchcock, G. H. (1995). *Research and the reader: A qualitative introduction to school-based research.* London: Routledge.

Hohenstein, J., & Uyen Tran, L. (2007). Use of questions in exhibit labels to generate explanatory conversation among science museum visitors. *International Journal of Science Education, 29*(12), 1557-1580.

Isaac, S., & Michael, W. (1981). *Handbook in Research and Evaluation*, San Diego, California. EdiTs Publishers.

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.

Jarvis, T., & Pell, A. (2005). Factors influencing elementary school children’s attitudes to science before during and following a visit to the UK National Space Centre. *Journal of Research in Science Teaching, 42*(1), 53-83.

Johnson, C. (2005). *Science Centers as learning environments*. Retrieved April 12, 2009, from Association of Science - Technology Centers: http:www.astc.org/resource/education/jojnson_scicenters.htm

Kadijevich, D. (2002). *TIMSS 2003 Mathematics cognitive domains: examination, operationalisation and implications*. Belgrade, Yugoslavia.

Kisiel, J. (2003). Teachers, museums and worksheets: A closer look at a learning experience. *Journal of Research in 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.

Koloko, A. (2008). Personal communication. Johannesburg, Gauteng, South Africa.

Krombaβ, A., & Harms, U. (2008). Acquiring knowledge about biodiversity in a museum - are worksheets effective. *Journal of Biological Education, 42*(4), 157-163.

Kubota, C. A., & Olstad, R. G. (1991). Effects of novelty reducing preparation on exploratory behaviour and cognitive learning in a science museum setting. *Journal of Research in Science Teaching, 28,* 225-234.

Lehman, J. R., & Lehman, K. M. (1984). The relative effects of experimenter and subject generated questions on learning from museum case exhibits. *Journal of Research in Science Teaching 21*, 931-935.

Lelliott, A. D. (2009). Teacher practices during science school visits in Gauteng. *Proceedings of the 17th Annual SAARMSTE conference.* Grahamstown: Rhodes University. 240-249

Malinga, A. (2007, September). The Sci-Bono Discovery Centre. *Marang News* . Johannesburg, Gauteng, South Africa.

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.

Mortimer, E. F., & Scott, P. H. (2003). *Meaning making in secondary school science.* Berkshire: Open University press.

Novak, J. D. (1977). An alternative to Piagetian Psychology for Science and Mathematics Education. *Science Education, 61*, 453-477.

Opie, C. (2004). Research approaches. In C. Opie, *Doing educational research* (pp. 73-94). Los Angeles: Sage publications.

Patton, M. Q. (1990). *Qualitative evaluation and research methods.* London: Sage Publishers.

Piaget, J. (1964, 2003). Development and Learning. *Journal of Research in Science Teaching, 40, Supplement*, S8 - S18.

Pollock, S. (1983). An inside view of education at the Natural History in London. *Journal of Biological Education, 17*(2), 119-122.

Price, S., & Hein, G. (1991). More than a field trip: science programmes for elementary school groups at museums. *International Journal of Science Education, 13*, 505-519.

Rahm, J. (2002). Multiple Modes of meaning-making in a science centre. *Science Education, 88*, 223-247.

Rennie, J. L., Feher, E., Dierking, L. D., & Falk, J. H. (2003). Toward an agenda for advancing research on science learning in out of school settings. *Journal of Research in Science Teaching, 40*(2), 112-120.

Rennie, L. J., & Johnston, D. J. (2004). The nature of learning and its implication for research on learning from museums. *Science Education, 88(suppl 1)*, s4-s16.

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.

Rix, C., & McSorley, J. (1999). An investigation into the role that school-based inter-active science centres may play in the education of primary aged children. *International Journal of Science Education 21*, 577-593.

Sanders, M. (2007, September). Evolution workshop. Johannesburg, Gauteng, South Africa.

Sanders, N., & Cramer, F. (1992). Matric Biology pupils' ideas about respiration: Implications for science educators. *South African Journal of Science, 88*, 543-548.

Scaife, J. (2004). Reliability, Validity and Credibility. In C. Opie, *Doing Educational Research* (pp. 58-72). London: Sage.

Smith, C., Carey, S., & Wiser, M. (1985). On differentiation: A case study of the development of the concepts of size, weight and density. *Cognition, 21*, 177-237.

Smith, J. P., DiSessa, A. A., & Roschelle, J. (1993). Misconceptions reconceived: A constructivist analysis of knowledge in transition. *The Journal of the Learning Sciences, 3*(2), 115-163.

Stainton, C. (2002). Voices and Images:Making connections between identity and art. In G. Leinhardt, C. Kevin, & K. Knutson, *Learning Conversations in Museums* (pp. 213-258). New Jersey: Lawrence Erlbaum Associates, Publishers.

Tal, R., Bamberger, Y., & Morag, O. (2005). Guided school visits to natural history museums in Israel: Teacher's roles. *Science Education, 89*, 920-935.

TIMSS report. (2007). Retrieved June 4, 2009, from International Association for the Evaluation of Educational Achievement: http://timss.bc.edu/TIMSS2007/frameworks.html

Tulley, A., & Lucas, A. M. (1991). Interacting with a science museum exhibit: Vicarious and direct experience and direct understanding. *International Journal of Science Education, 13*, 533-542.

Vygotsky, L. (1978). *Mind in Society: The Development of higher psychological processes.* Cambridge: Harvard University Press.

Wenger, E. (1991). *Communities of practice: Learning, Meaning and Identity.* Cambridge: Cambridge University Press.

Wertsch, J. (1991). *Voices of the mind. A sociocultural Approach to Mediated Action.* Cambridge: Harvard University Press.

Wertsch, J., & Kanner, B. (1992). Sociocultural approach to intellectual development. In R. J. Sternberg, & C. A. Berg, *Intellectual Development.* Cambridge: Cambridge University Press.

West, L. H., & Fensham, P. J. (1974). Prior knowledge and the learning of science. A review of Ausubel's theory of this process. *Studies in Science Education, 1*, 61-84.

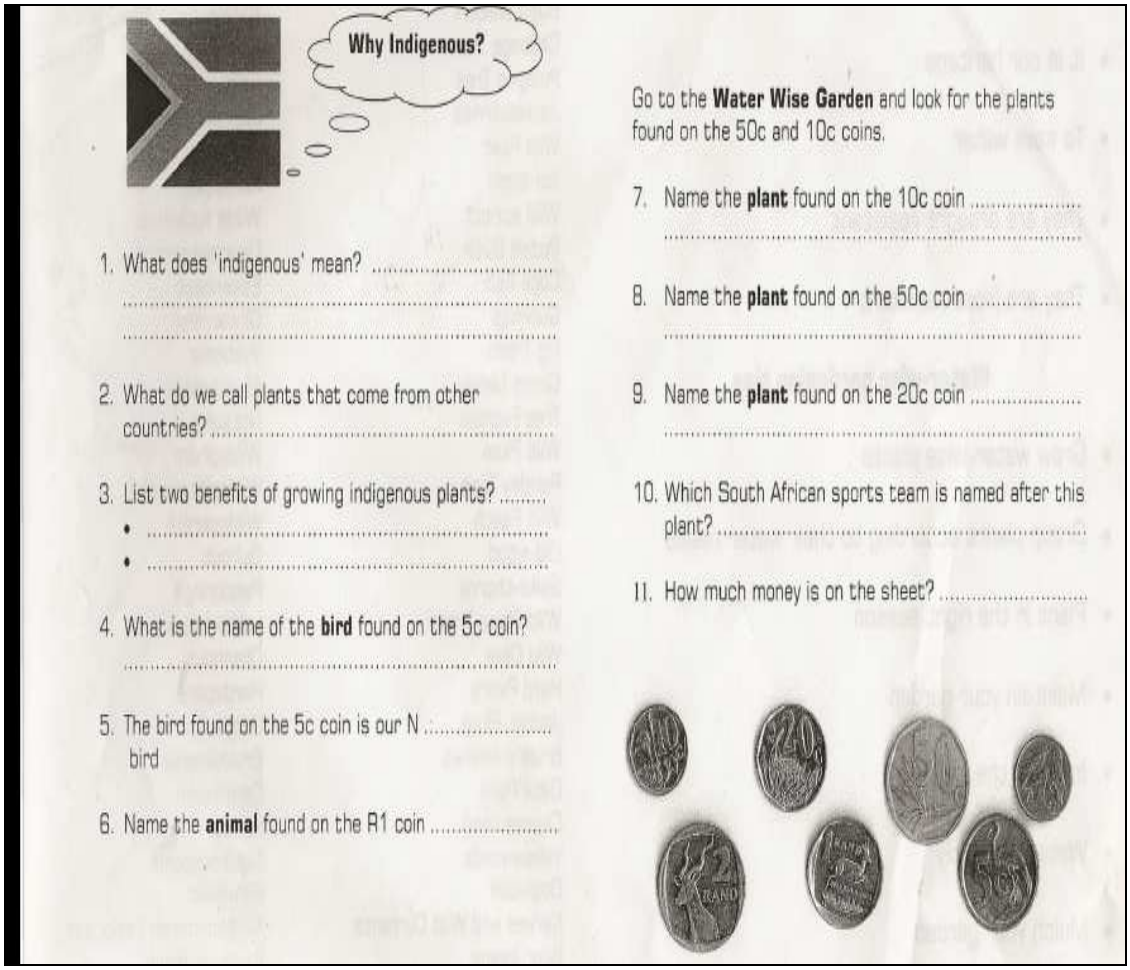
Wilde, M., &Urhahne, D. (2008). Museum learning: a study of motivation and learning achievement. *Journal of Biological Education, 42*(2), 78-86.

Appendices

Appendix A

Worksheets

Worksheet 1



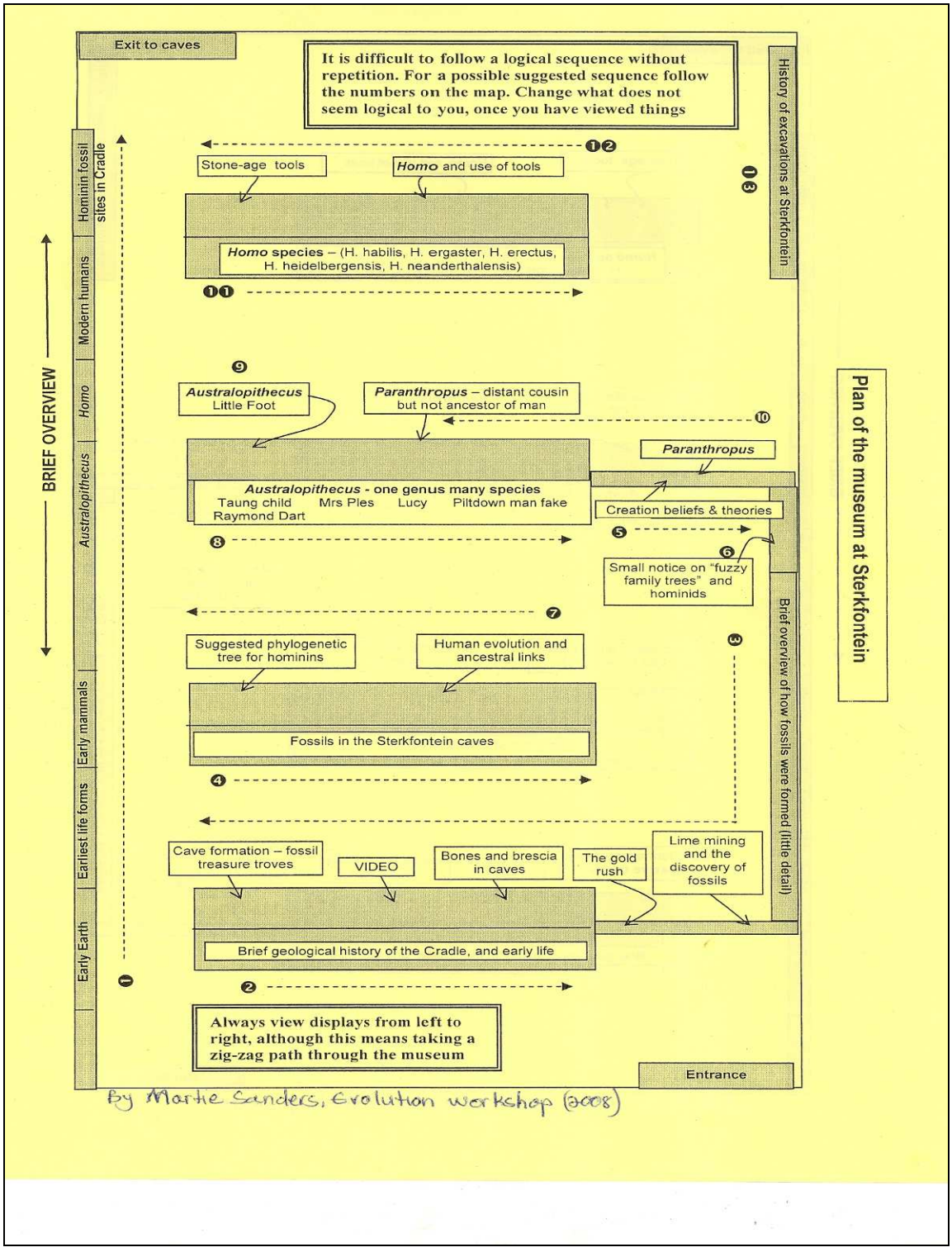
Why Indigenous?

1. What does 'indigenous' mean? .....
   .....
   .....
2. What do we call plants that come from other countries? .....
3. List two benefits of growing indigenous plants? .....
   - .....
   - .....
4. What is the name of the **bird** found on the 5c coin?
   .....
5. The bird found on the 5c coin is our N ..... bird
6. Name the **animal** found on the R1 coin .....

Go to the **Water Wise Garden** and look for the plants found on the 50c and 10c coins.

7. Name the **plant** found on the 10c coin .....
   .....
8. Name the **plant** found on the 50c coin .....
   .....
9. Name the **plant** found on the 20c coin .....
   .....
10. Which South African sports team is named after this plant? .....
11. How much money is on the sheet? .....

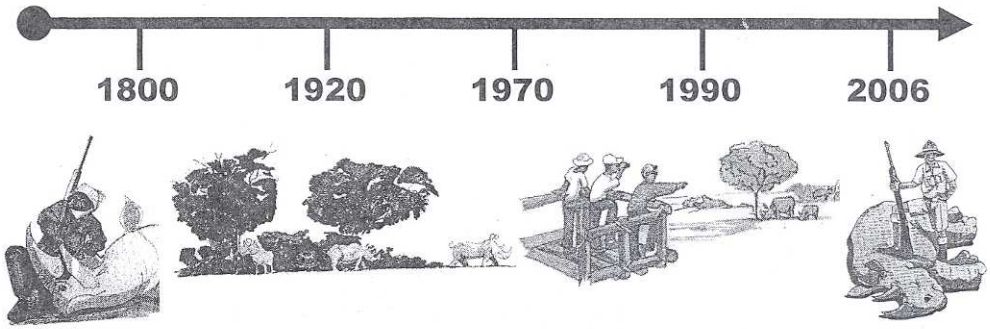
Worksheet 2: An example of a worksheet with orientation cues



A pre-visit worksheet

Pre-visit worksheet

What do you think happened first? Put the pictures in order along the time-line.



WHEN WERE YOU BORN? Mark it on the time-line

Why are Rhinos endangered?

1. _____
2. _____
3. _____

Why do we need to save the Rhinos?

_____

_____

_____

How do Rhino Rangers help the Rhinos?

_____

Find out 1 interesting fact about Rhino

_____

As a Rhino Ranger, what else would you like to know about Rhinos. Make up 3 questions to ask the Zoo Staff when you visit us.

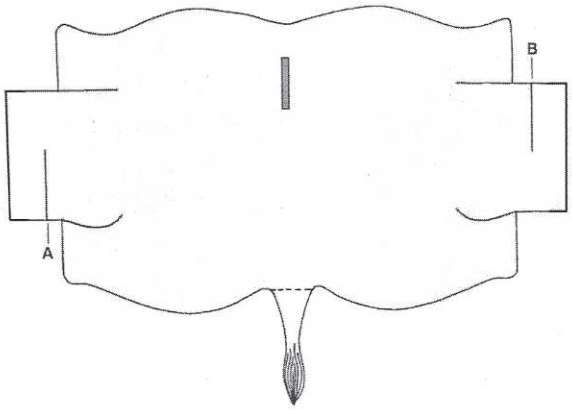
1. _____
2. _____
3. _____

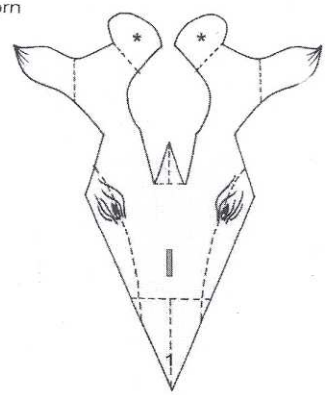
A post-visit worksheet

Post-visit worksheets

Make your rhino

1 **Colour** in using crayons, felt-tips or pencils
2 **Cut carefully** round the outlines of the rhino's body and head
3 **Fold** along the dotted lines
4 **Cut out** the **rectangle** (▯) to make slots for the head & horn
5 **Cut** along lines **A** and **B** to make slots
6 **Slot** A into B and insert head tabs (*) into head slot
7 **Fold** section **1** underneath and through hole on the nose





Thanks to EDINBURGH ZOO

RHINO RANGER TEAM PROJECT

- Make a Poster, poem or a drama about the Rhinos.
- It must have as much information about Rhinos that you can put in, all the information you have learnt on your three worksheets.
- It must have a sentence on what your parents or elders know about Rhinos (or what they believe about Rhinos)
- Your interesting fact from worksheet 1 (Training a Rhino Ranger)
- State on your poster or in your poem why Rhinos cannot become extinct.
- You must hand it in by _____.
- Who are the members of your Rhino Ranger Team?

_____ _____
_____ _____
_____ _____
_____ _____

Remember: The best project will win a very cool prize.

A general worksheet

General worksheet

II WATER IS LIFE – INTERMEDIATE PHASE

Examine the two rivers below and answer the questions.

A

B

1. Which river would you like to swim in or drink from?
   .....
2. Give two reasons for your answer:
   - .....
   - .....
3. Why has river B become so polluted? .....
   .....
4. Do you think river B is dying?
   .....
5. How could you get river B to look like river A again?
   .....
   .....
6. Why should we try to keep our rivers like river A?
   .....
   .....

Water is life

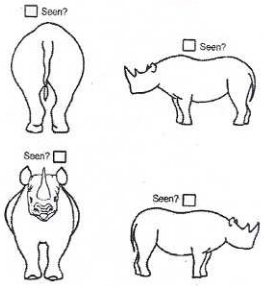
During-visit worksheets

Worksheet Z1

Meeting the Zoo Rhinos: Worksheet Z1

Name	Male or Female	Age	Eating/ Resting/ Walking/ Scratching/ Wallowing
			3b, 4a 5a

Have you seen this side of our Rhinos .....



Draw their horns on as you see them.



Thaba Zembi

Thaba and Zimbi eat a lot of food. Each day they get 213kg of food.

How much would they eat in a week? _____

What are the advantages of Rhinos living in the wild and in a Zoo?

Wild: _____ Zoo: _____

_____ _____

What are the bad things about Rhinos living in the wild and in a Zoo?

Wild: _____ Zoo: _____

_____ _____

Worksheet Z2

Worksheet 2

Catch the Poacher Game: Worksheet Z2

Checkpoint One

You are a ranger in a National Park and you find a dead Rhino. A poacher has shot the Rhino. It is the ranger's job to protect the Rhinos, you must find this poacher.

(1) **Question:** Why do the poachers catch Rhinos? 1K

A. They want the horns!
B. They are afraid of Rhinos!
C. The Rhinos eat their crops!

3a

Checkpoint Two

The poachers shot the Rhinos because they want the horn. It is used in traditional Chinese medicine, ornamental and handles for traditional daggers in Yemen. On illegal markets, the price is about R117,000 per kg.

(2) **Question:** How much is this horn worth if it is 10kg?

A. R2 000 000
B. R1 170 000
C. R1 300 000

3a C

Checkpoint Three

As a ranger, you have to know where to find the Rhinos, by identify footprints.

(3) **Question:** Here you can see footprints from a lion, a Rhino, a giraffe, an elephant and ape. Can you identify the Rhino footprint? Write down the letter next to the right answer. 3b K

Checkpoint Four

You can look for fresh dung. Rhinos drop their dung in well-defined piles and often furrow the area around the piles with their horns or feet.

(4) **Question:** Why does the Rhino drop its dung in piles? 3a 1K

F. Rhinos are very clean animals that do not want to mess up the savannah
G. To make it easier for the local people to collect manure for their vegetable gardens
H . The dung piles act as "sign posts" or territory marks

Checkpoint Five

There are 5 types of Rhinos: the Black and the White Rhino are found in Africa, the rest are in Asia.

(5) **Question:** What kind of Rhino can you see in the zoo? 3b 1K

I. Black Rhino
J. Greater one-horned Rhino
K. Sumatran Rhino
L. Javan Rhino
M. White Rhino

Checkpoint Six

One of the villagers tells you that he has spoken to a foreigner who says he killed a Rhino. By the description you identify the man in the Spaza. Well done!

(6) **Question:** What will happen to the poacher now? General 1K

R. He is asked to give the horn back
S. He is told that it is illegal to shoot Rhinos
T. The Rhino horn is found in his tent and he has to go to jail

(7) **What is the name of the Poacher?** 3b __ __ __ __ __ __
Can you see him? If you can, get the police to arrest him!

Worksheet Z3

Worksheet Z3



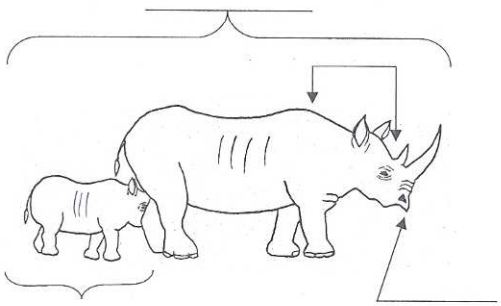
SAVE THE RHINO
TRAINING A RHINO RANGER

K1 Do you know which two Rhino species are found in Southern Africa? General or museum educator No information in text

1. _____ 2. _____

2 Identify the White and Black Rhino, also label the differences - some choice

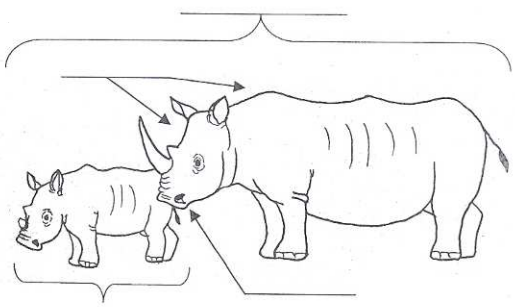
K



_____

WEIGHT: _____

HEIGHT: _____



_____

WEIGHT: _____

HEIGHT: _____

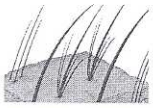
K3. How many toes does the Rhino have?



_____

4 What Body Covering does the Rhino have? (circle the correct answer)







K 5 What is the weight differences between the Rhinos? Convert the answer to grams (g). 6 K general

White Rhino _____ kg

Black Rhino _____ kg

_____ kg _____ g

7 What is the height differences between the Rhinos? Convert into meters (m). 8 K General

White Rhino _____ cm

Black Rhino _____ cm

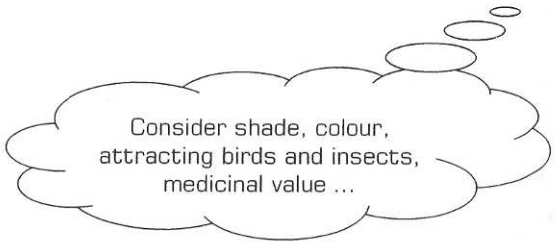
_____ cm _____ m

Indigenous Useful Plants

1. List three uses of plants?
   - .....
   - .....
   - .....
2. Name one plant that can be used to treat colds and flu?
   .....
3. How does one prepare the treatment? .....
   .....
4. Which plant can be used to treat wounds and sores?
   .....



5. Name the plant that can be used to chase snakes away?
   W_ _ _ _ g _ _ _ _ _
6. What does the smell remind you of? .....
   .....
7. What do we call plants that have been exploited and are no longer available? E_ _ _ _ _ _ _ _
8. What is the name of the tree that is almost extinct in the Garden? P_ _ _ _ _ _ b _ _ _ _
9. Which plant/tree would you like to grow in your school? .....



10. Give reasons for your choice
    .....
    .....
    .....

B2

Did you know . . .
When petals and sepals look the same, they are called **tepals**

FLOWERING PLANTS – INTERMEDIATE PHASE

With the help of your AEO, find an example of a monocotyledonous and dicotyledonous plant. Look at it closely and answer the following questions:

	ANGIOSPERMS		
	MONOCOT	**DICOT**	
What kinds of veins have the leaves of these plants? Net veined or parallel veined?	.....	.....	Leaves
Make a small drawing to show the venation			
How many **petals** has a typical flower?	.....	.....	Flower parts
How many **sepals** has a typical flower?	.....	.....	
Make a small labeled sketch of the flowering parts of this plant			

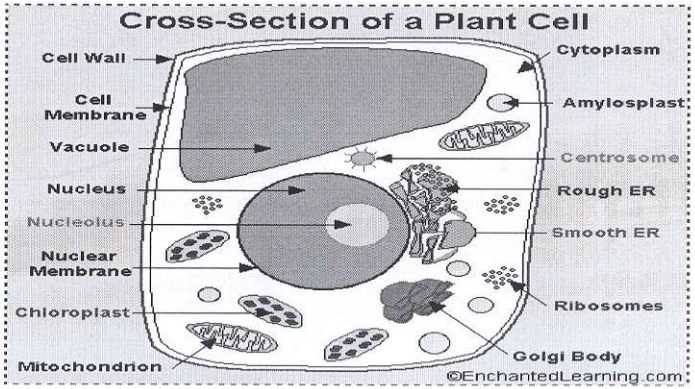
	ANGIOSPERMS		
	MONOCOT	**DICOT**	
			Root system
What kind of root system do these plants have?	.....	.....	
You will not be able to see the roots. Use the diagrams to help you answer the question.			
How is this root system effective?	.....	.....	
	.....	.....	
	.....	.....	

Have you noticed that very few monocotyledons are trees – can you think why? .....

Worksheet-B3

Pre-visit section

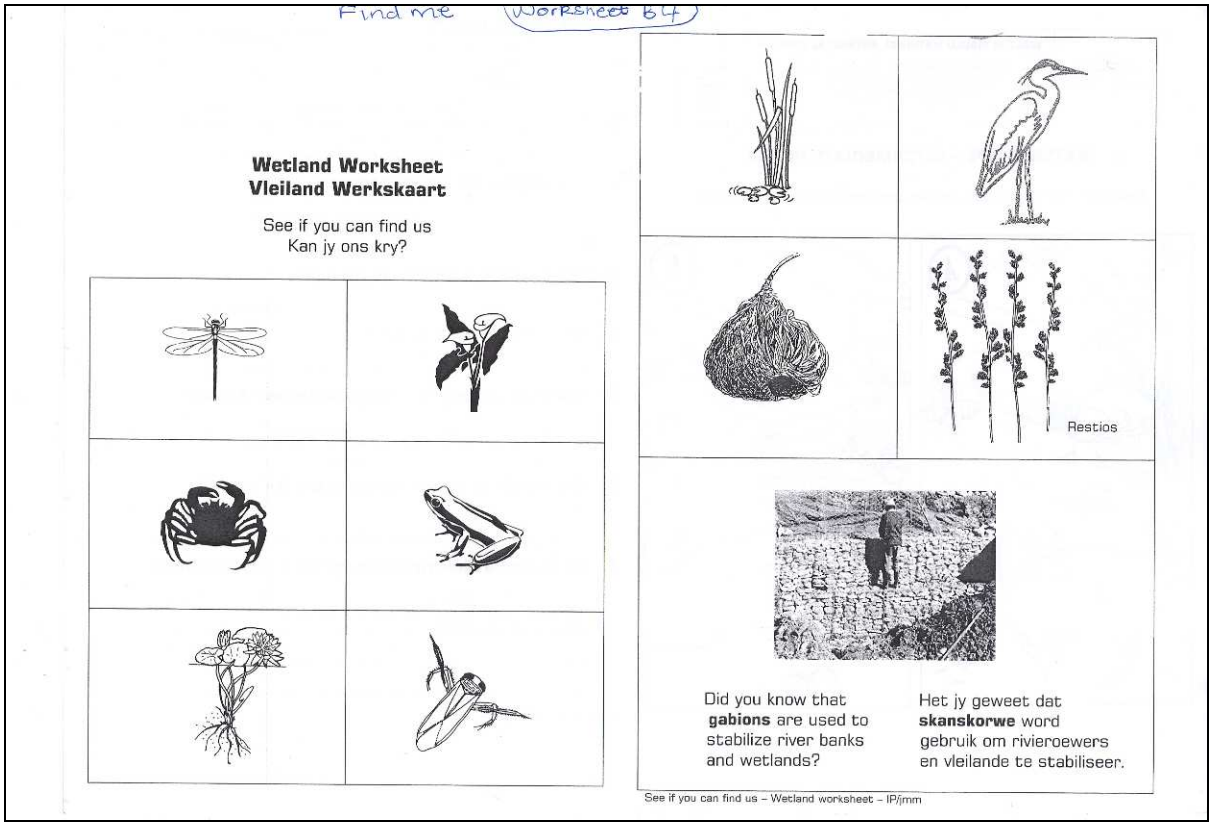
1. What is a botanical garden? .....
   .....
2. Is there any difference between a botanical garden and a zoological garden? .....
   .....
3. When was the Garden started? .....
4. What does SANBI stand for? .....
   .....
5. What do you think is offered at the Walter Sisulu National Botanical Garden? .....
   .....
   .....
   .....
6. Where can you go if you have been given a task to research about plants? .....
   .....
7. Choose one plant in the Garden and investigate about the following:
   - Its botanical name .....
   - The scientific name .....
   - A description of the plant .....
   - Uses of the plant .....



8. What does a plant cell look like? .....
   .....
9. All plant cells have three main parts, can you name them?
   - .....
   - .....
   - .....

Science expo/General/TR/jmm

Worksheet B4



Find me Worksheet B4

Wetland Worksheet
Vleiland Werkskaart

See if you can find us
Kan jy ons kry?

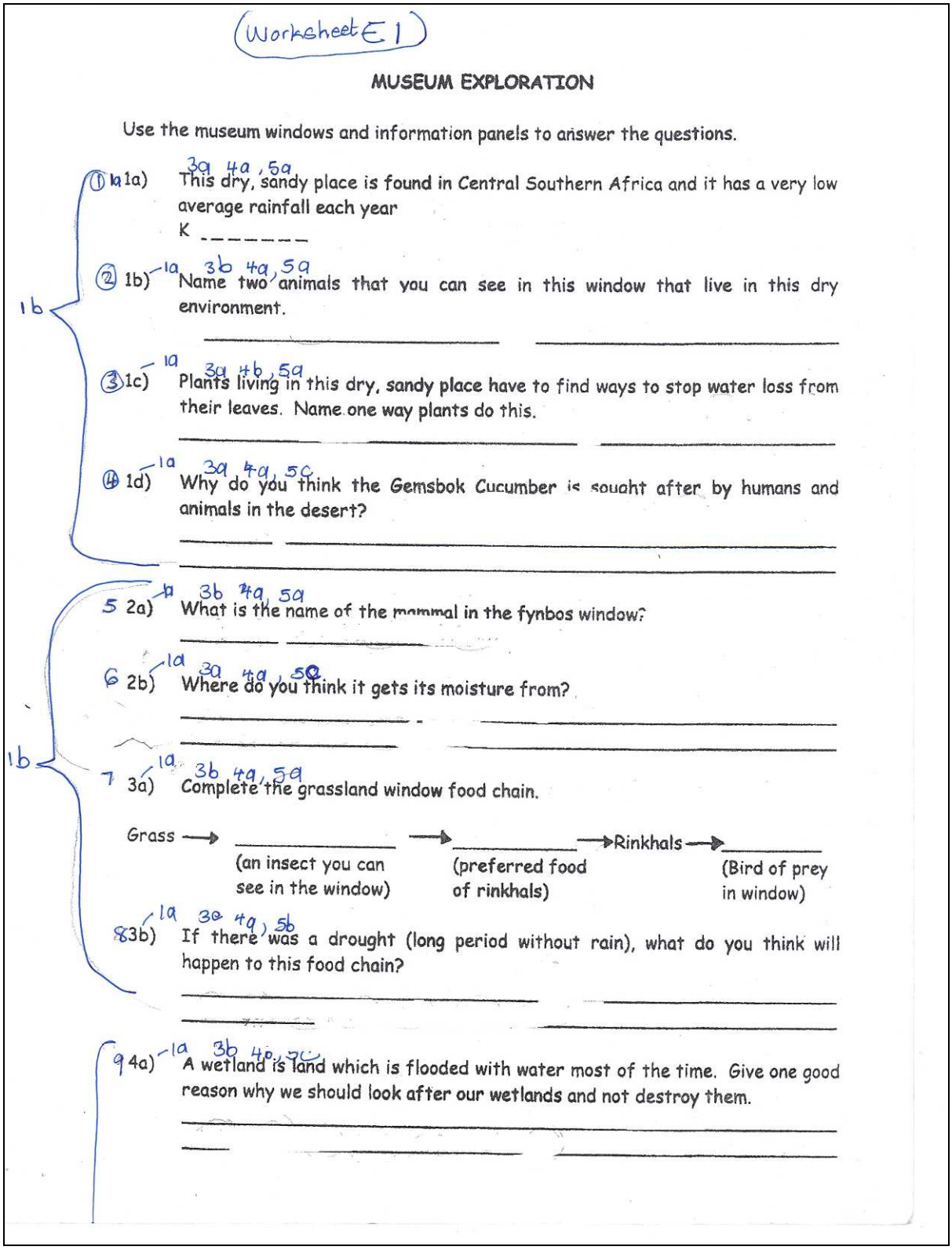
Restios

Did you know that **gabions** are used to stabilize river banks and wetlands?

Het jy geweet dat **skanskorwe** word gebruik om rivieroewers en vleilande te stabiliseer.

See if you can find us – Wetland worksheet – IP/jmm

Worksheet E1



(Worksheet E1)

MUSEUM EXPLORATION

Use the museum windows and information panels to answer the questions.

1a 1a) This dry, sandy place is found in Central Southern Africa and it has a very low average rainfall each year
K _____

2 1b) Name two animals that you can see in this window that live in this dry environment.

_____ _____

3 1c) Plants living in this dry, sandy place have to find ways to stop water loss from their leaves. Name one way plants do this.

_____ _____

4 1d) Why do you think the Gemsbok Cucumber is sought after by humans and animals in the desert?

_____ _____

5 2a) What is the name of the mammal in the fynbos window?

_____ _____

6 2b) Where do you think it gets its moisture from?

_____ _____

_____ _____

7 3a) Complete the grassland window food chain.

Grass → _____ → _____ → Rinkhals → _____

(an insect you can see in the window) (preferred food of rinkhals) (Bird of prey in window)

8 3b) If there was a drought (long period without rain), what do you think will happen to this food chain?

_____ _____

_____ _____

9 4a) A wetland is land which is flooded with water most of the time. Give one good reason why we should look after our wetlands and not destroy them.

_____

_____ _____ _____

Worksheet E1 cont.

1a, 3b, 4b, 5a

4b) There are many different birds that live in a wetland. Name two birds you can see in the wetland window.

1a, 3b, 4a, 5a

11 Draw the feet of the bird that likes to paddle in the water.

1a, 3b, 4a, 5c

12 4c) The wetland provides the heron with lots of food. Look at the shape of the heron's beak. Draw a picture of what you think it eats?

1b

1a, 3a, 4b, 5c

5a) Mangrove Trees live in a very interesting place – where salt and fresh water meet. Some of the tree roots grow up into the air instead of down into the ground. Why do you think the roots grow like this?

1a, 3a, 4a, 5a

5b) Why is it a good sign to find otters in an ecosystem?

1b

1a, 3b, 4b, 5a

6a) The ocean is a vast expanse of salty water. That means humans cannot drink it but, there are many animals that can live in it. Draw one creature you can see living in the rocky shores window.

1a, 3b, 4b, 5c

16 6b) Give one reason why you think the ocean is important to humans.

Worksheet E2

WATER ECOLOGY

(Worksheet E2) ECOSYSTEM

Water is essential for life. All life on earth depends on it. Both plant and animal communities are adapted to make efficient use of available water. The presence of water in an ecosystem depends on abiotic (non-living) factors such as:

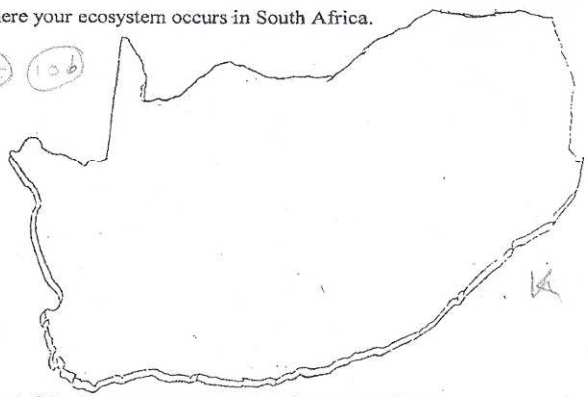
1. Ocean Currents (influence pattern and distribution of rainfall).
2. Soil types which affect the drainage and collection of water eg. sandy soils do not retain water while clay soils retain water very well but, this water may be difficult for the plants to extract.
3. Climate (Temperature, wind, rainfall, humidity etc.)
4. Topography (slope).

(1) 1a
In the block below sketch your ecosystem. Include the biotic (living) and abiotic components. Use the information windows to help you write in descriptive labels. 1b

1a, 3b 4b 5b 6c 7a 8a 9c 10b C.

(2) 1a
On the map below shade in the area where your ecosystem occurs in South Africa.

3e 4a 5a 6c 7b 8a 9c 10b



(3) 1a, 3a, 4a, 5a, 6e, 7b
In the block below shade in the annual rainfall of your ecosystem and make sure you have indicated this on either the summer or winter rainfall side of the block.

K

NC

3a 4a 5a 6e 7b 8a 7b

SUMMER RAINFALL	WINTER RAINFALL
0 – 120mm	0 – 120mm
120 – 500mm	120 – 500mm
500 – 1000mm	500 – 1000mm
1000 – 1500mm	1000 – 1500mm
> 1500mm	> 1500mm

Worksheet E2 cont.

Worksheet E2 p2

(4) Shade in the relevant soil type and water retention on the supplied table.

WATER RETENTION				
	High			
	Medium			
	Low			
		Sandy	Clay	Loamy

SOIL TYPE

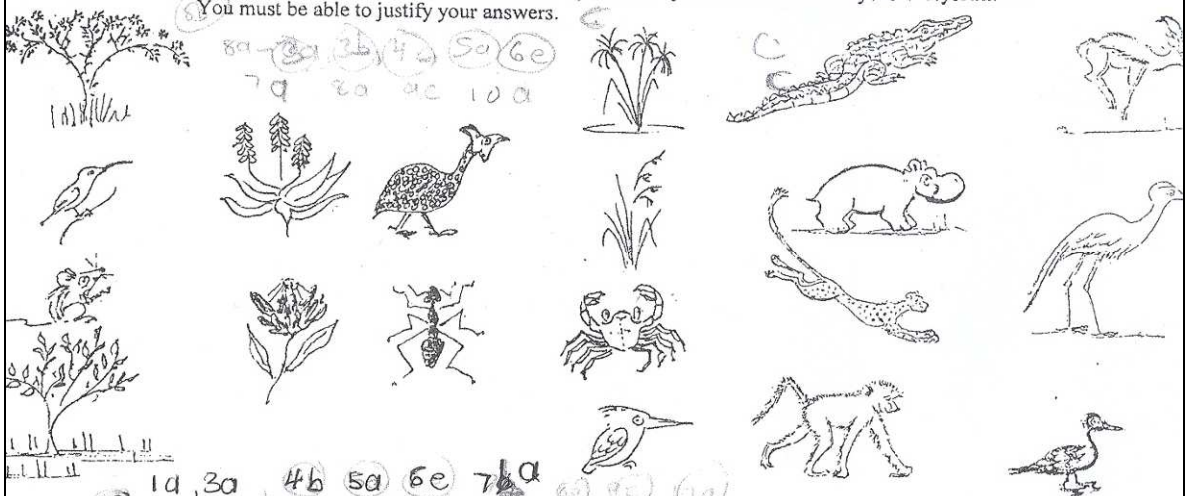
(5) In your own words describe the climate in your ecosystem.

(6) Choose one plant that you see in your ecosystem. How do you think this plant is adapted to living in this ecosystem?

(7) Make a food chain using the plants and animals in your ecosystem.

(8) How is this food chain influenced by the availability of water in your ecosystem?

(9) Your ecosystem has been destroyed by human activity. You are part of the rehabilitation team. Which of the following animals and plants will you re-introduce into your ecosystem. You must be able to justify your answers.



(10) Name/list any animals (from pictures above) that can survive in all of the ecosystems, namely; Kalahari, Fynbos, Grassland, Wetland and Mangroves.

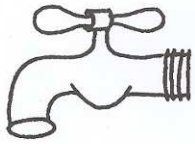
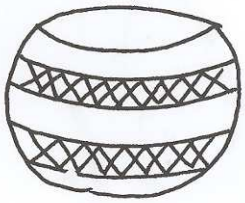
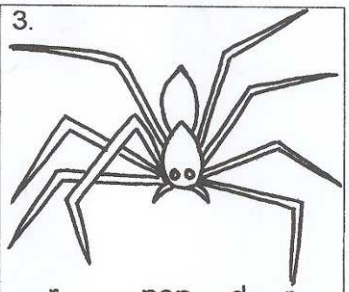
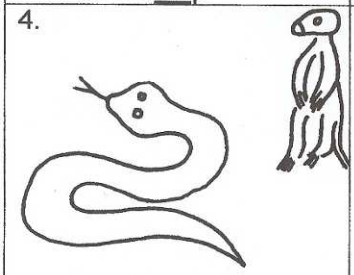
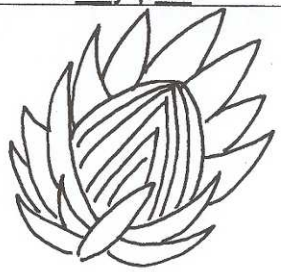
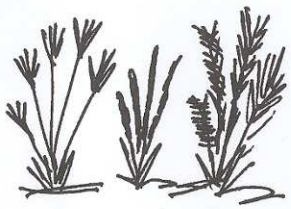
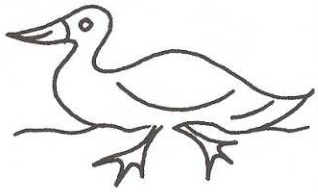
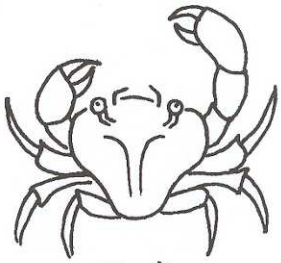
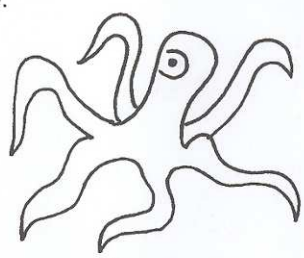
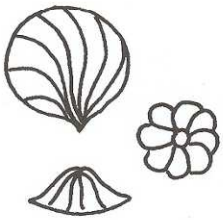
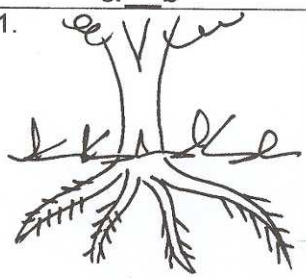
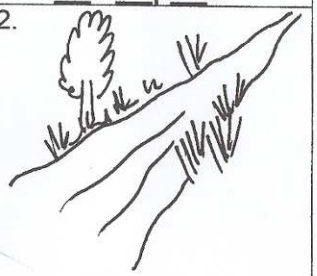
(11) Explain your choice.

Worksheet E3

FIND ME!

Worksheet E3

How many of these pictures can you find in the museum?
When you find it, fill in the missing letters to complete the word

1.  t__p	2.  cl__y p__t	3.  r__ __nsp__d__r
4.  d__s__rt	5.  f__nb__s	6.  gr__ssl__nd
7.  d__ck	8.  cr__b	9.  __ct__p__s
10.  sh__ll	11.  r__ __ts	12.  w__t__r

Name: _____ Grade:_____

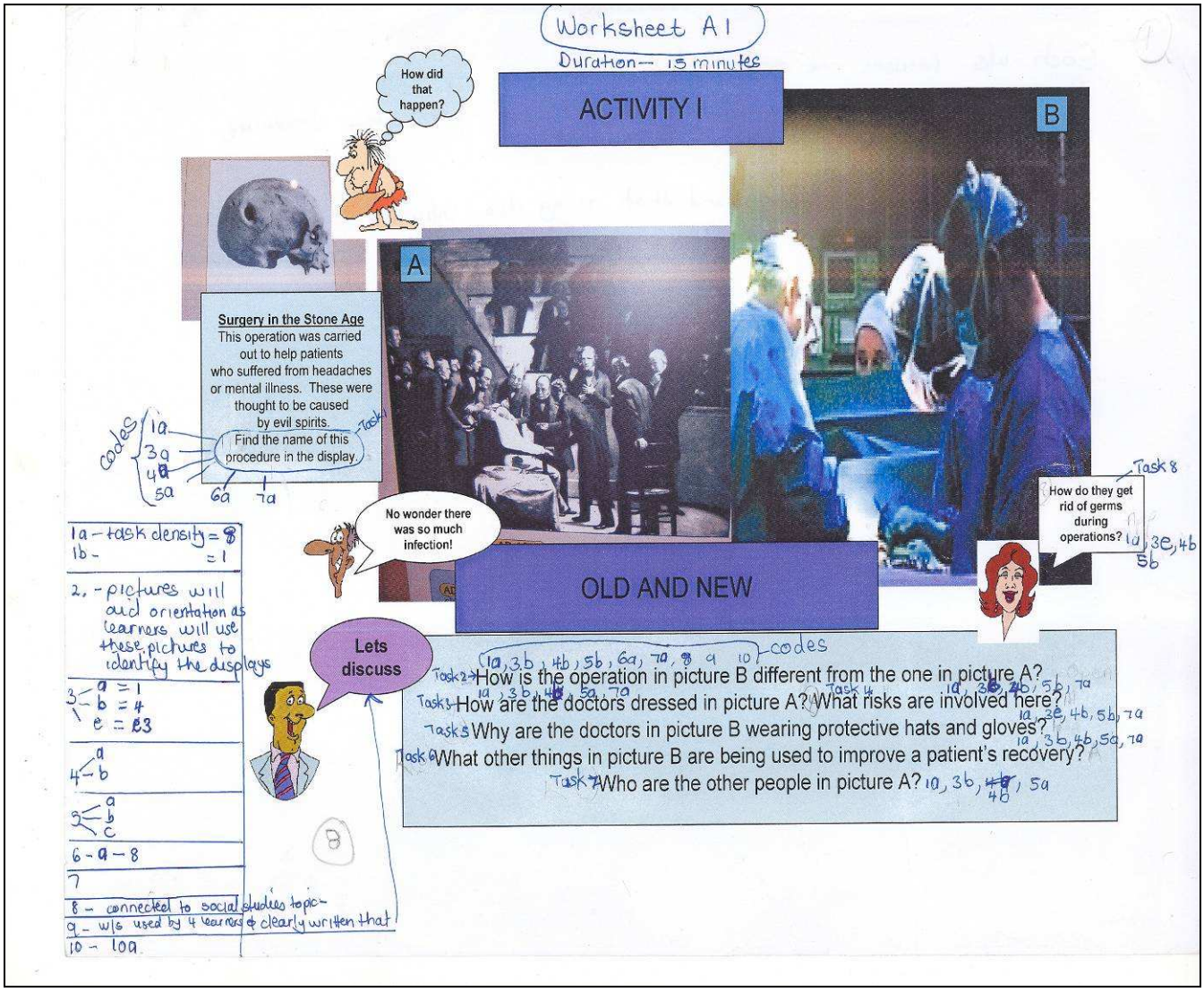
Worksheet E3 clues

CLUES TO "FIND ME" MUSEUM WORKSHEET E3

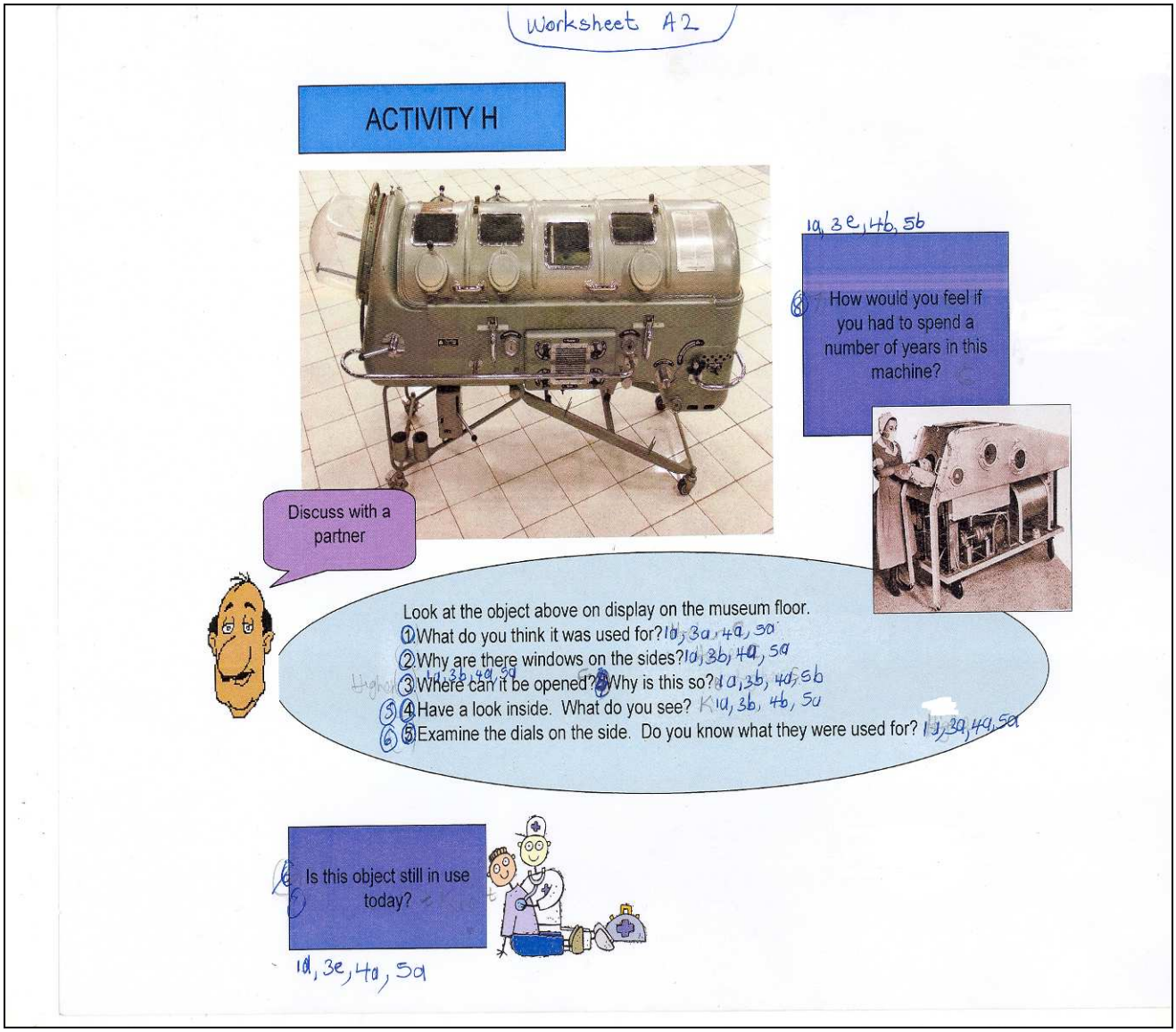
Each clue is numbered according to the picture learners need to find.

1. Today (modern times), people use me to get their drinking water.
2. A very long time ago people had to use me to carry water from the river which they used for drinking, cooking and cleaning.
3. My name has something to do with rain, and I have eight legs.
4. I do not get a lot of rain and so I am a hot and dry place.
5. These plants live in an area where they get their rain in winter.
6. These plants live in an area where they get their rain in summer.
7. I can float on the water and I do not get wet.
8. I live inside the water and I walk sideways.
9. I live in salty water and have eight long legs.
10. You can pick me up on the beach. I have many shapes and colours.
11. We look like many legs but cannot walk. Plants use us to "drink" water for them.
12. Nothing can survive without me. Everything needs me to have life.

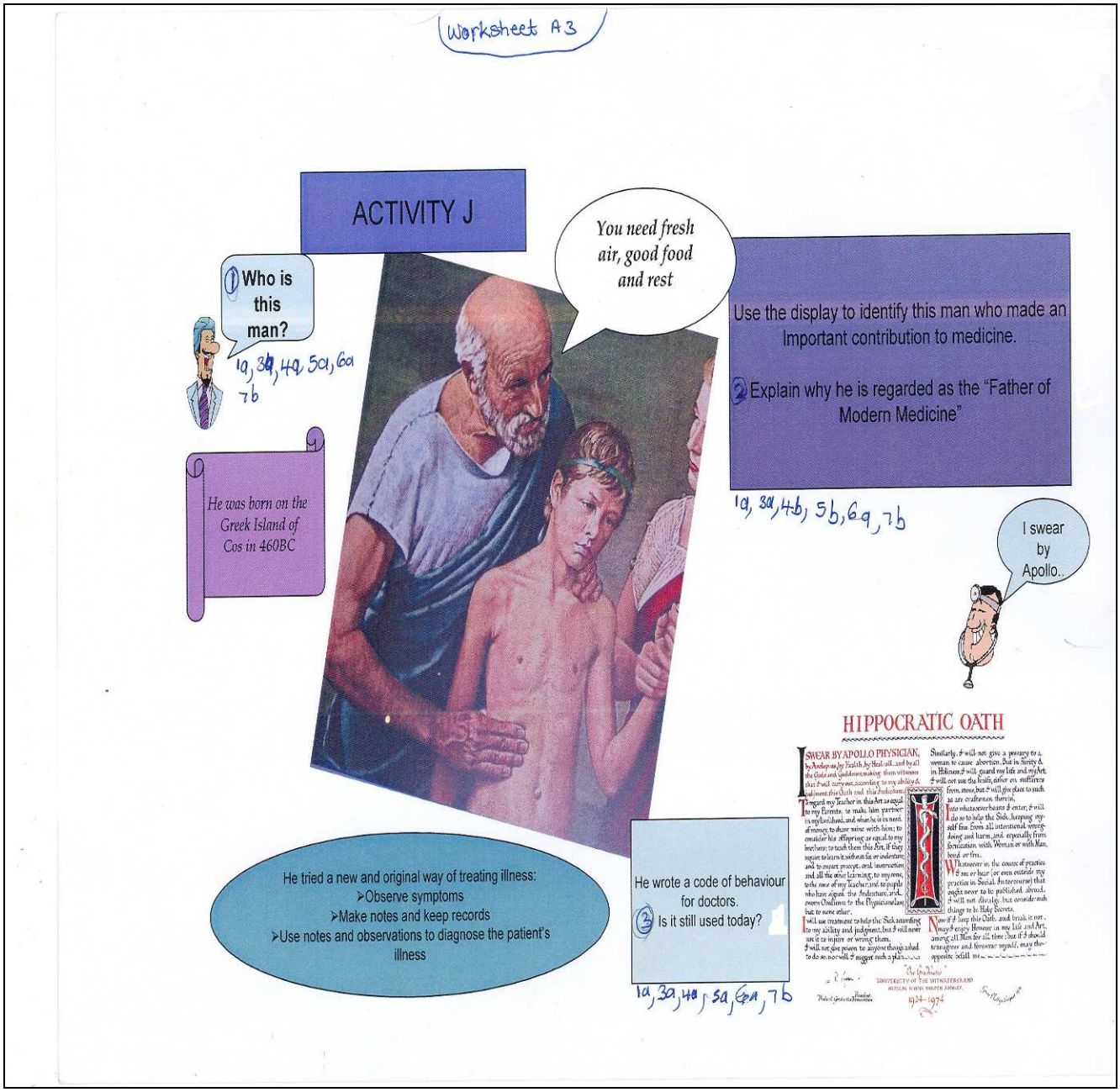
Worksheet A1



Worksheet A2



Worksheet A3

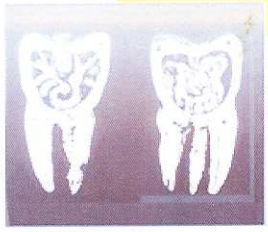


Worksheet A4

Worksheet A4

DENTISTRY

Tooth worms, tooth pullers, toothache!
Early beliefs and treatments.



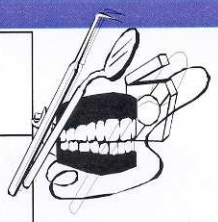






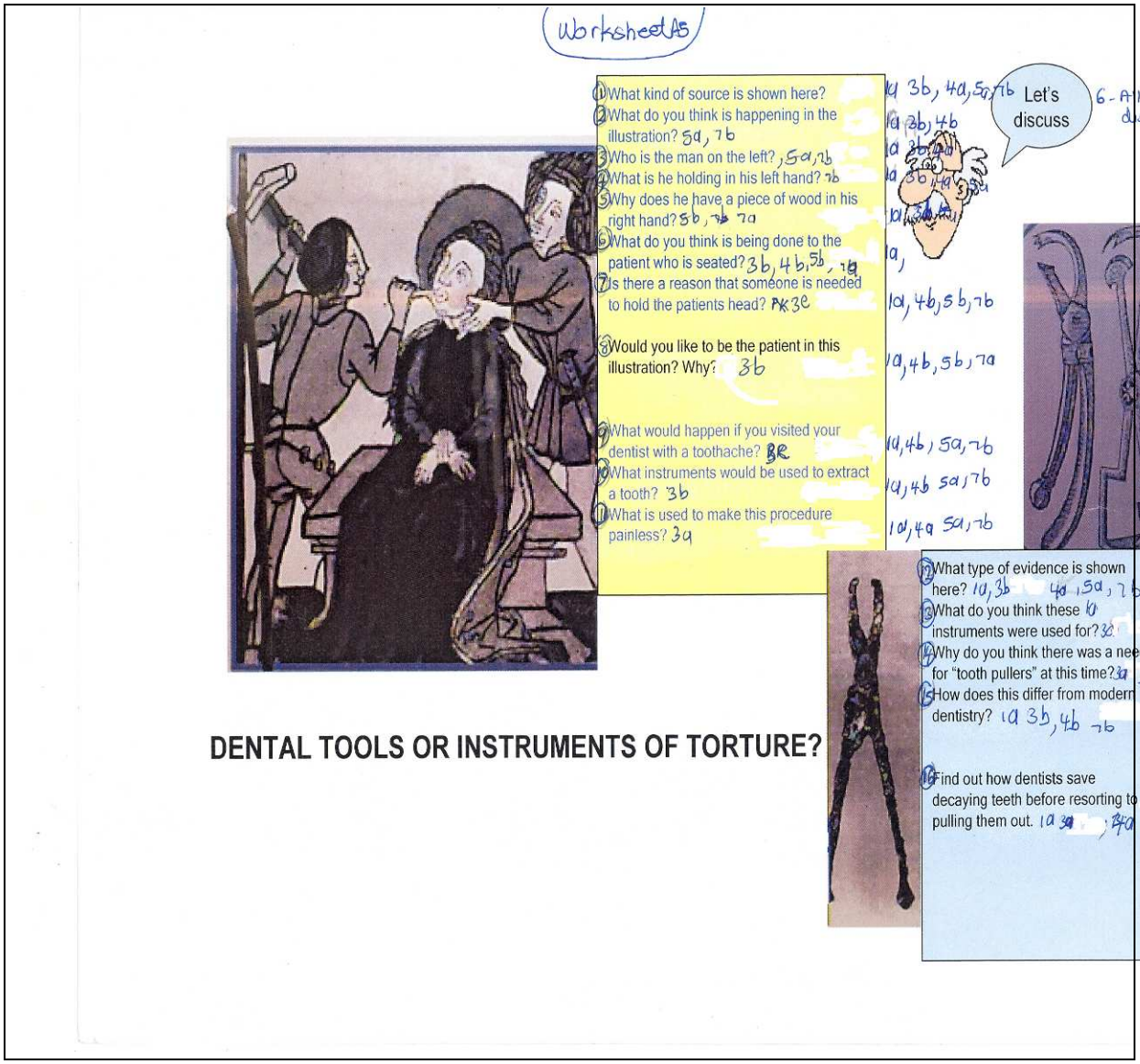
Have a look at the following carving depicting dental decay.
Who were the first people to record reference to oral disease?
Why do you think this concept of dental decay was accepted for centuries in Western Medicine?
How does modern society view 'dental decay' and its causes?
Using the display to assist you fill in the following timeline of discoveries that assisted people developing the science of dentistry.

54 BC - 17 AD	Archigenes, a Roman physician..... ..
130-200 AD	Claudius Galen, a Greek physician...





Worksheet A5



Worksheet A6

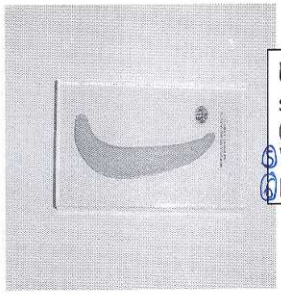
Worksheet A6

ACTIVITY CARD D



Study the source.

1. What do you think is happening in the picture? 1a, 3b, 4b, 5b, 7a
2. Why do you think the person on the left is holding a cup to drain the patient's blood? 1a, 3a, 4b, 5a, 7a
3. What does this tell us about people's beliefs at this time? 1a, 3a, 4a, 5a, 6b
4. Can you think of any dangers in using this kind of treatment? 1a, 3e, 4b, 5b, 7b



Examine the object in the slide.
(Look at the display)

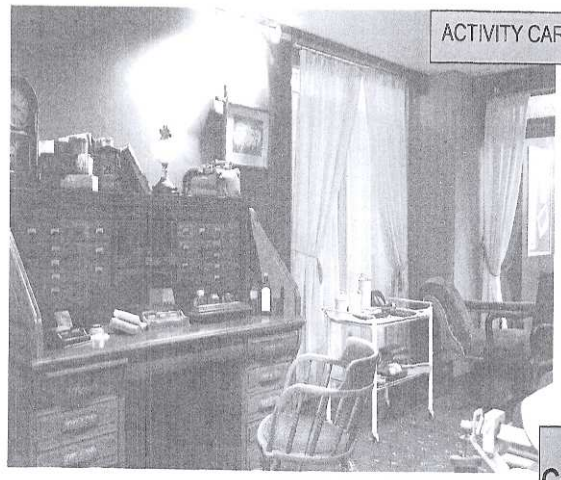
5. What do you think it is? 1a, 3a, 4a, 5a
6. Describe it. 1a, 3b, 4b, 5a, 7b

Another treatment used by doctors from AD 800 onwards was to prescribe leeches. Doctors would keep leeches in a jar and place them on the patient's skin. The leeches would then bite and suck the patient's blood. It was believed that the reason why a patient was sick was because they had too much blood!

6. Oral discussion in gps of 4

Worksheet A7

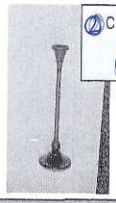
Worksheet A7



ACTIVITY CARD F

Look carefully at the display and list the differences and similarities of a doctor's surgery in the 1900s and a modern doctor's rooms today.

1) 10, 3b, 4b, 5b, 6e, 7b



2) Can you remember what this object is? 10, 3b, 4a, 5a, 6a, 7b
3) Find it in the display. 10, 3b, 4a, 5a, 6d, 7b
4) Has it changed much today? 10, 3b, 4a, 5a, 6a, 7b



COMPARE AND CONTRAST

5)

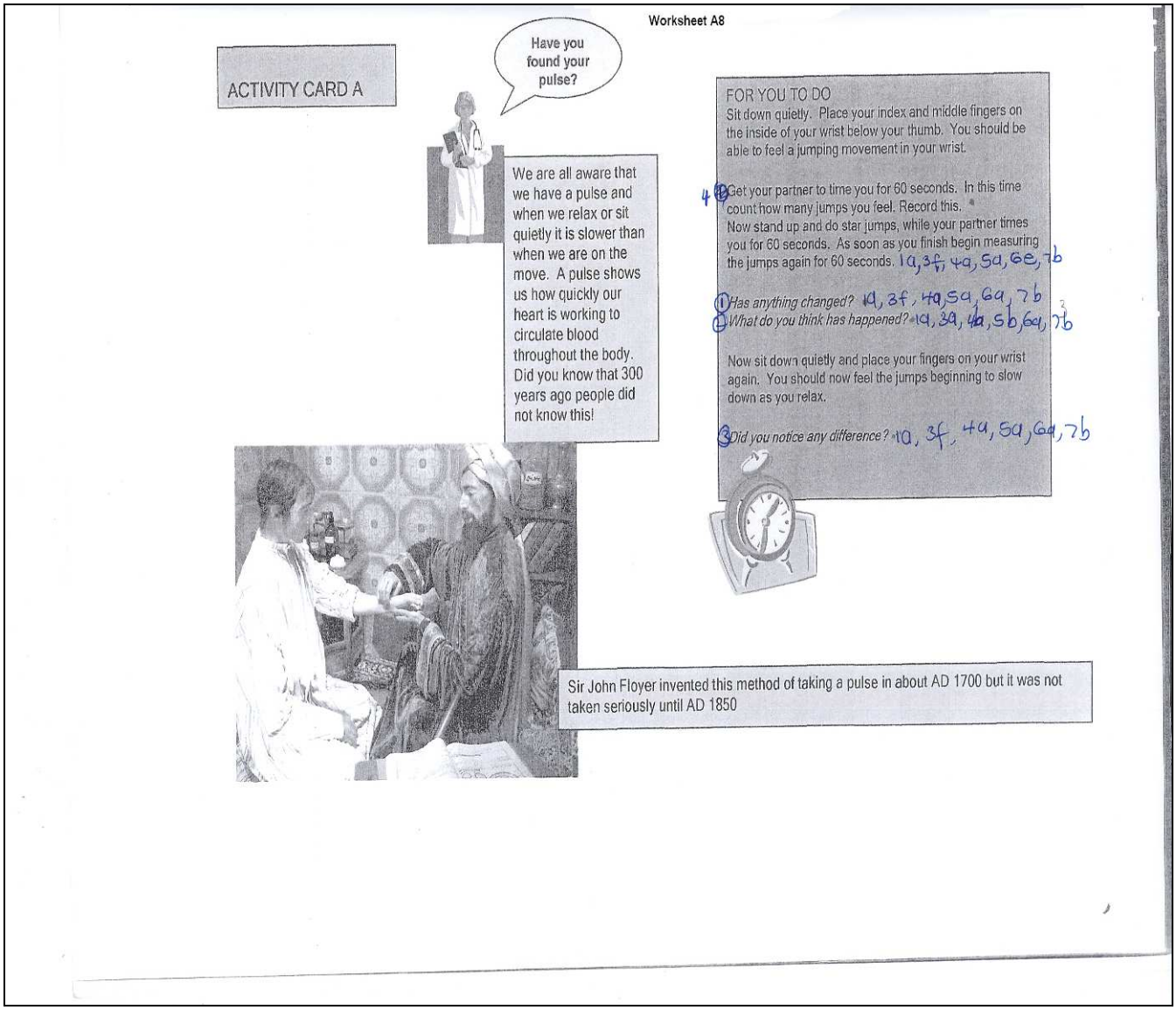
A Doctor's Surgery in the early 1900s

A Doctor's Surgery in the 21ST Century



Wow, some Interesting changes! How many did you find?

Worksheet A8



Worksheet A8

ACTIVITY CARD A

Have you found your pulse?

We are all aware that we have a pulse and when we relax or sit quietly it is slower than when we are on the move. A pulse shows us how quickly our heart is working to circulate blood throughout the body. Did you know that 300 years ago people did not know this!

FOR YOU TO DO

Sit down quietly. Place your index and middle fingers on the inside of your wrist below your thumb. You should be able to feel a jumping movement in your wrist.

4 Get your partner to time you for 60 seconds. In this time count how many jumps you feel. Record this.
Now stand up and do star jumps, while your partner times you for 60 seconds. As soon as you finish begin measuring the jumps again for 60 seconds. 1a, 3f, 4a, 5a, 6e, 7b

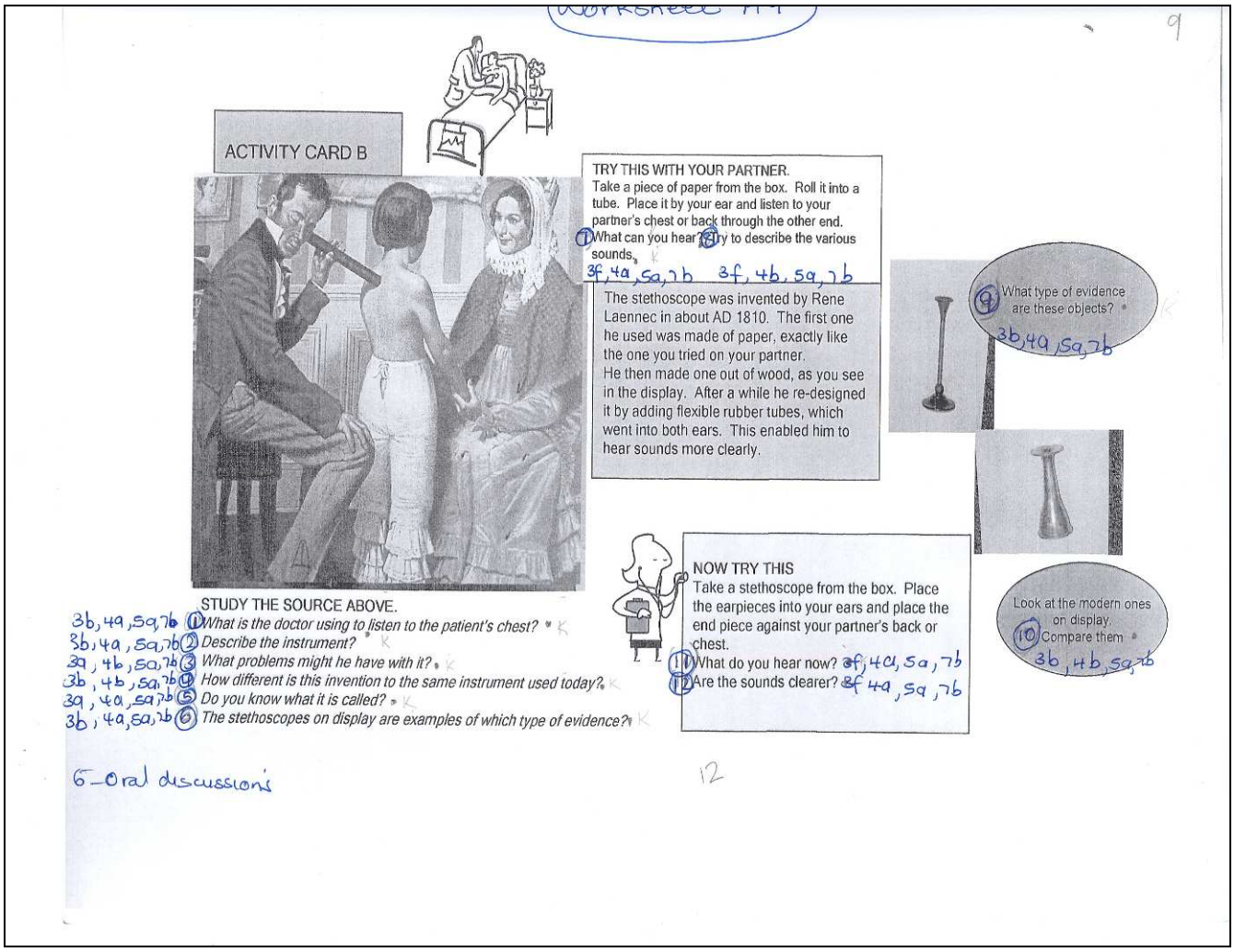
1 Has anything changed? 1a, 3f, 4a, 5a, 6a, 7b
2 What do you think has happened? 1a, 3a, 4a, 5b, 6a, 7b

Now sit down quietly and place your fingers on your wrist again. You should now feel the jumps beginning to slow down as you relax.

3 Did you notice any difference? 1a, 3f, 4a, 5a, 6a, 7b

Sir John Floyer invented this method of taking a pulse in about AD 1700 but it was not taken seriously until AD 1850

Worksheet A9



ACTIVITY CARD B

TRY THIS WITH YOUR PARTNER.
Take a piece of paper from the box. Roll it into a tube. Place it by your ear and listen to your partner's chest or back through the other end.
(7) What can you hear? (8) Try to describe the various sounds.
3f, 4a, 5a, 7b 3f, 4b, 5a, 7b

The stethoscope was invented by Rene Laennec in about AD 1810. The first one he used was made of paper, exactly like the one you tried on your partner.
He then made one out of wood, as you see in the display. After a while he re-designed it by adding flexible rubber tubes, which went into both ears. This enabled him to hear sounds more clearly.

(9) What type of evidence are these objects?
3b, 4a, 5a, 7b

NOW TRY THIS
Take a stethoscope from the box. Place the earpieces into your ears and place the end piece against your partner's back or chest.
(11) What do you hear now? 3f, 4a, 5a, 7b
(12) Are the sounds clearer? 3f 4a, 5a, 7b

Look at the modern ones on display.
(10) Compare them
3b, 4b, 5a, 7b

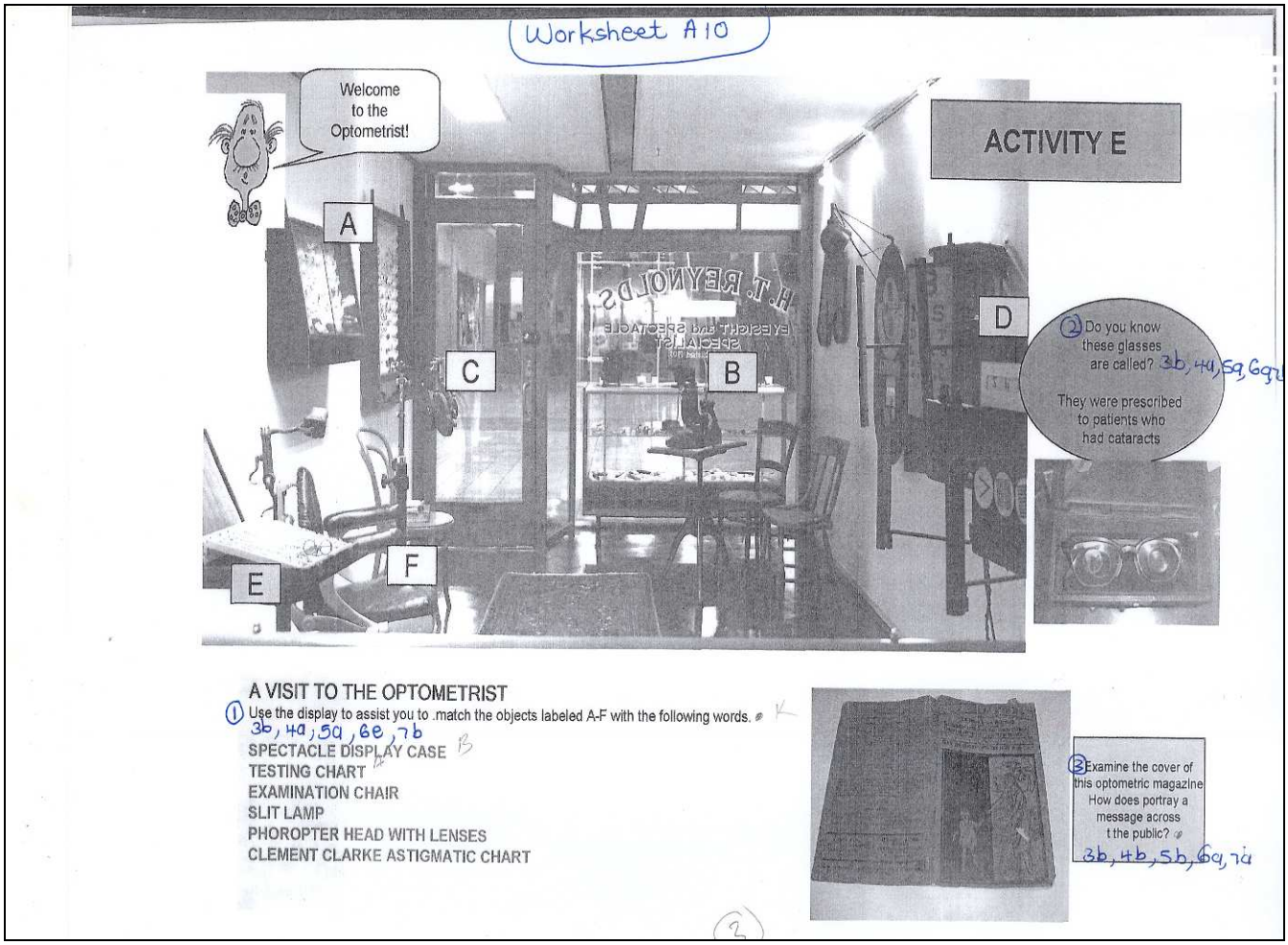
STUDY THE SOURCE ABOVE.

3b, 4a, 5a, 7b (1) *What is the doctor using to listen to the patient's chest?*
3b, 4a, 5a, 7b (2) *Describe the instrument?*
3a, 4b, 5a, 7b (3) *What problems might he have with it?*
3b, 4b, 5a, 7b (4) *How different is this invention to the same instrument used today?*
3a, 4a, 5a, 7b (5) *Do you know what it is called?*
3b, 4a, 5a, 7b (6) *The stethoscopes on display are examples of which type of evidence?*

6 – Oral discussions

12

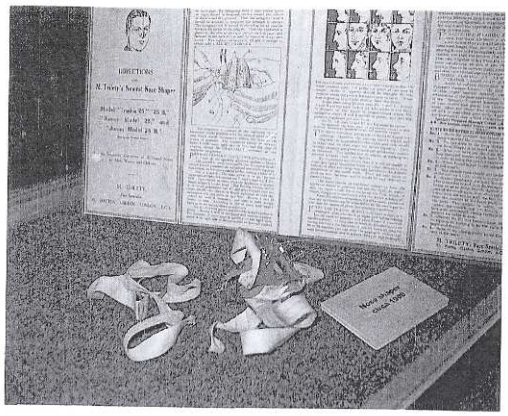
Worksheet A10



Worksheet A11

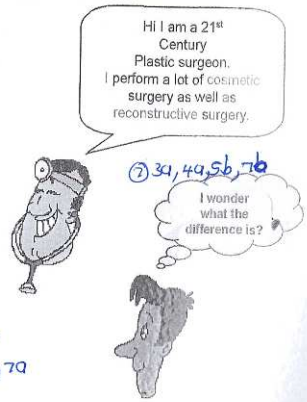
Worksheet A11

ACTIVITY J

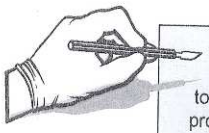


Look for the Nose Shaper on display.

1. a) What was it used for? 3a, 4a, 5a, 7b
2. b) Do you think it was popular? 3e, 4b, 5a, 7a
3. c) What would you do if you wanted to have something changed on your face or body? 3a, 4a, 5a, 7b
4. d) What do we call this kind of surgery? 3a, 4a, 5a, 7b



7) 3a, 4a, 5b, 7b



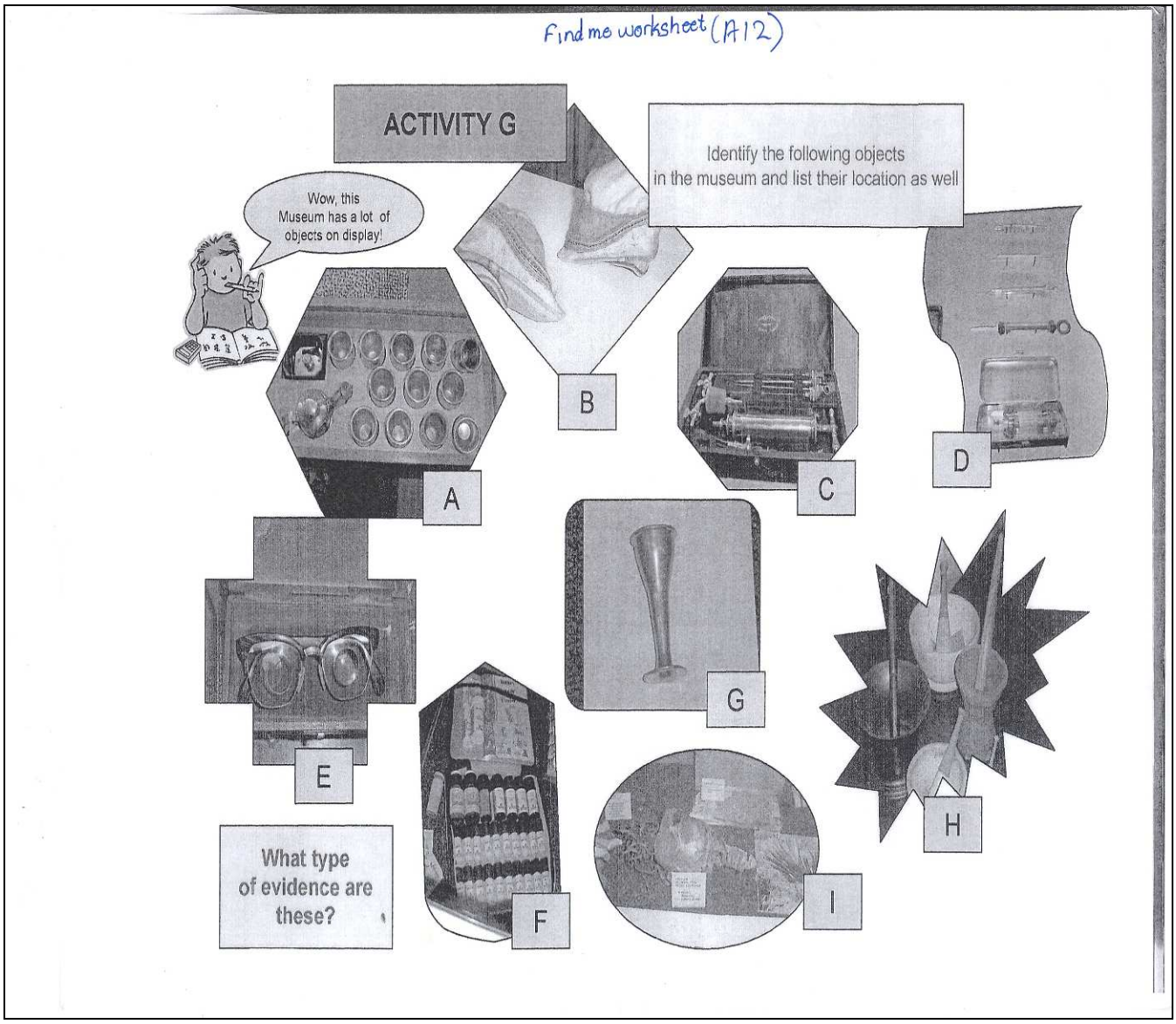
Discussion

Many people go under the knife to make changes to their bodies. Television programmes showing the results of "extreme makeovers" have become very popular.

5. Do you believe in this type of surgery? 3e, 4b, 5b, 7a
6. Would you ever consider having plastic surgery? 3e, 4b, 5b, 7a

6 – Oral discussions

Worksheet A12 (find me)



Worksheet A13 (role-play)

Role-play worksheet (A13)



Grated turnip applied to the skin to treat acne.

iNngwevu-Forest Elephant's foot is used to treat rheumatism

Radish juice to use as an antiseptic (to kill germs)

The Calendula flower (marigold) applied to the skin to draw poison from insect bites.

A tea brewed from this plant to relieve fever

Turnip and honey mixed together to relieve a cold



Something to think about

Western Medicine would prescribe different medicines for the ailments described on the left. If you visited your doctor, what would he or she prescribe for the following conditions?

Acne
Fever
Rheumatism
A cold





A MUTI SHOP

If you visit Johannesburg City you will find a number of muti shops where a person can buy plants, herbs, clay and animal parts prescribed by Sangomas to treat illness. Sangomas who work in the city will also visit these shops to obtain the necessary ingredients to make up medicines to treat their patients.

In 1995 a delegation from a Californian pharmaceutical company visited Johannesburg to speak to traditional healers, as well as botanists and anthropologists to try to find out more about using plants for medicine. This new interest is called *ethnobotany*.

In 2004 a bill was drawn up and sent to parliament to make African traditional healers part of the Health Professionals Council.

ROLE PLAY

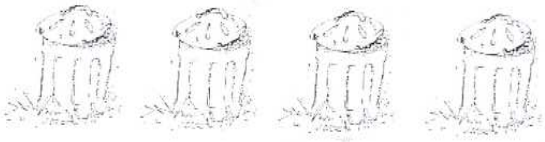
Examine the labels on the bottles. One of you is a Sangoma, the other a patient.

Choose a symptom card and ask the Sangoma to provide a treatment.

Yebo Gogga Foundation phase worksheet

1. Make Haste Reduce Waste

a) What colours are the recycling bins? Colour them in correctly.



b) Circle the bin you would throw a Coke can into?

2. Underground defenders

a) How do earthworms improve our soil?



3. SA Roachman

a) Do cockroaches bite people?

4. Defending our Heritage

a) Draw a picture of an Iron Age tool that women would use.

5. Defenders of water, our most precious resource

a) Is water from your tap safe to drink?



6. Saving Biodiversity for Future Generations

a) How big is the largest dung beetle?

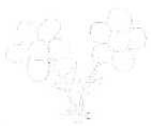
b) How small is the smallest dung beetle?



7. Green Defenders for All

a) Who is the botanical garden named after?

b) Why are flowers different colours?



8. Bee-ing Social

a) Why is a bee an insect?

b) What colours are bees? Why are they these colours?



9. War and Peace in the Distant Past

a) The Taung child would never have become a fossil if it could have defended itself against: (circle the right answer)

Leopard

Sabre-Tooth Cats

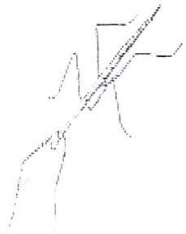
Lion

Eagle

Venomous snakes

10. Arthropod Arsenal

a) How does a stick insect defend itself?



11. Scale Up your Defences

a) What type of animal is a snake?

b) What is your favourite reptile?

c) What is the name of one of the pythons on display?



12. The Moz Squad

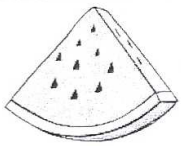
a) What do male mosquitoes eat?

b) What do female mosquitoes eat?

13. Drosophila

a) What is the name of the fly that is shown in this stand?

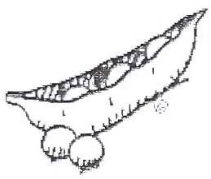
b) Can you catch a fruit fly?



14. Seed Dispersal

a) What do we find inside fruits?

b) What attracts animals to eat fruit?



15. Locusts



a) How do locusts protect themselves?

- ☐ Eating
- ☐ Camouflage
- ☐ Flying
- ☐ Spitting
- ☐ Jumping
- ☐ Drinking Water
- ☐ Sleeping
- ☐ Egg pots
- ☐ Swarming
- ☐ Swimming

b) How can we protect ourselves against locusts?

16. Urban Wildlife Warriors



a) Which animal has lots of quills on its body?

b) Why is it good to have owls in our gardens?

17. Defenders of the Skies

a) What is a bird?

b) What do birds eat?

c) What do you call a whole lot of birds together?

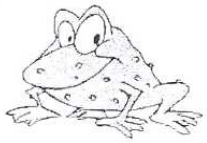
18. We are the Defenders

a) Is dumping in a wetland? | GOOD | BAD |

Is riding Quad bikes in a wetland? | GOOD | BAD |

Is burning tyres in a wetland? | GOOD | BAD |

b) Are the endangered frogs in Gauteng poisonous?



19. Defending the Kraal

a) How do plants protect themselves?



20. Awesome Arachnids—The Aggressive Defenders

a) How many legs does a spider have?

b) How many legs does a scorpion have?

Yebo Gogga Intermediate phase worksheet

1. Make Haste Reduce Waste

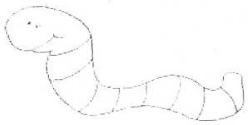
a) Why do we recycle?

b) What can we use Organic Rubbish for?



2. Underground defenders

a) How do earthworms improve our soil?

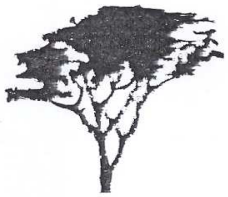


3. SA Roachman

a) What spends more time washing itself daily - a cockroach or a cat?

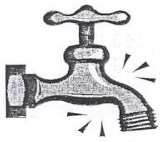
4. Defending our Heritage

a) What would happen to you if a conservation defender found a huge Jacaranda tree in your garden at home?



5. Defenders of water, our most precious resource

a) How can you check whether your toilet has a silent leak?

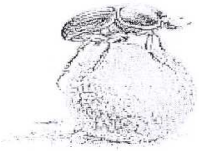


6. Saving Biodiversity for Future Generations

a) How many estimated dung beetles species are there in South Africa?

b) How big is the largest dung beetle?

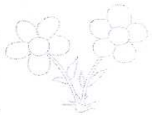
c) How small is the smallest dung beetle?



7. Green Defenders for All

a) Why do plants have green leaves?

b) Where do plants get their energy from?



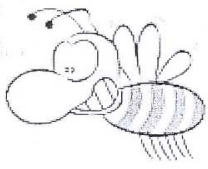
8. Bee-ing Social

a) What do bees make?

b) Where do bees live?

c) What sex of bees live there?

d) What else may live with them and may harm them?



9. War and Peace in the Distant Past

a) This mammal-ancestor had poisonous fangs for attack. Its scientific name was?

Homo sapiens

Erythrosuchus

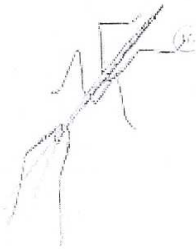
Massospondylus

Tyranosaurus rex

Euchambursia

10. Arthropod Arsenal

What does this grasshopper do to protect itself?



b) Why have insects developed defence mechanisms?

11. Scale Up your Defences

a) How do snakes hear?

b) What does a mole snake usually eat?

c) Spitting cobras don't spit, they actually _____ their venom. Pressure on the venom glands forces the venom along ducts and down and out _____ fangs.



12. The Moz Squad

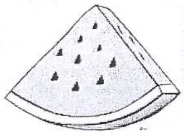
a) Name three symptoms of Malaria

b) Name one thing you can do to prevent being bitten by mosquitoes.

13. Drosophila

a) How do fruit flies defend themselves?

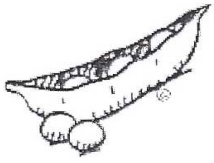
b) What is the scientific name for the fruit fly?



14. Seed Dispersal

a) How do *bidens* (black jack) seeds stick to your socks?

b) Why do the pods of the lucky beans open and the seeds stay there?



15. Locusts



a) Name two ways in which locusts protect their eggs.

b) Name three ways in which locusts protect them selves from predators.

16. Urban Wildlife Warriors



a) Why do owls have such big eyes?

b) What colours are pied crows?

c) With which part of their bodies do chameleons catch their prey? How is it adapted to catch prey?

17. Defenders of the Skies

a) Why are birds unique in the animal kingdom

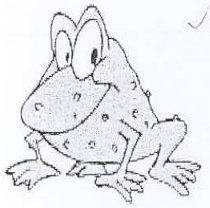


b) What do you call a group of wild geese in flight?

c) What do we call it when birds fly away to warmer areas during winter?

18. We are the Defenders

a) Give 3 things we can do to protect our wetlands.



b) What frog is on the endangered list in Gauteng?

19. Defending the Kraal

a) What are scorpion fences and electric fences killing?

b) How do plants defend themselves?



20. Awesome Arachnids—The Aggressive Defenders

a) Which spiders in South Africa are venomous?

b) How can spiders help humans?

Yebo Gogga senior phase worksheet

1. Make Haste Reduce Waste

a) (1) What are LAND FILLS?

b) (2) Why are land fills bad for the environment?

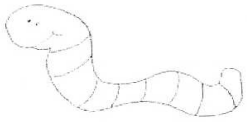
c) (3) Why is it our duty to protect the environment we live in?



2. Underground defenders

a) (4) How many hearts does an earthworm have?

b) (5) How do earthworms improve our soil?



3. SA Roachman

a) (6) Name five foods that cockroaches eat in nature?

b) (7) Roaches have exoskeletons - describe BRIEFLY how they grow?

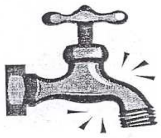
4. Defending our Heritage

a) (8) Write down three of the worst alien invasive plants you can get.

b) (9) What would conservationists do to them?



5. Defenders of water, our most precious resource



a) (10) What is a dual flush toilet?

6. Saving Biodiversity for Future Generations

a) (11) How many dung beetles on average would one find in a pile of elephant dung?

b) (12) How many eggs does each dung ball contain? Why? (13)

c) (14) What is the survival rate of newly hatched dung beetles?

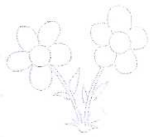
d) (15) Which is larger, the male or the female dung beetle? Why? (16)



7. Green Defenders for All

a) (17) How do plants chemically protect themselves?

b) (18) Give an example of a plant that does this.



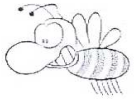
c) (19) How do insects use plants for protection?

8. Bee-ing Social

a) (20) What type of cells do the mites infest?

b) (21) What is the name of the disease that the mite passes on to the honey-bees?

c) (22) Name two additional hosts the mites infest?



9. War and Peace in the Distant Past

a) (23) Gorgonopsians used to cut up their prey with:

Sharp claws

Razor sharp tails

Long knife-like canine teeth

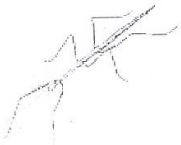
Very long fork-like incisor teeth

Specially shaped molar teeth

10. Arthropod Arsenal

b) Match the following columns by determining which insect (24) uses each specific defence mechanism

1) bombadier beetle	A) startle response
2) stick insect	B) camouflage
3) hawkmoths	C) autotomy – losing leg and body parts
4) hymenoptera e.g honey bee	D) spines, stinging hairs
	E) venom
	F) Pulse Combustion



1_____ 2_____

3_____ 4_____

11. Scale Up your Defences

(25)

T a) Why is the fat-tailed gecko's tail so fat?

T (26) b) What method does the Southern African Python (*Python natalensis*) employ to kill its prey?



12. The Moz Squad

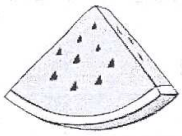
T a) (22) What are the four stages of the mosquito's lifecycle?

T b) (18) Explain briefly how malaria is transmitted.

13. Drosophila

T a) (29) What are mutations?

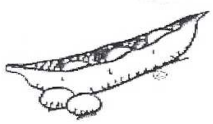
T b) (30) Name different types of mutations that can be shown on a fruit fly?



14. Seed Dispersal

T a) (31) What is the importance of seed dispersal?

T b) (32) What are the different ways of seed dispersal?



15. Locusts



T a) (33) Can locusts be harmful and cause danger to human life? Explain. (34) T

T b) (25) What can humans do to protect themselves and their crops from locusts?

16. Urban Wildlife Warriors

T a) (36) Where do plovers lay their eggs?

T b) (37) Why do lizards' tail sometimes fall off

T c) (35) What does a hedgehog do when it feels threatened?



T d) (38) Where do bullfrogs hibernate through the winter?

17. Defenders of the Skies



T a) 42 To which Class of animals do birds belong?

4a1 5a nc

T b) 41 Do you think birds see in colour? Explain.

4a nc 5a

c) 42 Why can't ostriches fly?

4a nc 5a

18. We are the Defenders

T a) 43 What is a Wetland? 4a 5a nc

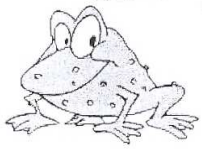
T 44 b) Where do we find frogs? Describe their main habitat. 45

4b T 4a

5a c 5a nc

46 c) Why must we discourage poaching? T

5b c 4b green



19. Defending the Kraal

47 a) T How do plants mechanically protect themselves?

c 4b 5a

45 b) T Give an example of a plant that does this.

c 4b 5a



20. Awesome Arachnids—The Aggressive Defenders

49 a) T Which spiders in South Africa are cytotoxic (their venom destroys cells)?

c 4b 5a

50 b) T How do you take a spider outside without killing it?

nc 4a 5a

Yebo Gogga FET worksheet

1. Make Haste Reduce Waste

1) a) What are the effects are Global Climate Change?



2) b) How could we reduce the progression of Global Climate Change

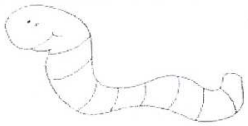
3) c) Do you think South Africa is capable of running a recycling operation alongside Pikit Up? NC K

2. Underground defenders

4) a) How many hearts does an earthworm have?

NC K

5) b) How do earthworms improve our soil?



3. SA Roachman

6) a) How do *Gromphadorina portentosa*, (one of the species of Hissing Cockroach) make the sound for which they are famous?

NC K

7) b) Some roaches are parthenogenic - what does this mean?

NC K

4. Defending our Heritage



8) a) Why can researchers be regarded as 'DEFENDERS OF HERITAGE'?

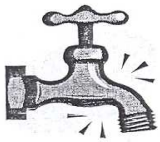
C Com

Open

5. Defenders of water, our most precious resource

9) NC K 10) C Com

a) What is mulch, & how does it help you to conserve water in your garden?



K C

6. Saving Biodiversity for Future Generations

a) What is the major threat to dung beetles? Would cars driving over pads have a significant influence? 11) NC K 12)

NC Com

b) What are the predators of dung beetles? 13)

C K

c) Are most dung beetles dung specific? 14)

NC K

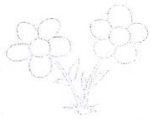


7. Green Defenders for All

a) What cell organelle regulates the water content in the plant cell? K

15) NC

b) Why are botanical gardens important?



16) C Com

Open

c) What compounds do plants release when they use their chemical defence?

17) NC K

8. Bee-ing Social



a) What is the scientific name of the honey-bee?

18) NC K

b) What is the scientific name of the mite?

19) NC K

c) How does the mite make the bees weak?

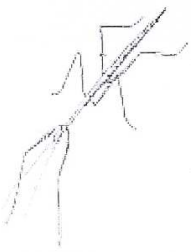
20) NC K

9. War and Peace in the Distant Past

a) These organisms which were not plants or animals gave the Earth its protective and life sustaining shield of Oxygen about 2.2 Billion years ago. What were they? (21)

Dinosaurs
Trees
Photosynthesizing Grass
Seaweed
Blue-green bacteria

NC K



10. Arthropod Arsenal

a) Apart from spines, venom etc what else makes arthropods so good at protecting themselves? (22) C K

11. Scale Up your Defences

a) There are 3 types of venom. What are they? What major body systems do they attack? (23) NC K (24) NC K

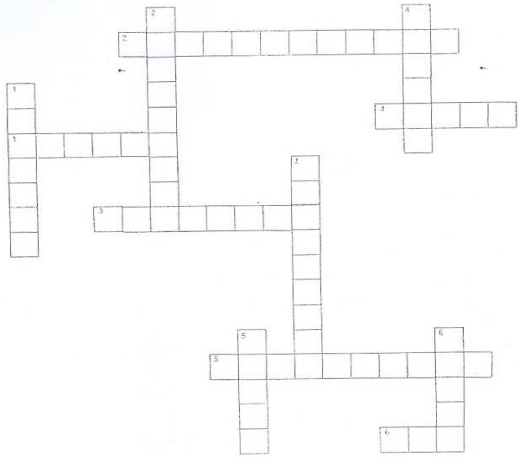
_____ ⇨ _____
_____ ⇨ _____
_____ ⇨ _____

12. The Moz Squad

(25) 15 NC, K

Across
1. a baby mosquito
2. the chemical used against malaria
3. a biting, flying insect
4. where mozzies lay eggs
5. malaria-causing parasite
6. to soothe a bites itchiness

Down
1. a disease carried by mozzies
2. the mozzie that transmits malaria
3. needle-like mouth-parts of mozzie
4. male mozzies feed on...
5. female mozzies feed on...
6. mozzie growth stage before adult hood



13. Drosophila

a) What is a model organism? (26) NC K

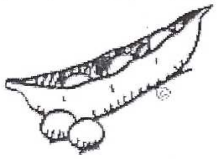


(27) b) Why are flies good model organisms state 4 reasons? Com NC

14. Seed Dispersal

(28) a) How do seeds disperse by means of animals? C, K

(29) b) What is the advantage of seeds being able to pass through the digestive system of the animal? C Com



15. Locusts



(30) a) Describe the morphology of the locust's hind legs and how they are used. 31/48 C K, K

(31) b) Explain the mechanism of camouflage as a way of protection by locusts. NC Com

(32) c) How do locusts protect their eggs? NC K

16. Urban Wildlife Warriors



(33) a) Why do chameleons change colour? NC K

(34) b) What materials does a weaver use to build its nest? NC K

(35) c) Why don't ducks' feathers get wet? NC K

17. Defenders of the Skies



a) (36) Name anything which allows birds to fly.

C K

b) (31) Why do you birds sing or call?

NC K

c) (35) Most male birds are more brightly coloured than their females. Why? (42)

NC K

18. We are the Defenders

a) (34) What is a Wetland?

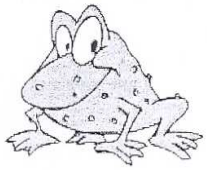
NC K

(6) b) Why must we discourage poaching?

C Com

Open

(11) c) Comment on the effectiveness of the different methods people use to trap/kill our indigenous animals.



C Ana

Open

19. Defending the Kraal

a) (47) How do plants protect themselves?

C Comp

20. Awesome Arachnids—The Aggressive Defenders



Only a few species of South African spiders are venomous. Once of the most maligned species, the rain spider, is harmless and helps us by eating mosquitoes.

However, many people think all spiders are dangerous and are scared of them. Comment briefly. (43)

NC Comp

Open

Appendix B
(Ethics sheets and forms)

Letter requesting for museum worksheets

I am a Master of Science student at Wits University undertaking a research project on learning in museums. The objective of the project is to investigate how worksheets are constructed and then assess potential usefulness in facilitation of learning during museum visits. I would be grateful if you would send me a copy of any worksheets you use in your museum/science centre, as well as grant permission to analyse such worksheets as part of my project. If you do not produce worksheets, I would be grateful if you would refer me to any visiting schools that produce their own.

I would greatly appreciate your favourable response and am happy to discuss my project with you if you so wish.

All the information will be treated according to the University ethical policy on confidentiality. I will not disclose the name of your institution unless you give me permission to do so.

For any clarifications please don't hesitate to contact me.

Yours sincerely

Worksheets enclosed _____

I _____consent to the above worksheets being analysed in the study to be conducted by Mrs. Eunice Nyamupangedengu for her Masters Research project.

Name _____

Signature _____

Date _____

Letter to the Oppenheimer Life sciences Museum curator

RE: Request for permission to use Oppenheimer Life Sciences museum for my study

I am a Master of Science (Science Education) student at Wits University undertaking a research project on learning in museums. The objective of the project is to investigate how worksheets are constructed and then assess potential usefulness in facilitation of learning during museum visits. I kindly request the permission to conduct my research at your institution. The research will involve analyzing the museum's worksheets as well as recording conversations of some of the learners who will attend the 27th to 30th September 2008 exhibition as they tour the museum.

I would greatly appreciate your favourable response and am happy to discuss my project with you if you so wish.

All the information will be treated according to the University ethical policy on confidentiality. I will not disclose the name of your institution unless you give me permission to do so.

1. The study is being conducted for educational purposes and will cause no harm to the learners.
2. Even if verbatim quotes from the learners are used in the research report, they will be reported so that their identity is anonymous. The results of the study may be published, but the learners' identities will be anonymous.
3. Everything the learners say will be kept confidential by the researcher. The learners will only be identified by a pseudonym in the transcript.

For any clarifications please don't hesitate to contact me.

Yours sincerely

Letter to school principals

RE: Request for permission to involve learners from your school in my study

I am a Master of Science student at Wits University undertaking a research project on learning in museums. The objective of the project is to investigate the usefulness of worksheets in facilitating learning during museum visits. I understand that your school has booked to attend the 27th to 30th September 2008 Oppenheimer Life sciences Museum's YEBO GOGGA exhibition. I would be grateful if you would grant me the permission to observe your learners and to record their conversations during their tour of the museum as part of my project. I will request permission from learners separately.

I would greatly appreciate your favourable response and am happy to discuss my project with you if you so wish.

All the information will be treated according to the University ethical policy on confidentiality. I will not disclose the name of your institution unless you give me permission to do so.

1. The study is being conducted for educational purposes and will cause no harm to your learners.

2. Even if verbatim quotes from your learners are used in the research report, they will be reported so that their identity is anonymous. The results of the study may be published, but the learners' identities will be anonymous.

3. Everything the learners say will be kept confidential by the researcher. The learners will only be identified by a pseudonym in the transcript.

For any clarifications please don't hesitate to contact me.

Yours sincerely

Information sheet for learners

Research on worksheets and learning in museums

My name is Eunice Nyamupangedengu. I am a Master of Science student at Wits University undertaking a research project in museum learning. The objective of the project is to find out if worksheets are useful in facilitating learning during museum visits. This involves analysing conversations that will be recorded during the tour of the museum.

I would like to invite you to participate in my study. If you do so, I would like to observe and audio-record your conversations during the school's visit to the museum. The observation and audio-recording of the conversations will only take place during the duration of the museum visit.

Please note that participation in my study is absolutely voluntary and no harm will come to you. I will treat all the conversations with confidentiality and anonymity. If you choose to participate, you may withdraw from the study at any time. I hope to publish the results of my study in academic journals and conference proceedings. To protect confidentiality, all names I use will be fictitious.

Thank you

Informed consent form – Learner

Research project: Worksheets and learning in museums

I, _____, a student at _____ consent participating in the study to be conducted by Mrs Eunice Nyamupangedengu for her research on learning at Oppenheimer Life Sciences Museum at Wits University, Johannesburg. I fully understand the following points

1. The study will cause no harm to me and that the study is being conducted for educational purposes.
2. Even if verbatim quotes from me are used in the research report, they will be reported so that my identity is anonymous. I understand that the results of the study may be published, but my identity will be anonymous.
3. Everything I say will be kept confidential by the researcher. I will only be identified by a pseudonym in the transcript.
4. I participate voluntarily and understand that I may withdraw from the study at any time.

Name _____

Signature _____

Date _____

I further consent to myself being audio recorded as part of the study.

Name _____

Signature _____

Date _____

Information sheet for parent/guardian

Research on worksheets and learning in museums

My name is Eunice Nyamupangedengu. I am a Master of Science student at Wits University undertaking a research project in museum learning. The objective of the project is to find out if worksheets are useful in facilitating learning during museum visits. This involves analysing the children's conversations that are recorded during the tour of the museum.

I would like to observe and audio-record your child's conversations during the school's visit to the museum, if you agree to your child participating in my study. The observation and audio-recording of the conversations will only take place during the duration of the museum visit.

Please note that participation in my study is absolutely voluntary and no harm will come to your child. I will treat all the conversations with confidentiality and anonymity. If you choose to have your child participate, she/he may withdraw from the study at any time. I hope to publish the results of my study in academic journals and conference proceedings. To protect confidentiality, all names I use will be fictitious.

Thank you

Informed consent form – Parent/Guardian

Research project: Worksheets and learning in museums

I, _____, parent/guardian of my ward _____ consent to her/him participating in the study to be conducted by Mrs Eunice Nyamupangedengu for her research on learning at a museum.

I realise that no harm will come to my ward, and, that the study is being conducted for educational purposes.

Everything my ward says will be kept confidential by the researcher. My ward will only be identified by a pseudonym in the transcript.

Verbatim quotes from my ward may be used in the research report, but they will be reported so that his/her identity will be anonymous. I understand that the results of the study may be published, but my ward's identity will be anonymous.

I allow my ward to participate voluntarily and understand that s/he may withdraw from the study at any time.

Name _____

Signature _____

Date _____

I further consent to my ward being audio recorded as part of the study.

Name _____

Signature _____

Date _____

Appendix C

Worksheet analysis results, raw data

A summary of the results of the analysis of the structured worksheets from museum z			
Worksheet characteristic	**Worksheet (identified by codes)**		
	Z1	**Z2**	**Z3**
Task density	6 tasks	7 tasks	8 tasks
Orientation cues	Absent	Absent	Absent
Information source	Object:3 Prior Knowledge (PK): 3	Object: 3 PK: 3	Text:2 Object: 3 PK: 3
Level of choice	No choice: 4, SC: 2 tasks	No choice: All 7 tasks	No choice: All 8 tasks
Cognitive level	Knowledge: 3 Comprehension: 3	Knowledge: 6 Comprehension: 1	Knowledge: 6 Comprehension: 2
Response format	Written: 5 pictorial: 1	Written: All 7	Written: All 8
Question format	Open-ended: 2 Closed: 4	Closed: All 7	Closed: All 8
Classroom connection	Connected: Conservation	Connected: Conservation	Connected: Conservation
Social interaction	Students work in groups of four	Students work in groups of four	Yes: Students work in groups of four
Site specificity	High	High	High

A summary of the results of the analysis of the structured worksheets from museum B			
Worksheet characteristic	**Worksheet (identified by codes)**		
	B1	**B2**	**B3**
Task density	10	8	12 (6 pre-visit and 6 during-visit tasks. Pre-visit tasks were taken to be a form of orientation cue. After that category, only during-visit tasks were further analysed.)
Orientation cues	Absent	Absent	In form of 6 pre-visit tasks
Information source	Text: 5 Object: 3 PK: 2	Object: All 8	Text: 3 Object: 1 PK: 2
Level of choice	No choice: 9 Some choice: 1	No choice: 7 Some choice: 1	No choice: 4 Some choice: 2
Cognitive level	Knowledge: 9 and Comprehension: 1	Knowledge: 6 Comprehension: 1 Analysis: 1	Knowledge: All 6 during visit tasks
Response format	Written: All ten	Written: 6 Pictorial 2	Written: All 6
Question format	Open-ended: 2 Closed: 8	Open-ended:1 Closed 7	Open-ended: 0 Closed: 6
Classroom connection	Connected: Importance of plants/diversity	Connected: Monocotyledons and dicotyledonous plants	Connected: plant uses and plant cell structure
Social interaction	Worksheet is silent about the way learners should interact. Each learner is given own w/s so it is assumed that they will work individually	Worksheet is silent about the way learners should interact. Each learner is given own w/s so it is assumed that they will work individually	Worksheet is silent about the way learners should interact. Each learner is given own w/s so it is assumed that they will work individually
Site specificity	High	High	Low

A summary of the results of the analysis of the structured worksheets from museum E		
Worksheet characteristic	**Worksheet (identified by codes)**	
	E1	**E2**
Task density	16 tasks and 5 displays/30 min	11 tasks/30 min
Orientation cues	Absent	Present in form of introductory text to the worksheet
Information source	Text: 6 Object: 9 PK: 1	Text: 6 Object: 4 PK: 1
Level of choice	No choice: 10 Some choice : 6	No choice: 6 Some choice: 5
Cognitive level	Knowledge: 9 Comprehension: 1 Analysis: 6	Knowledge: 4 Comprehension: 6 Analysis: 1
Response format	Written: 13 Pictorial: 3	Written: 9 Pictorial: 2
Question format	Open-ended: 4 Closed: 12	Open-ended: 6 Closed 5
Classroom connection	Connected: Biomes of southern Africa	Connected: Ecosystems
Social interaction	No instruction indicated: Individual work assumed	No instruction indicated: Individual work assumed
Site specificity	High	Low

A summary of the results of the analysis of the structured worksheets from museum A											
Worksheet characteristic	**Worksheet codes**										
	A1	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**	**A11**
Task density	8	8	3	4	16	6	4	4	12	3	7
Orientation cues	Pictures and Exhibit (PE)	PE	PE	PE	PE	PE	PE	PE	PE	PE	PE
Information source	Text (T):1, Object (O):5, Prior Knowledge (PK):2	T: 2, O:4, PK:2	T:3	T:2, PK:2	T:4, O: 10, PK:2	T: 2, O: 4	O: 4	T: 1, PA: 3	T: 2, O: 6, PA: 4	O: 3	T: 3, PK: 3
Level of choice	No Choice (NC): 1, Some Choice (SC): 7	NC: 5, SC: 3	NC:2, SM: 1	NC: 2, SC2	NC: 8, SC: 8	NC: 2, SC: 4	NC: 3, SC: 1	NC: 4	NC: 8, SC: 4	NC: 2, SC: 1	NC: 4, SC: 3
Cognitive level	LO: 4, MO: 4	LO: 6, MO: 2	LO: 2, MO: 1	LO: 3, MO: 1	LO: 9, MO: 7	LO: 4, MO: 2	LO: 3, MO: 1	LO: 3, MO: 1	LO: 12	LO: 2, MO: 1	LO: 4, MO: 3
Response format	Oral (Or): all	Or: all	Or: all	Or: all	Or: all	Or: all	Or: 3, Written: 1	Action: 2, Or: 2	Action: 5, Or: 6	Oral: all	Oral: all
Question format	Closed (Cl): all	Open (Op): 4, Cl: 4	Cl: all	Op: 2, Cl: 2	Op: 5, Cl: 11	Op: 5, Cl: 1	Cl: all	Cl: all	Cl: all	Cl: all	Op: 1, cl: 6
Classroom connection	Connected (Con)	Con	Con	Con	Con	Con	Con	Con	Con	Con	Con
Social interaction	Discuss with tour guide	Work in pairs	Group work (Gpw)	Gpw	Gpw	Gpw	Gpw	Work in pairs	Gpw	Gpw	Gpw
Site specificity	High	High	High	High	High	High	High	High	High	High	High

Appendix D

Conversation excerpts

Group C (2 boys 1 girl)

At the arthropod stand

L3: Ticks, ticks

L1: That's a bumble Bee. Bumble B please get off you are

L2: They are alive.

L1: Move, move. I wanna see. Damn, this looks weird. Look at those ticks. Their fillers look like they are animated

---

L2: Look at this. Look at the big one. A bumble bee.

L1: A bumble bee can sting. We are moving places now.

L3: Excuse me, is that a leech.

E: Yes

---.

At the wetlands stand

L1: What is that Dude?

E: This one?

L1: Yes.

E: It acts as vegetation ok and vegetation holds soil particles together ok. You have heard of soil erosion, isn't it?

L: yah

E: Soil erosion is the result of land surface not being covered by vegetation.

L: Oh

L: Oh that's cool

L: Oh, ok

E: (pours water on bare soil then on soil covered by vegetation to illustrate erosion).

L1: Ok. Wow, it's cool. Do you know how cool that is?

L1: Bug race, bug race, bug race, Cockroaches. Does it bite?

E: Cockroaches don't bite; they have a very small mouth

L2: It's big, it's big, it's a real scorpion

L1: Excuse me, excuse me.

L2: Can you see it? Oh, look here.

L1: What is it?

E: Water eagle

L1: Is it real?

---.

L1: Look at this' uuh. Fat little one. Fat little one.

---.

L1: Veroma mites

L2: Let me see the veroma mites.

L1: Keep your eyes open and don't blink when looking up there.

---.

L1: What is this? Did you make that? That's very good.

L1: Which one is the biggest?

E: Find the biggest?

L1: That's the biggest butterfly.

L1: Ants there. That's a big ant.

L1: There is the water wise show. I hate that thing; manzi. Manziwe is a good dancer.

---.

L1: Earthworms. There is earthworms here. Earthworms, earthworms, earthworms.

Group H conversations (three grade seven girls)

At the bird stand

E: What grade are you? Seven?

Ls: Yes maam.

L2: What class of animals do the birds belong? [WSQ]

E: What do you think?

L1: Mammals

E: No. Its something I have learnt today as well. AVES, A, V, E, S [explainers spells the word AVES]

L1: AVES really. That's interesting.

L: Do you think birds see a wide range of colours? (WSQ).

E: What do you think?

Ls: Yah, yah

E: A wider range of colours. They have a colour sensitive pigment in their eyes. They have more than actually what we have

L2: Really

At the recycle stand

L1: What are land fills (WSQ).

L2: Here, this is a land fill. [L2 pointing to a picture of a land fill]

L3: Hullo [greeting the explainer]

E: Hi

L2 Land fills are they e-e-e land fills are they pieces of land where they fill up with rubbish?

E: Land fills are holes that are filled with rubbish

Group K conversation (two girls and one boy in grade 10)

L2: There are 3 types of venom. What are they? What major body systems do they attack? (WSQ)

L1: Cytotoxic

L2: Haemotoxic is blood going substance. Neurotoxic is the tissue.

L1: Neurotoxic?

L3: I thought neurotoxic is the nervous system.

L1: Cytotoxic, nervous system and tissue.