Investigating learners' participation in an astronomy quiz.

Mpolai Anacletta Koloko

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Abstract

The purpose of this study is to investigate how learners work collaboratively during their astronomy quiz preparation. Research has been conducted extensively on cooperative and collaborative learning, however not much has been done to investigate learners preparations in quizzes. There has been very little research done on learners' interactions and behaviour but more on comparing learners' performance individually with when they work collaboratively. The subjects of this study were five schools from the Gauteng West district comprising of teams made up of four learners. These five teams were observed and two members per team interviewed. The teams were observed in order to understand how they interact with each other and the roles assumed by each member and the teacher. The use of interviews was to get more understanding of the benefits of the team and also find out if the quiz contributed in their astronomy content gain.

The results show that all teams had an understanding of their roles and responsibilities as members, however only two teams displayed more commitment to attain the goal by advancing to further rounds of the astronomy quiz. In view of the findings I concluded that collaborative testing is an effective strategy for improving learning and potentially for the retention of content.

Keywords

Collaborative learning
Collaborative testing
Peer collaboration
Astronomy quiz

Declaration

I hereby declare that this research report is my own unaided work. It has been submitted exclusively to the University of the Witwatersrand in partial fulfilment of the requirement of the degree of Master of Science Education.

Mpolai Anacletta Koloko

7th Day of MAY 2012

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Chapter 1: Introduction

1.1 Background

The astronomy quiz is a project that is funded and partly organized by the South African Agency for Science and Technology Advancement (SAASTA), which is an agency of the National Research Foundation (NRF). SAASTA is the official vehicle for facilitating the promotion of science and technology in our country. The mandate of SAASTA is to advance public awareness, appreciation and engagement in science, engineering and technology (SET) in South Africa (SAASTA 2008). The activities that SAASTA engages in are aimed at building the quantity and quality of mathematics and science outputs at school level (developing SET human capital), raising the general interest in science (especially poorer communities) for the benefit of science (strengthening the SET culture) and communicating science to the South African citizenry (bringing science and scientists closer to civil society). The above aims are achieved through various projects funded by SAASTA like National Science Week (NSW), Platform months (Antarctica, Marine Bio Sciences, Africa Origins and Astronomy months) and the astronomy quiz.

In my study I have looked specifically at the astronomy quiz. The aim of the astronomy quiz is to promote astronomy education in South Africa. In South Africa we have a shortage of scientists, more especially astronomers, so by engaging learners at a young age in stimulating activities such as the astronomy quiz, SAASTA aims at achieving the following objectives:

- To contribute to the improvement of awareness, interest, understanding and insight into basic astronomy;
- To build appreciation of and pride in South Africa's history of astronomical activity and achievements, and current projects;
- To record and celebrate the participation of women in astronomy so as to foster interest of girl learners in career opportunities in astronomy. (SAASTA, 2008).

Various Science centres around South Africa facilitate the astronomy quiz implementation. According to Eshach (2007) science centres and museums play an important role in promoting learning. Eshach explores the concepts of formal, informal and non-formal education and emphasises that the learning that takes place out of school is as important as the learning that goes on at school. Museums and science centres contribute greatly to the understanding of science and encourage learners to further their interests outside of school.

In 2005 Sci-Bono Discovery Centre developed an astronomy quiz as a project for the astronomy focus month for Grade 6 and 7 learners. In 2006 and 2007 SAASTA sponsored the expansion of the quiz to 6 centres, namely Sci-Bono Discovery Centre (Gauteng), Hartebeesthoek Radio Astronomy Observatory (HartRAO-Gauteng), South African Astronomical Observatory (SAAO-Western Cape), Southern African Large Telescope (SALT-Northern Cape), Boyden Observatory (Free State) and UniZulu Science Centre (Kwa Zulu Natal). In 2008 there were two additional centres running the quiz, Potchefstroom University Science Centre (North West) and Mondi Science Centre (Mpumalanga). The expansion of the project was aimed at making it a national project to create awareness in astronomy and since 2005 the competition has been running every year and has reached many learners from Grade 6 and Grade 7.

Research has been conducted on learners understanding of astronomy concepts (e.g. Trumper, 2001; Dove, 2002) but the use of the quiz has not been explored well, so by conducting the study I intended looking at how learners prepare and work cooperatively to achieve their goals of advancing to the next round in the quiz as well as examining their perceptions of the quiz in relation to astronomy knowledge. The astronomy quiz is a knock-out competition which consists of four rounds and the national final. In the first round there are about 30 schools represented by four learners per school in a site and they go through four rounds until there is only one school to represent the site. The four learners that win the site finals then proceed to the national finals to represent the site.

1.2 Rationale and Research Problem

Astronomy is important in education because it is deeply rooted in almost every culture (Percy, 1998; Trumper, 2001) as a result of its practical and philosophical aspects. It advances physics and other sciences, and is itself a dynamic and relevant science which deals with the origins of the universe. According to Percy (1998), astronomy increases public awareness and interest in science and technology. South Africa is relatively well established in terms of astronomy due to the presence of observatories such as SAAO and HartRAO which have been operating for decades. However, there is much that is yet to be done in order to ensure that everyone is reached. The Department of Science and Technology (DST) has developed the Youth into Science Strategy in order to enhance science and technology literacy among the public and the youth in particular and also to enrol more youth in SET based careers (Department of Science and Technology, 2007). The DST is working on a ten-year plan for astronomy in South Africa to ensure the success of Southern Africa as a world-class hub of cutting edge astronomy and there is a need to attract more youth into astronomy as a career.

1.2.1 Astronomy in the curriculum

In order to ensure that learners' interest is created in astronomy they need to be taught the basic principles in their early years of school and our curriculum is structured in a way that it caters for this need. One of the principles of South Africa's National Curriculum Statement (NCS) is that science studies involve natural phenomena and processes of inquiry are an essential part of the nature of science thus it should be included in science curricula (Department of Education, 2002). Learners also become motivated through interacting, and then they discover the science for themselves. One of the NCS components is content knowledge and in the intermediate phase (grade 4-6) and Senior phase (grade 7-9) there are four themes, namely; *Life and Living, Energy and Change, Planet Earth & Beyond* and *Matter and Materials.* In the curriculum Astronomy section falls under the theme "Planet Earth and Beyond", which focuses on the structure of the planet earth and how the earth changes over time (Department of Education, 2002). Topics such as the sun, moon and others as shown on table 1 are covered in the curriculum. In Further Education and Training (FET) band there is not much emphasis put in astronomy (table 1).

Table 1.Structure of the natural science and physical science curriculum

Phases	**Grade**	**Astronomy content**
Foundation	1 to 3	Identifying objects like the sun, stars and planets
Intermediate	4 to 6	Understanding why there is -Day and night -Phases of the moon - Seasons -Star patterns and their usefulness
Senior	7 to 9	-The solar system and gravity. -Predicting the motions of planets -Space exploration programmes using telescopes and also investigating the existence of life in other planets
Further Education and Training	10 to 12	Minimum coverage in new curriculum -Geometrical Optics- SALT telescope – Only how the lenses work and not what SALT is all about... -Newton's' Laws – Calculating the force of gravity between the moon and earth and not much on the effects of gravity (e.g. galaxies – non-Newtonian rotation – dark matter).

In the astronomy quiz the structure of the curriculum is considered and most of the work that the learners are tested on should have been done in the lower grades (grade 4 and grade 5).

According to the National Curriculum Statement (NCS) for Grades 10-12 there should be progression from the General Education Training (GET) band and at the same time provision of access to Higher Education and Training (HET) and this is not evident in the astronomy part of the curriculum because of minimum coverage in FET band. The lack of astronomy coverage in the FET could be a contributing factor to the small number of astronomers in our country. The new curriculum aims to develop the full potential of every learner. Consequently, the new system of education endeavours to grow learner potential by adopting an inclusive approach that stipulates that all learners, despite capability levels, should reach a set minimum standard of competence (R-NCS, 2002).

1.2.2 Astronomy in South Africa

According to Whitelock (2008) there are about 65 astronomers in SA, who are based at the various universities and observatories across the country. This is a very low number of astronomers considering that South Africa has astronomy observatories that are working in collaboration with other countries in different astronomy research disciplines. South Africa due to its geographical advantage in terms of its position has the largest optical telescope in the southern hemisphere, Southern African Large Telescope (SALT), which has a hexagonal mirror array 11 metres across. South Africa is also in the bid to build the largest radio telescope in the world, the Square Kilometre Array (SKA). The SKA is the largest and most sensitive radio telescope ever and it is likely to consist of thousands of dishes, each 10 - 15 m in diameter. South Africa needs to train more learners in astronomy and related fields so that the number of astronomers and engineers increases.

The experience, facilities and resources that South Africa has can be shared with fellow African countries that may not be as well-equipped in the respective areas. With the kind of facilities in this country, South Africa still has to provide human resource development in the form of training of outreach personnel, students, researchers, science communication officers, stargazers, amateur astronomers so as to make good use of the available facilities. However, with all the publicity that SALT and SKA have been getting, the public awareness in astronomy is slowly increasing. With these two projects (SKA and SALT) aimed at putting South Africa on a good position globally, there is a need to develop interest in our society on astronomy and related fields, starting at an early age. South Africa is statistically ranked as one of the weakest countries in science and mathematics, particularly in the junior grades (SAASTA, 2008). In seeking to address this, it is imperative that an interest in and understanding of mathematics and science is inculcated in the younger learners.

The astronomy quiz is an attempt at creating more awareness about astronomy in both learners and educators. Learners who participate in the quiz get more exposure and insight into the history and latest developments in astronomy. While this is done it is hoped that in the long term these learners will gain more interest in SET careers, more especially astronomy. The involvement of the educators in the quiz is hoped to increase their astronomy content knowledge and this might assist them better in teaching the earth and beyond section of the curriculum. SAASTA's requirement for the quiz is that learners should participate as a team consisting of four learners to encourage cooperative learning. Studies have shown that cooperative discussion improves problem solving behaviour (Johnson & Johnson, 1998; Slavin, 1989), and when learners work together they produce more and better ideas than when they work individually. By investigating how learners prepare for the quiz my findings might help SAASTA to review the strategy of group quizzing if it is not working well. One of the requirements of the NCS curriculum is to ensure that learners work cooperatively to achieve goals so it is important to look at the effectiveness of the quiz as a group quiz while also looking at how learners behave in their groups. Cooperative learning requires learners' cooperation and interdependence in the given task, goal and reward structures, so I believe it is important to investigate how learners work collaboratively in the quiz towards a common goal.

1.3 Aim and Research Questions

The SAASTA astronomy quiz is structured in such a way that learners are in a team of four per school in order to promote cooperative learning. Research has shown the positive effects of cooperative learning activities on academic success, development of critical thinking skills, quality of relationships among learners, self-esteem and the ability to solve problems (Rao, Collins & Di Carlo, 2002; Johnson & Johnson, 1998). As students work together towards a common goal, they are learning more than just content, they are also learning social skills.

The aim of the study was to seek an understanding of how learners work together to prepare for the SAASTA astronomy quiz and also in what way does the teacher assist them. Consequently the following question guided my study.

How does participation in a quiz promote learning about astronomy?

- How does a selection of learners prepare collaboratively for the SAASTA astronomy quiz?
- In what ways do learners perceive the astronomy quiz to be valuable in increasing their knowledge and interest in astronomy?

1.4 Research Design

Learners who participated in the quiz were selected by the schools using their own criteria which could possibly be by pre-test or teacher selection based on learner achievement. When selecting the schools I considered the following criteria; positions of schools, under resourced or resourced schools, only grade 7 learners or both grade 6 and 7 learners in a group. The sample of my study consisted of Grade 6 and 7 learners from 5 schools in the Gauteng West District. The design is further explained in detail on chapter 3.

In the next chapter, I look at the literature review and the theoretical framework guiding my study.

Chapter 2: Literature Review & Theoretical Framework

2.1 Introduction

The purpose of a literature review is to show the relationship between research at hand and previous investigations relating to the research. According to Vithal and Jansen (1997) it is the researcher's responsibility to indicate connections in the literature reviewed (current studies and previously completed ones). A review of previously completed studies can also provide a researcher with useful methods and techniques to gather information, which might be beneficial in carrying out the current research.

In light of the above I review literature from two main areas: learners' conceptions of astronomy and collaborative learning and testing/quizzing which is the main focus of my study.

2.2 Understanding Astronomy Concepts

Concepts are like mental representations that are in their simplest form. They may represent a set of ideas that can be described in a few words. Through the use of language, individual concepts can be connected to build more complex representational structures (Zirbel, 2004). More complex concepts can describe a whole idea, such as the theory of natural selection, or the Big Bang model of the universe. Much of how we form concepts, both alternate concepts and scientifically correct ones depends on the learners' prior knowledge. This prior knowledge influences how much learners assimilate new concepts and also how many alternative conceptions learners bring with to the classroom. For example due to learners' exposure to space pictures and television information about the earth, learners are told that the earth is round; they believe that because they are told by a trusted source.

Learners' conceptual ideas are based on personal experiences and require adjustment and real changes in thinking. Posner, Strike, Hewson & Gertzog (1982) acknowledged this and proposed the conceptual change theory which tackles the use of existing concepts to deal with new phenomena. Conceptual change occurs in every field of learning where there is a need for learners to accommodate new information and replace their previous knowledge.

Educational research has shown that learners develop intuitive ideas and beliefs about natural phenomena. As they learn more about the world around them they tend to interpret any new

information from the viewpoint of these existing ideas and beliefs. Research suggests that both children and adults have difficulty in understanding astronomical concepts and explaining them (Trumper, 2001; Barnett and Morran, 2002; Dove, 2002; Bakas and Mikropoulos, 2003; Plummer, 2009). A number of studies have indicated however, that learners are not consistent in the way in which they apply their conceptions. For example Bakas and Mikropoulos (2003), in their study with 102 learners aged between 11 and 13 found that there was lack of knowledge of the modern universe. The learners were asked to complete a questionnaire consisting of nine multiple choice questions covering the following astronomy concepts; the movement of the earth, the sun and the moon; size of these bodies, as well as the distances between them; the day/night cycle; alternation of seasons of the year. All the learners who participated in the study had already been taught a related unit in class about two weeks before the study was conducted so they were expected to know some astronomy. The results showed that 72, 5 % of learners had a clear understanding of the sun-earth-moon system and this could be because they were exposed to the content before. Children interpret the physical phenomena that they observe and have been taught in their own way and do not easily accept any scientific explanation (Bakas and Mikropoulus, 2003). This is evident from the study because it was identified from learners responses that even though they were exposed to the phenomena there were those who still held on to their alternative conceptions. This study shows that it is important that learners are provided with a clear explanation of scientific concepts and phenomena. Based on learners' responses, Bakas and Mikropoulos developed (as a form of intervention), an educational virtual environment aimed at supporting the teaching of planetary phenomena. The findings were that virtual environments have great potential for learning since learners could easily describe the earth's movements and estimate which part of the globe is day and night with less uncertainty.

Trumper (2001) conducted an investigation of learners' conceptions of basic astronomy. He analysed learners' conceptions by means of a written questionnaire consisting of 16 questions from different sources. The participants were 13 to 18 years old. The main findings from his study were that learners have problems in understanding some astronomy concepts for example they have alternative conceptions that the earth's shadow is somehow involved in causing the phases of the moon. The overall correct response rate for this question was found to be 36.4 %, increasing slightly through the years, from 33.6 % in grade 7 to 39.2% in grade 9. Trumper's study showed that there is a serious discrepancy between junior high school students' conceptions of some basic astronomy concepts and the corresponding accepted scientific view.

Dove (2002) investigated responses of a science exam from 98 12-year-old girls. The topics taught over the year had included an explanation for day and night and seasons, the phases of the moon, locations and orbits of the planets and a basic understanding of constellations and the night sky.

During the lessons, learners had used various objects like globes, torches, tennis balls and the concepts were also supported by videotapes and worksheets. The questions included in the astronomy section were those chosen to reflect the core concepts taught during the year. Dove (2002) found that nearly 91% of the learners were able to explain correctly the concept of day and night while only 46% of them were able to suggest correctly about how the phases of the moon are formed. This could be due to the fact that in most cases diagrams could be misleading and also the confusing way of using terms such as new moon and full moon, so Dove suggests that teachers should be careful when using such terms because learners get easily confused.

Barnett and Morran (2002) used 17 grade 5 learners as participants in their study. These learners were taking a special science course where they met 3 days a week for the 10 weeks duration of the study. This was an intervention consisting of two projects whereby learners had to investigate the orbital motion of the moon and the earth, and phases of the moon. The second project involved learners enquiring about the causes of lunar and solar eclipses and their relationship to the position of the moon relative to the earth. At the beginning of the project each student was asked to write down their initial beliefs about the Earth-Moon-Sun system in their journals. Barnett and Morran used pre and post interviews to determine students' conceptual understanding prior to intervention and after. During interviews students were asked to express their understandings either verbally or by drawing. The researchers found that students' understanding of concepts evolved from their experiences in completing activities and from classroom discussions. This shows that a carefully planned intervention helps in learners' conceptual gain.

In order to explore children's ideas about the earth in space, Sharp and Sharp (2007) used a quasi- experimental study and the participants were 31 learners between the ages of 9 to 11 from a primary school from mixed socio-economic community in Devon. One class was designated the experimental group, the other the control group. The control group was used to help ensure that any changes observed as a result of intervention involving the trial astronomy unit were not due to growth, maturation or casual encounters with astronomy beyond the limitations of the experiment. The intervention astronomy unit introduced comprised ten two-hour astronomy lessons spread over ten weeks. The researchers gave careful consideration to what each child should know and be able to do at the end of the unit. The experimental group was engaged in a variety of activities that are illustrative, investigative, and problem-solving and there was also sky-viewing. The main intention of this study was not to compare the outcomes from these two groups. The learners in the control group were taught astronomy later. Children's ideas in all of the different areas of astronomy were investigated as part of the study in a form of structured interviews comprising 66 questions. Most responses and task outcomes were recorded in writing and audio taped. Pre and post interviews took place three months apart. At the end of the intervention, children in the

experimental group had learned about the earth in space and they were also able to demonstrate the earth's movement around the sun. Sharp & Sharp found that their results were telling very little about children's ideas concerning the history and nature of science or how scientists work.

While each of the cited studies reported different approaches to conceptual change, there were some common factors. For example, all the researchers were looking at learners understanding of astronomy concepts and if after some sort of intervention there was conceptual change. In all the studies the findings were that there was conceptual change and also knowledge acquisition in the learners understanding (Trumper, 2001; Barnett and Morran, 2002; Dove, 2002; Bakas and Mikropoulos, 2003; Sharp and Sharp, 2007). Although in all the reviewed studies researchers used different methodologies, Vosniadou (2007) on her work on observational astronomy discovered that learners between the ages of 4 to 12 showed changes in their conceptual understanding of the earth. In other studies (Sharp and Sharp, 2007; Dove, 2002; Trumper, 2001) children in preschool thought of the earth as a physical object that is stationary and located in the centre of the universe. At the end of primary school most children were found to think of the earth as spinning on its axis and going around the sun. These changes in learners understanding were considered by researchers such as Vosniadou to be influenced by children's slow ability to process information which is due to their experience and interactions with each other when working on scientific concepts. This can also be due to learners' lack of "meta-conceptual awareness of their beliefs and of the process of change" Vosniadou (2007:50).

It is clear from the studies that conceptual change involves processing of information by an individual's active mind and is influenced by social processes. The teacher can provide a socio-cultural environment to encourage collective participation from learners by engaging them in a more interactive lesson. The learners can be in small groups and this will enhance deep understanding and comprehension leading to the likelihood of conceptual change. From the above studies it shows that for learning to be effective, teachers need detailed knowledge of the subject and an understanding of how best to present the concepts in the classroom. Although the focus of my study is not on conceptual gain, the literature on learners' understanding of astronomy concepts has been reviewed because throughout the quiz learners were exposed to various astronomy material and resources which might have contributed to their gain in astronomy content.

In my study I am looking at the astronomy quiz as an intervention and how the learners prepare for it. The learners are expected to work as a team with the assistance of their teacher either as a mediator (Vygotsky, 1978) and facilitator (Piaget,1964). Vygotsky (1978) suggests that a child can do more under adults guidance or in collaboration with a more capable peer than he or she can do alone so the teacher could guide the learners in preparation for the quiz by just being a mediator.

The guidance of an adult helps learners in the reduction of their possible alternative conceptions and helps them to deal with problems with less uncertainty.

2.3. Cooperative learning, Collaborative learning and testing

2.3.1. Cooperative Learning vs Collaborative learning

Cooperative learning is based on the group work in which learners are responsible for each other's learning. This learning strategy involves learner to learner interaction with the aim of instilling successful learning. Cooperative learning is a specific kind of collaborative learning. In cooperative learning, the teacher is the centre of authority and learners are provided with closed-ended tasks in contrast to collaborative learning where the teacher gives learners more opportunity to work on the assigned tasks that are usually complex and open-ended.

The aim of collaborative learning is to help members of the group share knowledge from the other learners, develop skills that are important for them to function in various other situations and to encourage all participants to work towards a common goal (Jansen et.al 2002). Collaborative learning is therefore seen as a way to get the learners to participate in their own learning process actively. While collaboration can help create well rounded learners, it is still not easily differentiated from cooperation and is not yet sufficiently established. In many studies the two terms are used interchangeably and below I have defined the two in detail supported by literature.

2.3.2. Cooperative learning

According to Slavin (1989) cooperative learning refers to instructional methods in which learners of all levels work together in small groups toward a group goal and its essential feature is that the success of one learner helps others to be successful. Social interaction is said to play a central role in facilitating learning. According to Bennett (1994) the foundation of learning and development is cooperatively achieved success and that the basis of that success is language and communication. "Learning awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and in cooperation with his peers" Vygotsky (1978). Learning can be considered a dynamic process in order to attain preferred goals like getting good grades or acquiring knowledge and skills (Neber, Finsterwald and Urban, 2001). In order for the goals to be attained interdependency among group members is emphasised. Positive interdependency is one form of interdependency that is a defining characteristic of cooperative learning in which each member contributes to the success of all other members of the group. Numerous investigations have resulted in advantages for cooperative versus other organised types of learning. Positive effects have been found for cognitive achievements and

cognitive development, motivation and perceptions of social cohesion (Johnson and Johnson 1998; Johnson, Johnson & Holubec, 1994; Slavin, 1991).

Cooperation enhances student satisfaction with the learning experience by actively involving students in designing and completing class procedures and course content (Johnson and Johnson, 1990). Effective teams or groups assume ownership of a process and it results when individuals are encouraged to work together toward a common goal, often defined by the group. Cooperative learning has been among widely investigated approaches in the educational research literature. Researchers (Jensen, Moore and Hatch, 2002; Zeilik and Morris, 2004; Rao, Collins and Di Carlo, 2002) in their studies have compared the effects of cooperative learning with other instructional methods. These other methods are the lecture method or individualised instruction.

Research has generally shown positive effects of cooperative learning activities on academic success, development of critical thinking skills, self-esteem and quality of relationships among learners (Slavin, 1989; Johnson and Johnson, 1998; Rao *et al*., 2002; Lusk and Conklin, 2003). When learners work with each other there are interactions within each other. Some research has focused on conditions under which small groups are most productive, including research on the relationship of small group interaction to outcomes and the kinds of communication that lead to varied learning outcomes. Language passing back and forth between individuals in written and oral forms is viewed as indispensable for the development of understanding (Belenky et al, 1986; Driver, 1995; von Glasersfeld, 1995). The social interdependence perspective has the assumption that the way social interdependence is structured determines how individuals interact. This, in turn, determines what is accomplished by the group (Johnson & Johnson, 1994). Intrinsic motivation is generated by interpersonal factors and joint aspirations. At the same time that students become more aware of and take more responsibility for their own thinking, they increase their understanding and appreciation of other people's thinking.

Johnson & Johnson (1998) elaborate further that learners should work under conditions that meet the following five criteria:

Positive interdependence - Positive interdependence results in promotive interaction and this leads to good performance from the group because of good cooperation of group members, which implies that learners work together to ensure the success of everyone in the group. If there is no positive interdependence, there is no cooperation (Johnson & Johnson 1998). The result of positive interdependence is that learners will be more highly motivated to work cooperatively when task success depends on the participation of other group members (Doolittle, 1995).

Individual accountability - depends on holding each member of the group accountable for the group's success. Individual accountability exists when the performance of each individual is assessed and the results are given back to the group and the individual in order to ascertain who needs more assistance, support, and encouragement in learning. According to Johnson *et al.* (1994) determining the level of mastery of each student is necessary so students can provide appropriate support and assistance to one another. It also prevents situations where select group members do most of the work and other group members become "free loaders" (Doolittle, 1995; Johnson & Johnson, 1998).

Face-to-face interaction - refers to group members supporting, assisting, influencing, motivating and challenging each other in an attempt to facilitate the achievement of the groups' goals (Doolittle, 1995; Johnson & Johnson, 1998). There are important cognitive activities and interpersonal dynamics that can only occur when children promote each other's learning. Appropriate use of collaborative skills ensures that the members of the group have a chance of meeting regularly for self-assessment of team functioning.

According to Johnson & Johnson 1998*, Social skills* that are necessary for a student to perform competently in a small group are usually taught during cooperative learning. Leadership, decision-making, trust-building, communication, and conflict-management skills empower students to manage both teamwork and task work successfully and these can be achieved only if learners are equipped with good social skills.

Group processing helps in clarifying and improving the productiveness of all group members in contributing to the cooperative efforts of achieving group goals (Doolittle, 1995). Groups need to describe what member actions are beneficial and detrimental, and what group member actions should be continued or changed.

Many studies have shown that when correctly implemented, cooperative learning improves information acquisition and retention, higher-level thinking skills, interpersonal and communication skills, and self-confidence (Johnson *et al.,* 1994; Doolittle, 1995; Johnson and Johnson, 1998).

2.3.3. Collaborative learning

Collaboration is defined as mutual engagement of participants in a coordinated effort to solve the problem together (Roschelle and Teasley, 1995). It is recognised as a desirable ingredient in a learning community, as well as an essential quality in the social context.

Collaborative learning facilitates the development of higher order thinking skills and allows the learners to develop both academically and interpersonally (Hudgins *et al.,* 2007, Jensen *et al.,*

2002, Rao & Di Carlo, 2000, Rao *et al.,* 2002, Slusser & Erickson, 2006, and Lusk & Conklin, 2003). Collaboration is defined as the process of building and maintaining a shared conception of a task, distributing responsibility across members of the group (Van den Bossche, Segers and Kirshner, 2006), sharing expertise and mutually constructing and negotiating cognition. In South Africa Messerschmidt (2003) investigated the behaviour of Grade 4 learners in a group in terms of their interaction and communication, the social roles that learners assume as a result of working in groups and the learning process which takes place in the groups. His findings were that the learners were able to work well together and also showed potential to learn in a different classroom setting. Studies also show that cooperative learning exerts positive effects on a wide range of social-effective outcomes, including improved peer and cross-ethnic relations, increased self-esteem, improved attitudes toward school and subject matter and learning (Tan, Lee & Sharan 2007).

2.3.4. Peer Collaboration

A core principle of OBE (Outcomes Based Education) is peer collaboration (DoE, 2002b). Within the South African context; it is left to the educators to decide on how to implement such collaboration. In order for peer collaboration to be effective, the intricacies of collaboration need to be defined. Friend and Cook (2000) explains it as a direct interaction between individuals (a minimum being two) who are at the same level and voluntarily engage in a shared decision making process in order to reach a common goal. According to Gnadinger (2007), peer collaboration is an effective strategy for all learners and it assists teachers in focusing more on teaching. Peers are considered an effective source for promoting cognitive conflict. Piaget cognitive development theory focuses mainly on how individuals undergo cognitive change through interactions with each other and also with their surroundings / environment. Research has found social interactions and collaboration with others as an important component of knowledge acquisition and learning (Piaget, 1964). Peer collaboration is also said to develop or improve reasoning ability. The sociocultural processes of collaborative engagement and the continuous attempt for shared meaning, contributes to learning (Tudge & Winterhoff, 1993).

2.3.4. Collaborative Testing

Collaborative testing offers learners a chance to learn from each other as they are assessed. That is, during the quiz, learners not only show evidence of their knowledge, they gain understanding through discussing questions in an exam atmosphere. Collaboration is recognised by several researchers as an important ingredient in a learning community as well as an essential quality in the social context. A key component of effective collaborative efforts is social interdependence, when individuals share common goals and each individual's outcomes are affected by the actions of others (Johnson & Johnson 1998, Zeilik & Morris 2004).

Several studies have been conducted on collaborative quizzes mostly with university students where researchers were comparing learners performance when working in groups and individually (Jensen *et al*., 2002; Zeilik and Morris, 2004; Rao *et al*., 2002) and the findings were that learners perform better when in groups than individually, as described below. There is lack of research on collaborative quizzes with learners at primary or junior schools so my study is aimed at addressing this issue by focusing on primary school learners.

Jensen *et al.*, (2002) investigated the implementation of electronic quizzes in an anatomy class. In this study the quiz was used as a method of teaching in a college at the University of Minnesota. A computer program was created that enabled students to complete cooperative quizzes on computers. Cooperative quizzing offers students a chance to learn from each other as they are assessed. That is, during the quiz, students not only show evidence of their knowledge, but they also gain understanding through discussing questions in an exam atmosphere. The paper describes several issues like evaluation of different methods of using the program with students and suggests implications for the future of cooperative learning and distance education. The students were grouped in groups of 3 to 5 learners and they had to complete quizzes using the electronic cooperative quiz (ECQ) programme. The group members were allowed to communicate via chat rooms. They were expected to complete the quiz individually first, before they could do it as a group and the computer programme did not allow them to chat with others before answering individually. Two scoring methods were used and the first one looked at individuals' work and then at the group's work. A total of 151 students participated and the results showed that the use of a quiz was an effective way to teach anatomy and physiology as a large amount of work was tested in a short period of time. Jensen *et al.* found out that the use of an ECQ programme created a cooperative learning environment where educational benefits were gained.

Zeilik and Morris (2004) in their research conducted on first year university students, looked at the impact of cooperative quizzes in an introductory astronomy course and one of their research questions was “Did cooperative quizzes result in gains for the class overall?” They employed the quiz method in a class and the teams consisted of four to five students who engaged with their peers in negotiating over specific astronomical concepts and agreed on the specific answers. In this study, once students finished with their groups, they were given the same questions to answer individually and the findings were that they performed better when working in groups than individually.

According to Rao *et al*.,(2002) quizzes have some advantages such as facilitating the assessment of learning in a number of learners over an extensive field of knowledge. When learners learn

together, they have intellectual and emotional support that allows them to go beyond their present knowledge and skills and accomplish shared goals (Rao *et al.,* 2002). In my study the shared goal that the learners will be aiming to accomplish is winning the site final, representing HartRAO site at the national finals and perhaps even winning the national finals, so they need to work together to achieve that goal. Using control and experimental groups, Rao *et al.* found that physiology students who completed quizzes using collaborative groups earned higher grades than those who completed them individually. Cortright, Collins, Rodenbaugh and DiCarlo (2003) in their study with 38 physiology students found out that group testing provided an opportunity for learners to discuss their reasoning for a particular answer and receive immediate feedback on their performance. Their findings led to a conclusion that collaborative testing also improves students' retention of course content. Quizzes also provide feedback regarding what has and has not been learned (Rao *et al.,* 2002), for example if learners answer incorrectly on astronomy in South Africa it will be easy for the teacher to see where they are lacking. The quiz can also assist learners in discovering the scope and depth of their knowledge. The SAASTA astronomy quiz covers a variety of astronomical concepts over only 30 questions (i.e. planets, galaxies, history of astronomy, and astronomy in South Africa etc.).

In the South African literature there is no evidence of literature on quizzes, more especially astronomy quizzes, so my study will attempt to raise issues relevant to the South African context. Russo (1999);Panitz (1999); Lusk and Conklin (2003) ascertain that collaborative testing or quizzing can help reduce anxiety levels because learners are expected to work together to get to the agreed answer, while it builds peer cooperation and aids in development of teamwork skills, which are very useful in many situations. In group testing learners also see that the teacher is able to evaluate how they think as well as what they know. Lusk and Conklin's (2003) findings are relevant to my study since I observed learners' preparation as they worked collaboratively to achieve the goals of advancing to the next round of the quiz. In the South African curriculum a core principle of OBE is peer collaboration (DoE, 2002). In order for peer collaboration to be effective, the intricacies of collaboration need to be defined. Friend and Cook (1990) explain it as a direct interaction between individuals who are coequal parties and voluntarily engage in a shared decision making process in order to reach a common goal. It is clear that there should be equal and active participation expected from each member of the group as well as working together to achieve a common goal.

From the reviewed literature it is evident that collaborative quizzing has some benefits at university level, (like developing learners' academic skills) to the participating learners. In my study I observe how learners from primary school interact with each other and what social roles they play in their group and trying to compare it with the findings by Messerschmidt and other researchers.

2.4. Theoretical Framework

My study focuses mainly on collaborative learning as outlined in the social interdependence theory (Johnson & Johnson 1998).

Social interdependence theory (Johnson, Johnson & Holubec, 1994), which views cooperation as a group dynamic that can be positive (cooperative), negative (competitive) or non-existent (individualistic). Social interdependence exists when the outcomes of individuals are affected by each other's actions. This theory refers to learners' efforts to achieve, develop positive relationships, adjust psychologically and show social competence. One of the elements of interaction that has to be structured in the group is positive interdependence or cooperation and when this is done it will result in promotive interaction as group members encourage and ease each other's' efforts to learn (Johnson *et al.,* 1994). The social interdependence perspective has the assumption that the way social interdependence is structured determines how individuals interact. This, in turn, determines what is accomplished by the group (Johnson, Johnson & Holubec, 1994)

In a cooperative learning approach, learners are encouraged to teach one another, and incentives are usually provided in such a way that it is the group's responsibility to ensure that all members understand all aspects of the task. The teacher might assign different roles to group members to ensure total commitment. According to Slavin (1989) two elements must be present if cooperative learning is to be effective; group goals and individual accountability. Groups must be working to achieve some goal or earn rewards and the success of the group must depend on the individual learning of all the members. Children do learn from their peers, who may propose innovative ideas at critical points. In the case of the quiz, as learners go to the next rounds, they are rewarded with some gifts in the form of educational material which will assist them further in preparing for the next rounds. The material awarded to learners as prizes also promote collaboration between them because they are expected to utilise the resources for the benefit of everyone in the group.
Cooperative learning develops positive student-teacher attitudes (Panitz, 1999; Johnson & Johnson, 1998). Through interactions with learners, the teacher gains a better understanding of each learner's learning style and how each performs, and an opportunity is created whereby the teacher may provide extra guidance and counselling for the learners. In the social interdependence theory the following aspects of cooperative learning are considered:

1. Cognitive -development as grounded in the work of Jean Piaget (1964) and Lev Vygotsky (1978).

It views cooperation as an essential prerequisite for cognitive growth and development (Johnson & Johnson, 1998).The study of children's cognitive development (development of their thinking, reasoning, knowledge and understanding) has long been a central concern of psychologists as well as of educationists. Cognitive approaches look at how group work impacts upon the intellectual skills and processes involved in children's learning. Piaget (1964) suggests that when individuals work together, socio-cognitive conflict occurs and creates disequilibrium that stimulates perspective taking ability and reasoning. The resolution of conflicting points of view is believed to lead to conceptual growth (Brodie and Pounara, 2005), thus learner interaction which is supportive of the construction of new ideas should contain verbalisation and disagreement in order to facilitate learning and development. According to Vygotsky (1978) social interaction and cooperation are necessary for successfully constructing and retaining knowledge which is influenced by society and the community. Constructivist approaches and cooperative learning techniques can be thought of as having both personal and interpersonal components. Each person constructs his or her own mental frameworks and conceptions using preferred learning styles. The cognitive developmental perspective emphasizes that participants should engage in discussion in which cognitive conflict is resolved and inadequate reasoning is modified.

Vygotsky further suggests that the space which provides for cognitive, emotional and social development is the zone of proximal development (ZPD). The ZPD is considered to be the space where learning and development happen, in collaboration with a more capable other, a peer or a teacher. It is created through interaction, where communication enables participants to shift their understanding and to internalise ways of speaking and representing ideas, which further develop their thinking. The zone of proximal development is a dynamic construct addressing the issue of not only learning, but cognitive development (Doolittle, 1995). The theory according to Vygotsky is appropriate to my study because as the learners prepare for the quiz, they are assisted by a more capable adult (teacher) and other learners so that they can reach their ZPD and develop cognitively.

2. Social Cohesion Perspectives

The social cohesion perspective focuses on the fact that learners encourage each other to succeed and in the process help each other to learn. The empowerment created by the many interpersonal interactions between learners and the teacher leads to a very positive attitude on the part of all parties involved. In this view, three types of relations can exist between group members (Deutsch, 1949):

1. Positive interdependence - what helps one group member is perceived as helping all, and what hurts one group member is seen as hurting all. Positive interdependence encourages cooperation.

2. Negative interdependence - what helps one group member is seen as hurting others and what hurts one is viewed as helping the others. Negative interdependence encourages competition.

3. No interdependence - what happens to one group member is not perceived as affecting the others. No interdependence encourages an individualistic attitude.

According to Van den Bossche *et al* (2006) teams are more effective in adequately solving the problems than individuals. This is because of bringing together people with different experiences, values and knowledge. By setting obtainable goals for groups and facilitating group interactions, teachers establish high expectations that become self-fulfilling as the students master the collaborative approach, learn how to work well together in teams and demonstrate their abilities through a variety of assessment methods. Johnson & Johnson (1994) have developed many means of encouraging positive interdependence. They also emphasise the importance of individual accountability and of students being in heterogeneous groups, based on such criteria as past achievement, sex, ethnicity, nationality, and social class.

3. Motivation Perspective

According to Slavin (1990), motivational perspectives on cooperative learning mainly focus on the reward or goal structures. Cooperative learning creates a situation whereby individual goals can only be achieved if the group is successful. Therefore motivation is based on the achievement of all members and goal-directed behaviour is encouraged within the group. When learners feel positively interdependent toward their peers, they become an alternative source of positive reinforcement for learning (Johnson & Johnson 1998). This reinforcement encourages students to work hard to succeed and help their team mates succeed at learning tasks, and the use of thinking skills facilitates success in almost any task. Panitz (1999) suggests that collaborative learning as a motivational strategy includes all learning situations in which learners work in groups to accomplish particular learning objectives. Learners are also interdependent for successful completion of the objectives. Essential motivation is created by interpersonal factors and joint aspirations. At the same time that learners become more aware and take more responsibility for their own work, they begin to appreciate and understand each other's thinking.

Slavin (1990) and his colleagues have done a great deal of work on cooperative learning from this tradition, developing techniques such as student teams achievement divisions (STAD). In STAD, the teacher first presents material before a team of learners to study together in preparation for a quiz.

Each student contributes to team rewards (e.g., certificates) based on a comparison of this quiz score and their average on past quizzes, but grades are based solely on individual scores. In order for the best achievement, learners are encouraged to collaborate with each other.

In the next chapter I present the research design and methodology that is going to be used to achieve the objectives of the study. This will be done in such a way as to also consider the theoretical framework suggested above.

Chapter 3: Research Design and Methodology

3.1. Introduction

This chapter covers how the research was conducted. The chapter provides a description of the sample of participants, the instruments used to collect the data, the ethical considerations that were taken into account as well as the limitations of the research approach.

3.2. Methodology

In my study the research methodology chosen is a case study. The design type is a reflection of the methodological requirements (Henning 2004) of the research questions and therefore of the type of data collected and analysed. I investigated learners' participation in the quiz and how they prepare for it.

The case study methodology was chosen because it constitutes a group of methods that complement one another and are able to deliver data and findings that will reflect the research question and suit the research purpose (Henning 2004). In a case study it is the case and the interaction between context and action that is usually the unit of analysis (Henning 2004; Opie 2004). This means that in a case study it is important to identify the phenomenon and use the appropriate tools to collect data and analyse it. Henning refers to this kind of study as a "bounded system" because it concentrates on a specific group of people at a set location. I will discuss the case for my study in section 3.3.1.

3.3. Research Design

The research design is qualitative in nature. According to Fossey, Harvey, Mc Dermott & Davidson (2002), qualitative research is a broad umbrella term for research methodologies that describe and explain peoples' experiences, behaviours, interactions and social contexts without the use of statistical procedures or quantification. This paradigm lends itself to providing and developing knowledge in poorly understood and complex areas of science or any other subject. The study incorporates observations and interviews conducted with the learners at their schools. The principal research paradigms such as interpretive and critical, as indicated by Fossey *et al.* (2002) represent different ways of looking at the world and involve choosing a variety of methods to study certain phenomena. In my study I am using the interpretive paradigm because it focuses on understanding and accounting for the meaning of peoples' experiences and actions. Fossey *et al.* (2002) and Henning (2004) contend that in the interpretive paradigm the reason for conducting

research is driven by a need to understand social life and describe how participants construct social meaning. Henning (2004:20) further argues that in an interpretive paradigm “researchers are extremely sensitive to the role of context”. My intentions are to look for the way in which participants make meaning in their lives under certain social contexts.
Fossey et al (2002) elucidate that in qualitative research, questions mainly focus on language as a means to explore processes of communication and patterns of interaction within particular social groups. Interpretive research focuses primarily on understanding and accounting for the meaning of human experiences and actions (2002).

3.3.1. The case study

In a case study a particular event is studied in depth for a defined period (Leedy & Ormrod 2005; Opie 2004; Vithal & Jansen 1997).This method seemed to be suitable for my study because I aimed at getting a deeper understanding of how learners prepare for the astronomy quiz and also how the teachers were involved. Opie (2004); Leedy & Ormrod (2005) and Henning (2004), elucidate that it is not important to concentrate on a large number of participants; a case could be about an individual, a team or group of people within a particular common setting, a whole class or a community. In order to answer the research questions I set up 5 case study groups. Each group comprised of four learners which came to a total of 20 learners.

The learners were observed and interviewed at their schools which were within easy reach of the researcher. They can therefore be regarded as a convenience sample. The selected schools had also been participating in the quiz for the past three years. Hence it was easier to get a clear understanding of their social behaviour and the factors that could be influencing the situation. For a case study, extensive data is collected on the event on which the investigation is focused. The instruments used for data collection could include observations, interviews, documents (e.g. newspaper articles, journals), past records, and audio-visual materials (photographs, videotapes, audiotapes). Mine are described below.

3.3.2. The research instruments

The purpose of my study was to seek an understanding of how learners work together to prepare for the SAASTA astronomy quiz and also in what ways does the teacher assist them. Consequently the following question guided my study.

How does participation in a quiz promote learning about astronomy?

- How does a selection of learners prepare collaboratively for the SAASTA astronomy quiz?
- In what ways do learners perceive the astronomy quiz to be valuable in increasing their knowledge and interest in astronomy.

To answer the above research questions, I used two instruments namely, observation schedules and semi structured interviews. The observation schedule was used as a structured tool in order to observe specific things during learners' preparation while the use of semi structured interviews allowed the researcher an opportunity to probe. The interviews were audio taped and then transcribed. The choice of the two instruments was guided by the theory on conceptual understanding and collaborative learning. It was also guided by three aspects influenced by the social interdependence theory discussed in chapter 2; namely cognitive development, motivational aspects and social cohesion. I looked at the important points that needed attention in my study and designed the instruments accordingly.

Observation schedule

The observation schedule (appendix C) was used mainly to collect data to answer the first research sub-question. A structured observation schedule was used so that it was possible to look for certain aspects such as how learners behave in their groups and the teacher's participation during the quiz preparation. The reason for making it structured was so that there is room for further probing in the interviews. Observational procedures can capture naturally occurring behaviour and avoid some of the disadvantages associated with interviews (Opie, 2004). According to Slavin (1989), observation is aimed at recording and describing members' behaviour within a group to provide objective data about interaction among members. Observation involves recording what learners do while they work together to complete an assigned task.

Semi structured Interviews

According to Opie (2004) the role of interviews in qualitative research has become unquestionable. This is because interviews are necessary to gain access to participants' first hand impressions, beliefs, assumptions and justifications of observed events. Researchers argue that interviews may be used to eliminate some of the problems created by the use of other instruments such as questionnaires and observations. This is because interviews are interactive and allow for any ambiguity to be clarified immediately. The interview method was chosen as one of the methods in this study because it has the potential to answer both research sub-questions of the study. Interviews aim to elicit participants' views of their lives, and so to gain access to their experiences, feelings and social worlds (Fossey *et al*. 2002). In my study I used semi structured interviews in order to facilitate more focused exploration of the astronomy quiz. The interview schedule is in appendix D. This method of data collection is advantageous in ensuring sensitivity to participants' language and privileging their knowledge. For example where learners have difficulty in understanding the language, as a researcher I have an opportunity to code switch and learners can respond in their home language. This allows for further probing in an interview in order to get

better understanding of the learners' understanding. According to Fossey *et.al.,* (2002); Opie (2004); Henning (2004), semi-structured interviews assist the researcher to follow up on specific ideas or issues which might have emerged from group observations.

According to Opie (2004) and Breakwell (1995) semi-structured interviews can be used both to give and receive information. Semi-structured interviews are more flexible than standardised methods such as the structured interview or survey because they allow for probing. They also provide a greater scope for discussion and learning about the problem, opinions and views of respondents and consist of more open ended questions which serve to explore different facets of the issue. I used this instrument to find out the learners' feelings about cooperative testing and also their understanding of astronomy concepts. The use of interviews helped answer mainly the second research sub-question. I used semi-structured interviews because they allow further probing (Opie 2004, Henning, 2004, Fossey *et.al,* 2002). This enabled me to elicit more information from the participants on their views and attitudes.

3.3.3. Piloting

Piloting the instrument has to do with pre-testing research instruments in order to find out if there is a need to change it before conducting the research. For the results of the study to be believable, the procedures used to collect data had to be valid. Hence a pilot study was then undertaken to validate the instrument. I had intended to pilot the study on two schools during the 2008 astronomy quiz but due to timing of the study it was possible to do it with only one school. An observation schedule was designed one school from the Gauteng West district was observed. After observing these learners I then interviewed two learners from that group.

Some of the lessons learnt from the pilot are:

1. The observation schedule was not answering research questions properly because it did not have a space for comments by the researcher.

2. Some of the questions on the interview schedule were vague and the interview was too long.

3. I was writing learners responses down as they were talking and this took longer and it was allowing bias.

All efforts were made to improve on the questions in order to obtain valid information from learners. The above problems were solved with the help of my supervisor in the final observation and interview schedule. There was also a decision taken that all interviews should be audiotaped and then transcribed. The review of the instruments allowed for my study to be objective, reliable and valid.

3.4. Sample Groups

The schools that participated in the research were public primary schools from Gauteng West district of the Department of Education. This district was chosen because it is the closest to HartRAO for the purpose of data collection and it also had schools from different backgrounds to allow diversity. The learners who participated in the quiz were selected by the schools using their own criteria which in most cases was based on pre-test or teacher selection based on learner achievement. About 20 schools who had participated in the first round were given a form to complete and in the form they were requested to indicate the methods used for selecting learners, the gender composition of the group and also the grades, i.e. whether Grade 6 or Grade 7 learners.

The research was conducted with Grade 7 learners from schools participating in the astronomy quiz in 2009. Each team comprising of four learners was expected to work collaboratively and represent their school in the astronomy quiz competition. My intentions as a researcher were to observe about 5 schools and interview 2 learners per school giving a total of 10 learner interviews. When selecting the schools I considered the following criteria; geographical positions of schools, under resourced or resourced schools, only grade 7 learners or both grade 6 and 7 learners in a group. The study focused on Grade 7 learners from five schools and the learners were from different backgrounds (race, socio-economic status and language).

3.5. Role of the Researcher

I was involved in the study as a passive participant; in all phases of data collecting I was with the groups as an observer only and not interacting with the learners. I assumed the role of a spectator not a participant. I did the audio taping of interviews at the various schools and also observed learners together with their teachers. A non-participant or a spectator researcher only focuses on the observation of how participants interact with one another using a structured observation schedule (Henning 2004; Opie 2004). According to Opie (2004: 128), the role of a non-participant researcher can eliminate the “reactivity” of the presence of the researcher.

3.6. Data Collection

The study focused on the SAASTA astronomy quiz project that was conducted between May and October 2009, which is run as a knock-out competition whereby teams get eliminated until there is

only one team left per site to represent the site at the national finals. In this study I have looked at how various schools prepare for the astronomy quiz.

The quiz process is as follows:

1. Each school team consisted of four learners.

2. Each quiz = 30 questions + additional for tie-breaks.

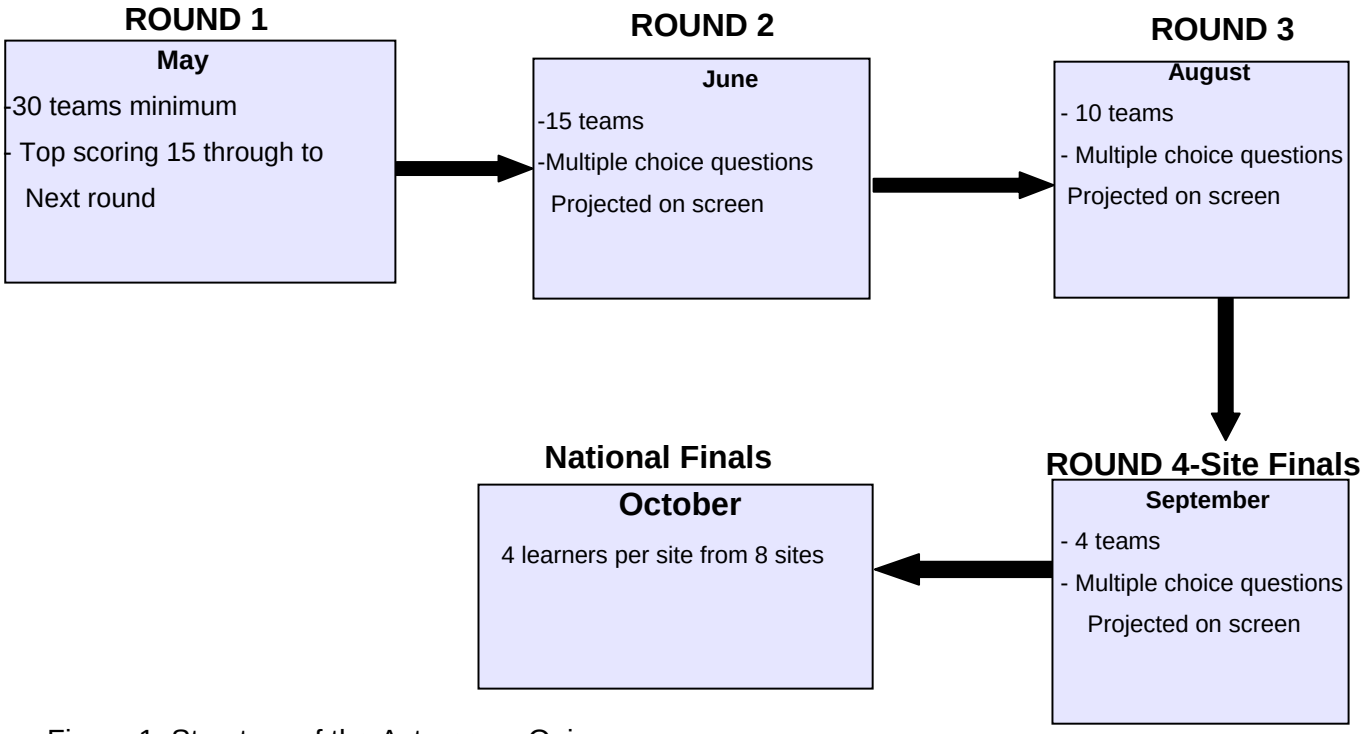

Figure 1. Structure of the Astronomy Quiz

These groups were observed by the researcher and two members from each group were interviewed as discussed in section 3.3.2.

The study was conducted in five schools in the Gauteng West area because they were within proximity to the researcher. Before the schools were approached, I requested permission from the Gauteng Department of Education to conduct the study in schools participating in the quiz. A copy of the research proposal was submitted together with a short questionnaire (included in appendix A). Once permission was granted I began approaching schools. I contacted the school and requested an appointment to see the teachers assisting learners with the quiz. The principal, teacher and the learners were asked to sign a consent form stating that consent was given to the researcher to conduct research in their school (see Appendix B). The consent form included the explanation on the nature of the research and that participation was voluntary and that they could withdraw at any point. Furthermore, the participants were assured of their anonymity during the study and in addition confidentiality was assured.

As indicated in Chapter 1, the astronomy quiz is a knock out competition whereby learners are issued with the same astronomy booklet before the first round. This booklet consisted of basic astronomy concepts and also South Africa's contribution in the history of astronomy. In May 2009 all learners participating in the quiz were issued with the same material in order to prepare for the first and second rounds and for other rounds they were given additional material in the form of copies from astronomy articles. The reason for giving them the same material was to ensure that all learners have access to the same resource with similar astronomy content. I was able to collect data from the third round (pilot) 2008, and for my main study I collected data in 2009 in the first, second, third and fourth rounds which was the time when I used the designed instruments.

The interviews were conducted mainly to answer research sub-question 2, "In what ways do learners perceive the astronomy quiz to be valuable in increasing their knowledge and interest in astronomy?" Two learners per school from the observed schools were interviewed as a follow up on observations. The criteria followed in selecting learners were such that there are a variety of learners in terms of race and gender (see table 2). This was done to avoid bias in the collection of data. The instruments were administered at the learners' schools on the day when they met to prepare for the quiz. I observed the learners participation and contribution during their preparation then interviewed two learners per school individually. The observation schedule guided me for probing during the interviews.

3.7. Ethics

In order to conduct this study, I obtained ethical clearance from the University of the Witwatersrand. I also abided by the principles of the University of the Witwatersrand of informed consent, confidentiality and anonymity and non-coerciveness. At the start of the research, the various principals as well as the teachers in specific schools were informed that all responses would be kept confidential, as no identifying information was required. The teachers were informed that the researcher and her supervisor would be the only ones to read the responses. Teachers gave their consent only after they had read the information letter and they understood that participation is voluntary. Schools were further informed that there would be no repercussions for choosing not to participate in the research.

3.8. Validity and Reliability

Validity and reliability are two factors which any qualitative researcher should be concerned about while designing a study, analysing results and judging the quality of the study. Reliability is the extent to which a test or procedure produces similar results under constant conditions on all occasions (Bell 2005). Reliability simply means consistency, which is when using different tools to collect data the outcomes should not be different, thus showing that the tools used are reliable. In order to ensure reliability I piloted my study to verify problems and make changes where necessary before administering it to the expected participants. The study was piloted on one of the schools that were not part of the actual study and changes were made accordingly. With regards to the observation schedules it was challenging to determine the reliability of the instrument because different groups of learners were observed and this could yield different results. It is very important for me as a researcher to ensure that there is trustworthiness in my research, so it is important to explain thoroughly how data was collected using both the interview and observation schedules, and this is assisted by presenting examples of interview transcripts and observation schedules. This is of assistance if there is need to compare my results with those of other researchers or for future use of my instruments.

Validity determines whether the research truly measures that which it is intended to measure or how truthful the research results are (Opie 2004). When using either the observation or interview schedules there could be bias by me as a researcher. To ensure validity the instruments were first given to a panel of experts to be tested (my colleagues at HartRAO and one educator) and then administered to the participants. So to ensure validity and reliability of my data I will have to admit to any bias. In order to ensure reliability I have attempted to answer my research questions by using an observation followed by interviews, and the interview is aimed at getting more information from the participants. The use of different methods in collection of data and data analysis improves the reliability of the study. While reliability is concerned with the accuracy of the actual measuring instrument or procedure, validity is concerned with the studies success at measuring what the researcher wants to measure.

3.9. Limitations of the Research

The following limitations should be noted:

First, the nature of the instruments used to obtain the data may have affected the information collected, as the observation schedule is not a standardised instrument. Therefore, the reliability and validity of the instrument might be questionable, as it has not been validated on a larger sample. Secondly, since the study was focusing on a knock-out astronomy quiz, I had to choose

schools based on their willingness to participate and those who had progressed to the next rounds. This therefore might have affected the extent to which generalisations can be made about learners' participation in the quiz and how their teachers are involved.

3.10. Data analysis and Interpretation

Hatch (2002: 148) indicates that " analysis means organizing and interrogating data in ways that allow researchers to see patterns, identify themes, discover relationships, develop explanations, make interpretations…". All this was done in order to make sense of the data. However Hitchcock and Hughes (1995: 299) also indicated that data can be interrogated if it gets "sorted into manageable units" which involves breaking data into categories. I analysed the observations and interview transcripts both deductively and inductively by carefully reading through the data in order to formulate categories. The data were then grouped in different categories that were guided by the interview questions. In inductive analysis the researcher goes through the data to look for themes which are not predetermined. This type of analysis provides a systematic approach to analysing large amounts of data. On the other hand in deductive analysis data is analysed using predetermined categories which can be adopted from the literature. Data analysis starts from the day the first set of data is collected and it is an on-going process constituted in all phases of qualitative research. This process involves selecting, categorising, synthesizing and interpreting the data. I transcribed the data collected from observations and audio recording. In order to categorise and analyse the data, I used the literature and experience gained on continuous interaction with the data (Hitchcock & Hughes, 1995).

In chapter 4 I analyse the observation and interview data using the categories developed. Observations were analysed using a coding scheme as in 4.3 and to analyse interviews I used the method explained in section 4.4.2. More on the analysis is covered in the next chapter.

CHAPTER 4: DATA ANALYSIS

4.1. Introduction

In this chapter I present the analysis of the data collected from observations and interviews with learners. As mentioned in chapter 3, there were two instruments used for the collection of data namely, observations of learners as they prepared for the quiz followed by learner interviews.
The analysis is conducted in order to answer the following research questions.

How does participation in the quiz promote learning about astronomy?

1. How does a selection of learners prepare collaboratively for the SAASTA astronomy quiz?
2. In what ways do learners perceive the astronomy quiz to be valuable in increasing their knowledge and interest in astronomy?

Recorded interviews and observations were transcribed. I will give a brief description of the participants.

4.2. Case study group

Five schools from the Gauteng West district participated in the study with a total of 20 learners and 5 educators. To capture a variety of experiences across the diverse schools in South Africa, schools came from four different historical communities; white, Indian, black and multi-racial. For the purposes of identification and ethical reasons, I have used fictitious names for schools, teachers and learners.
There were four learners participating per school to form a cooperative base group (Johnson & Johnson 1998). The learners were chosen by the participating school using their own criteria. According to Johnson & Johnson base groups are groups with long term membership and the astronomy quiz runs from April to October which allows for members to work together for a long period. In base groups, members give each other support, help, encouragement and assistance where there is need, in order to achieve academic progress and develop cognitively and socially. In the natural science curriculum learners are taught astronomy concepts to a limited extent but with the astronomy quiz they are expected to learn more and this gives them an opportunity to gain more knowledge on astronomy concepts.

Table 2 shows the demographics of the schools and participants.

Table 2 Demographics of the participating schools

School	Teacher	Learner	Gender	Race
1. Sun PS	U	A	Female	Black
		B	Female	Black
2. Galaxy PS	V	C	Female	White
		D	Female	White
3. Earth PS	W	E	Female	Black
		F	Male	Black
4. Mars PS	X	G	Male	White
		H	Male	Indian
5. Universe PS	Y	I	Female	Black
		J	Female	Indian

The first set of data to be presented and analysed is from the five observations that took place at the schools (observation schedule in appendix C).

4.3. Observations

My first method of collecting data was observations of learners at their schools. The purpose of observing was to learn from the participants in their natural context and how they behave during their preparation for the astronomy quiz. One advantage of observations is that it allows the researcher to record what is actually happening at a given situation (Opie 2004).

Observations alone do not yield enough interpretive data and due to this disadvantage there was a need to conduct follow up interviews with learners. Since only one preparation session was observed per school it was necessary to conduct interviews to ensure optimum and purposeful capturing of data.

4.3.1. How observations were conducted.

The observation schedule was used mainly to answer the first research sub-question, “how does a selection of learners prepare collaboratively for the SAASTA astronomy quiz?” This was used to

look for aspects such as how learners behave in their teams and the teacher's involvement during the quiz preparation.

Five schools from the Gauteng West district were observed before the first round, 2nd round, 3rd / 4th round and one school observed before the national finals. Learners from all participating schools were given the same booklet prepared by SAASTA, as mentioned in Chapter 3, in order to prepare for the quiz.

Table 3 Background information on the participating schools

School	**Background of School**	**Date Observed**	**Quiz round**
Sun Primary School	Situated in one of the previously disadvantaged townships in Krugersdorp. Predominantly black	27/05/2009	1st round
Galaxy PS	Situated in the suburbs of Krugersdorp. Predominantly Afrikaans (both staff & learners)	28/05/2009	1st round
Earth PS	Situated in one of the previously disadvantaged townships in Krugersdorp. Predominantly black (both staff and learners)	31/07/2009	2nd round
Mars PS	Multi-racial school situated in the suburbs of Krugersdorp.	09/09/2009	3rd / 4th round
Universe PS	Situated in the Indian Community outside Krugersdorp. Consists of both Black and Indian learners.	21/10/2009	National finals

The observation schedule was divided into four main categories, namely;

- **Organisation of session -** looking at how the teacher introduces the session and how learners are organised.
- **Learners' participation and interaction** - looking at the effective use of teams in terms of their interaction, roles assumed, communication skills and overall participation. Learners' interaction can be promotive or destructive. Promotive interaction is characterised by learners exchanging needed resources such as information and materials and providing each other with feedback in order to improve their performance. Learners can also be motivated to strive for mutual benefit and made an effort to achieve the set goals. **Learner behaviour** - looking at how learners behave in their groups, whether they participate

actively, they are motivated and show confidence in their groups. In their groups learners were expected to know and support each other so that they can resolve conflicts constructively.

- **Teacher / learner relationship** - looking at how the two parties relate to each other, in terms of openness and the running of the session. Whether the teacher clarifies things to the learners and offers praise where it is due.

4.3.2. Observation Results

4.3.2.1. Sun Primary School

Sun PS was observed on Wednesday 25th May 2009 in the afternoon. When the researcher arrived at the school it was just after classes had ended, and the learners were getting ready to go home. The learners who were involved in the selection for the quiz gathered in the school's computer room. According to the teacher the computer room was built as one of Gauteng online projects but it was not operational at that moment. The room was mostly used for small group discussions and it seemed appropriate for the astronomy quiz group to meet there.

The session started with six learners participating and the teacher handed out the previous years' question paper for learners to complete individually. When the learners were finished they were then requested to come together and answer the same quiz orally as a group. At this stage learners had a chance to discuss their answers and learn from each other. When learners work together they are provided with an opportunity to be actively engaged in the reasoning and application of concepts (Gnadinger, 2008; DiCarlo *et al.,* 2005). When the learners started engaging with each other it was easy to see their preparedness and also to observe how they interact with each other. For example in one of the questions it was difficult for learners to reach an agreement on the answer. The question was as follows:

Q3.Which is the largest of the dwarf planets in our Solar System?

1. Sedna
2. Pluto
3. Eris
4. Ceres

Learners were expected to choose the correct answer from the given four but it was difficult for them to reach an agreement and the teacher assisted them in deciding on the correct answer which is 3 (Eris). This could be caused by their lack of knowledge of dwarf planets or lack of preparation. There were two learners who seemed to be more confident and ready to contribute answers to most questions. For this school it was their first time meeting as a group to prepare for the astronomy quiz. The teacher was guiding learners through questions and also clarifying them.

He also kept on emphasising the importance of working hard in order to represent their school in the astronomy quiz. The group was still in its developmental stage (Friend & Cook, 1997). At this stage the team is still forming, which is a process of going through learning about each member and clarifying the reasons for existence.

The session lasted for an hour and at the end the teacher told the learners that they will hear the results on the following day during the Natural Science class. The learners were then dismissed.

4.3.2.2. Galaxy Primary School

The school is an Afrikaans school situated in the suburbs of Krugersdorp. The learners were observed on the 28th May 2009 which was on a Thursday morning. The teacher had asked for permission for the learners to be excused from the first period of the day and use this period for astronomy quiz preparation. On this day the first period is dedicated to class tests so learners in the whole school were not writing as they were preparing for the exams.

The group consisted of four girl learners. The session started with the teacher revising the previous sessions' work which was about the solar system. The learners were then asked about the latest developments in astronomy that they have learnt about in the past week.
i.e. ***"****Atlantis' astronauts repaired and upgraded the Hubble Space Telescope and installed a new Wide Field Camera, They successfully installed two new instruments and repaired two others, bringing them back to life, replaced gyroscopes and batteries, and added new thermal insulation panels to protect the orbiting observatory."*
http://www.nasa.gov/mission_pages/shuttle/shuttlemissions/sts125/main/index.html

Some learners were aware of the mission to service the Hubble telescope and the article was also in the daily newspapers such as the Star and also on Etv news.

The work for this session was based on names of astronomers who made a contribution in astronomy.

For example:

1. **Giovanni Cassini (1625 – 1712, Italian)** was the astronomer who first discovered the division in the rings of Saturn. He also found four moons orbiting Saturn.
2. **Aristotle (384-322BC., Greek),** the great philosopher, proved that the earth is spherical, and believed that it was the centre of the universe.

The learners came to the session prepared because they were able to answer questions from the teacher well.

What I realised about this group was that they had a language barrier because in my presence they were expected to discuss using English and this was their second language. The teacher had to intervene in most cases and also translate where there was a need. Among the four learners who were participating in the quiz there were three who were contributing more and the fourth learner was reserved and not as outspoken as other group members. The fourth learner was only answering questions that were directed to her and not voluntarily. The learners were working together collaboratively because they had prepared work to discuss with each other. The manner in which learners engaged with each other showed that they were not meeting for the first time. The organisation of the session provided an opportunity for learners to be actively engaged in reasoning and applying astronomy concepts.

4.3.2.3. Earth Primary School

The school is situated in one of the previously disadvantaged townships in Krugersdorp. This school composes of black learners and staff. I had requested to do my observations during break but it was not possible due the short break time of 30 minutes. The observations were then conducted in the afternoon of the 31st July 2009 on a Friday.

Earth PS had already gone through the first round and they were preparing for the second round of the astronomy quiz. The teacher and four learners participating in the quiz assembled in the staff room for their preparation. At the beginning of the session the teacher ensured that all learners had the astronomy booklets with them and she also gave them additional material in the form of copies of notes from the Internet. The group started by going through the task that was given by the teacher in the previous session. Learners worked well with each other as they prepared for the quiz and there was evidence of understanding portrayed.

4.3.2.4. Mars Primary School

A multi-racial school situated in the suburbs of Krugersdorp. The school was observed on a Wednesday afternoon of the 9th September 2009. Learners had managed to go through the second round of the quiz and they were preparing for the 3rd round of the astronomy quiz.

At the start of the session learners seemed to know their roles well. The teacher had subdivided work for the learners and they were expected to share with others by reporting back to the whole group. This was seen as a good act to improve communication skills and also see how prepared the learners were. The ability of a group to communicate with one another in an open and honest manner is vital in promoting team effectiveness (Friend & Cook, 1997). The procedure used by the

teacher, of subdividing the work, was used to guide and regulate the team's activities because this is important in order to maintain control.

While observing this group I noticed that all learners had prepared their bit and they only had to discuss with the group. They had developed good behavioural skills. These learners were active participants, sharing information and having respect for each other's opinion (Willis, Jones, Bundy, Burdett, Whitehouse & O'Neill, 2002). When discussing their given work these learners listened attentively to each other and also asked each other questions. The teacher was also adding to their knowledge by correcting them and giving guidance.

4.3.2.5. Universe Primary School

The school is situated in the Indian community outside Krugersdorp and has both black and Indian learners. The group consisted of 2 girls (black & Indian) and 2 boys (black & Indian). The learners at the Universe PS were observed on the 21st of October 2009, two days before the national finals of the astronomy quiz. The teacher responsible for the group was given permission to allow learners to prepare during school hours so I observed this group at 11 am.

The learners assembled in the Natural Science classroom of their teacher because the teacher had a free period. The session started with the teacher asking learners if they remember their roles well.

e.g. learner K was the 'card raiser' during the quiz

All learners knew that they were supposed to prepare well for the national finals because their preparedness was the one to guarantee their performance.

In the beginning of the session I asked learners if they were aware of the incident that happened during that month and what they thought of it.

"***Crash on the moon to find out if there are sufficient amounts of water on the moon surface"***

Some learners were aware, while others were not, but they started discussing amongst each other to find out how much they knew. During the observation for this school I interfered at the beginning of the session and this might have had contributed to the way learners related to each other. The teacher left the learners with me for most part of the session and I observed how they interacted with each other. Learners effectively used resources that were at their disposal. Every member was given an opportunity to contribute and their opinions were heard and also considered by other members.

At this stage of the quiz this team showed commitment towards achieving their goals and were working well together. There was evidence from the way they related to each other that they have been working closely with one another and this is a strong attribute of team effectiveness. These learners assumed different roles in their group and the relationships developed with one another determined the effectiveness of the team. Members of this group encouraged each other and were committed to follow through with the task and working out problems. Learners showed support for each other, were listening carefully to each other and were also willing to explain concepts to other members. The session ended with motivation from the teacher and learners also encouraged each other.

4.3.3 Analysis of Observation Results

In this section I will analyse the observation data using the criteria explained on 4.3.1. When observations were conducted all participating schools were observed using the same criteria and their results are in appendix D. While analysing the data I realised that there were other important aspects that I should also have put into consideration such as the content knowledge of individual learners as I believe this could have assisted me in getting sufficient data on learners' knowledge acquisition. Following is the analysis of all schools as observed and the differences in organisation of the sessions for schools are noted together with all other categories as stated on 4.3.1.

4.3.3.1. Organisation of Session

In all five schools observed, the sessions were started in different ways but they all depended on how the previous sessions went. At the Sun PS the teacher indicated that learners are in the selection process and there were six learners attending the session. The teacher used the previous years' astronomy quiz questionnaire to select learners and they had to answer the quiz individually.

At the Galaxy PS the teacher handed out additional material to the learners and explained to them what they were going to do during the session. She also made mention of the latest news in astronomy, "space shuttle that landed on the 25th May 2009 passing over South Africa."

In both Earth and Mars PS the session started with the teacher ensuring that learners had the required material and they were not provided with any additional material. The Universe PS was observed a week before the national finals. At this stage the teacher was there to give them minimal guidance since they were almost ready for the final leg of the competition. These learners had brought additional material in the form of newspaper clippings and books to the session to assist them in their discussions.

4.3.3.2. Learner Participation and Interaction

The participating schools all had a shared goal of winning the astronomy quiz but their approaches and preparation methods determined their achievement. According to Friend & Cook (1997) direct communication, interdependence, coordination and shared goals are essential team features. In the case of Sun PS learners had a shared goal of participating in the quiz but there was still no evidence of interdependence and other features of effective teams. This could be because it was still early in the quiz round and team members were still not familiar with each other. When learners started going through the quiz together there was little evidence of some learners taking leading roles.

In Galaxy, Earth, Mars and Universe Primary schools there was evidence of positive interdependence and learners communicated well with each other. This was an indication of promotive interaction which only occurs when individuals encourage and facilitate each other's efforts to reach the group goals (Johnson & Johnson, 1998). Group members promote each other's' success by giving and receiving help and assistance from peers and the educator. This was happening in four out of five schools observed, where peer collaboration was evident. Peer collaboration promotes and improves reasoning ability. The socio cultural process of collaborative engagement and continuous attempt for shared meaning contributes to learning.

4.3.3.3. Learner Behaviour

When learners from Sun PS started working as a team only three out of six were more knowledgeable and leading in answering the quiz questions. These learners worked collaboratively and this enabled them to complement one another and showed commitment towards a common purpose of winning the astronomy quiz (Fleming & Monda- Amaya, 2001). Learners were given the same material to prepare for the quiz and this met one of the requirements of positive interdependence as explained by Johnson *et.al*.,1998.

In Galaxy PS and Universe PS learners had brought copies from the Internet and newspaper clippings which they were using as additional material. Learners were sharing and exchanging resources and information. There are a number of benefits from this act, such as orally explaining, elaborating, summarising information and peer teaching. According to Johnson & Johnson (1998), peer teaching increases the level to which group member's process and organise information cognitively.

When learners engage in discussions and listen to each other they get an opportunity to interact and exchange resources and this is a sufficient tool to improve their performance. This was observed in the Universe PS where learners were using books that they had won in the previous round and other material to discuss developments in astronomy.

4.3.3.4. Teacher/ learner relationship

Teachers interacted positively with the learners. They gave praise to the learners and congratulated them on their efforts during preparations for the quiz. Teachers' behaviour such as praise for success on tasks and absence of blame for failure conveys positive perceptions and provision of unsolicited assistance may convey perceptions of high ability.

In all schools teachers were assisting learners and clarified things where there was a need. At first in the Sun PS the teachers' relationship with learners was not very clear. This is due to the way the session was structured because in the beginning of the session learners were not provided with a task that required them to work as a team. Most of the time learners were working on the quiz questions individually and later they started interacting and this was when the teacher started guiding them.

4.3.4 Summary of Observations

According to Slavin (1989) observing learners is aimed at recording and describing their behaviours within a group in order to provide objective data about their interactions. In the five schools it was very useful to observe them during their preparations because I was able to notice whether the members were prepared for their sessions and how they were imparting knowledge between one another. I was also able to record the role played by the teacher during the learners' preparations.

Learners interacted differently from one school to another and their rate of interaction played a key role in the learning process as well as having an impact on their performance. In this study, the performance of the group is only determined by the groups' effort because they are working towards a common goal. In the schools where continual interaction was evident, learners' tasks were distributed accordingly and it was observed from their discussions that they understood that the end product required that they collaborate and construct shared understanding and knowledge. Through constant interactions learners efforts are merged resulting in the culmination and achievement of a common goal which is winning the astronomy quiz.

According to Vygotsky (1978) the social environment shapes a learners way of thinking and interpreting the world, suggesting that learning is not a solitary process but that there is a

connectedness between how an individual learns and his environment and this influences their interpretation and understanding of the world. Therefore, Vygotsky's theory emphasises the active role an individual plays in his learning (Gnadinger, 2008; Vygotsky, 1978). In contrast to other theorists, Vygotsky states that learning is not achieved in isolation, but stresses the role of a mediator. The mediator is seen as a more knowledgeable other who is able to facilitate the learning process. This is better explained using the notion of the zone of proximal development (ZPD) which is considered to be the space where learning and development happen, in collaboration with a more capable other, a peer or a teacher. Vygotsky refers to this kind of assistance as scaffolding and it offers learners the necessary support which lessens as learners gain understanding. When preparing for the quiz, in the early stages learners needed more assistance from the teacher and as the quiz progressed the teacher offered minimum guidance. This behaviour was noticed when observing learners from Universe Primary School who were now preparing for the last leg of the competition. Their teacher had provided them with resources in the form of books and they were working independently in his classroom. These learners showed a lot of confidence and trust to each other, and this was an indication that they are at a stage where they can work responsibly with less assistance from the teacher.

In table 4 I have summarised the observation results according to the categories discussed in 4.3.3.

Table 4 Summary of Observation results

Category	Sun PS	Galaxy PS	Earth PS	Mars PS	Universe PS
Base Groups	Not evident Group consisted of 6 learners	Yes 4 members	Yes 4 members	Yes 4 members	Yes 4 members
Organisation of Session	Learners were given last year's quiz to complete individually	-Learners were told of the topic for this session. -Revision on previous sessions work. - Update on the latest news in astronomy	-Teacher ensured that learners have all material needed for the session. -She then revised the previous sessions work.	-Learners were prepared at the start of the session. -No additional material handed out.	-Learners were at the stage where they needed limited guidance for their preparations. The teacher was there for monitoring purposes.
Learner Interaction	-Learners initially worked individually and later answered the quiz together. - No evidence of different roles assumed.	-Learners worked on the given task well and they were discussing names of astronomers and their contributions. - Learners were very attentive and listened to each other	-Learners interacted well while working on their tasks. -They assumed the same role and listened to each other attentively.	-Winning was at the fore-front for this session. -Learners engaged in more preparation. -One learner assumed the leadership role as a group controller	-All learners seemed prepared for this session. -They worked well together and gave each other a chance to contribute in the discussions.

Category	Sun PS	Galaxy PS	Earth PS	Mars PS	Universe PS
Learner Behaviour	-Learners appeared not to be ready to work together. - Three members out of six were more knowledgeable and lead the group in answering questions.	-Learners worked well with each other. -Three of them were outspoken and there were interesting discussions that came up when they were discussing astronomers and their contributions.	Moderate participation and in some instances learners were hesitant to answer questions asked by the teacher.	-Learners encouraged each other and they were confident. -They showed good control over their situation.	-Learners were engaged in their final preparations for the quiz. -They had allocated different roles to each other and were discussing them -They showed readiness for the quiz National finals.
Teacher/ learner relationship	- Not clear due to the set-up of the session. - Learners were praised for giving correct answers.	-Teacher very supportive and mediated whenever there was a need. -She played a major role in their preparation.	- The teacher guided learners through their work and they were praised for good work.	-The teacher was very supportive and congratulated learners for getting this far in the quiz.	-The teacher was more of a guide and observed learners as they prepared. -He assisted with additional resources and monitored their progress. -He wished them luck for the national finals of the quiz.

4.4. Interviews

I used interviews as a follow up instrument to observations, as they enabled me to investigate in what ways the learners perceive the astronomy quiz to be valuable in increasing their knowledge and interest in astronomy. This is because interviews are interactive and allow for any ambiguity to be clarified immediately. Semi-structured interviewing allows an interviewer a chance to solicit more information from the participant than standardised methods such as the structured interview or survey (Opie, 2004). I used a semi-structured interview to find out the learners' attitude towards cooperative testing and also their understanding of its benefits in team effectiveness. The benefits of semi structured interviews are explained further in Chapter 3 of this study.

All interviews were tape recorded and then transcribed verbatim. The use of the tape recordings allowed me to play back the interviews several times so that I could capture everything that was said. In this study interviews assisted me in getting more information about the learners' feelings about working in teams.

4.4.1. How interviews were conducted

After observations I purposefully selected two learners from each school (table 2), for one-to-one, face-to-face interview. I used "ethnicity" as criteria to diversify the purposeful sample because learners were coming from different schools and they were of various ethnic groups. The interviews were conducted at the learners' schools immediately after the observations in order to make it easier to follow up on the observed behaviour of the learners and probe further.

The interview schedule focused on three main aspects of cooperative learning**: motivational aspects, social cohesion and cognitive development.** In cooperative learning, learners are encouraged to work collaboratively and help each other in the process. In the quiz, learners were expected to work in teams of four and research suggests that this will allow them to practice team effectiveness (Fleming & Monda-Amaya, 2001; Hoevemeyer, 1993; Friend & Cook, 1997). According to Henderson and Walkinshaw (2002) the effectiveness of the team pertains to the accomplishment of goals and objectives as defined by the project requirements.

4.4.2. Analysis of Interviews

In this section the analysis of learners' responses will be presented. I will first start with the development of the categories used for coding.

4.4.2.1. Development of the coding scheme

The coding scheme was guided by the research question and I was looking at how learners prepared for the quiz, how they interact with the teacher and if they acquired any knowledge during the preparation process. Upon analysis of the interview and observation transcription I made notes on sections containing information relevant to each of the research questions, as well as unanticipated revelations. Firstly, I scrutinised the transcription of the interview and the observation notes made during the observation session of the five schools and ten interviews.

When conducting interviews I was looking at learners' views of the usefulness of the astronomy quiz. In my initial stage of analysis of interview transcriptions twelve categories emerged. They are **winning, interest, career motivated/focus, team roles, individual accountability, resources, conflict resolution, preparation method, peer support, teacher support, out of school support and knowledge acquisition**. These were then grouped according to their similarities, into main categories namely; Shared goals, Roles and Responsibilities, Established systems and procedures, Effective relationships, Knowledge restructuring and conceptual gain.
These categories are supported by the literature on team effectiveness (Alexander, 1985; Hoevemeyer, 1993; Willis *et al.,* 2002; Friend & Cook, 1997; Fleming & Monda-Amaya, 2001) because they address aspects of an effective team such as; team mission, goal achievement, open and honest communication, positive roles and norms.
Each of the categories is described as follows and summarised in Table 4.4:

Shared goals

For an effective team there should be a compelling and dynamic picture of the desired end result. Understanding of the role of the group, its responsibilities and the things they want to accomplish is very important in teams. Group effectiveness is influenced by the achievement of the objectives of the project, success criteria set out by members and anticipation of both positive and negative outcomes (Kozlowsky & Ilgen, 2006).
In the initial categories that were identified, the shared goals that learners indicated for participating in the quiz are *winning, interest* and influenced by *career* choices. The astronomy quiz is a competition where learners participate in groups of four and all the participating schools aim at *winning* the competition. In most cases winning is influenced by learners showing commitment and showing *interest* in their tasks. For some learners their participation in the quiz inspired them to consider space science related *careers*.

Roles and Responsibilities

According to Willis *et al.* (2002), the development and cohesion of a team occurs when there is a feeling of shared leadership among members. Group members have clear but not rigid roles and

relationships and the commitment of learners to their groups ensures that they share their skills effectively.

The sub-categories which fall under this category are *team roles and individual accountability.* Each learner in a group is accountable for the achievement of the objectives of the group and can also influence the group positively or negatively. In a group setting if there is no evidence of *individual accountability* some members are not going to feel obliged to contribute to the group. This will likely lead to 'social loafing' (Willis *et al.,* 2002) which is described as the tendency of individuals to put less effort in their group and such behaviour can reduce the level of group effort. To avoid such situations learners are then encouraged by being given rewards or being congratulated for doing a good job.

Established systems and procedures

This category has to do with the procedures that the group undertakes to ensure that the goals are achieved. The learners are expected to have a commitment of meeting regularly to discuss matters pertaining to the task. This will ensure that decisions are reached by consensus. Hence the group develops the ability to openly recognise *conflict* and seek to resolve it through discussions and this is critical to the team's success (Fleming & Monda-Amaya, 2001). When team members use the *resources* available to them effectively their team will function effectively. The sub-categories which fall under this category are utilisation of *resources, trust and conflict resolution and preparation method* which learners employ during their preparations for the quiz.

Effective relationships

The relationships among team members can affect the quality of work the team is expected to produce and the achievement of their goals (DiCarlo *et.al*., 2005). It is important that in a group there is optimisation of synergy by building trust amongst each other and scheduling activities in order to maintain control. Effective relationships in a group are influenced by the way learners work together (*peer support/assistance*), the support they get from the teacher (*teacher support*) and from other people (*out of school support*) in their community.

Knowledge restructuring and conceptual gain

The constructivist theory is based on the premise that children have coherent theories about the world and they constantly restructure their understanding of concepts (Posner, Strike, Hewson & Gertzog, 1982). This is the process of *conceptual change* which involves modification of the learners' existing theories in the light of experience. Sneider and Ohadi (1998) capture the essence of this interpretation when they state: "The process of learning involves a cognitive change, in which students must actively modify or reject their personal views in order to construct new models and theories" (p. 267).

When learners prepare for the astronomy quiz, they constantly restructure their understanding of astronomy concepts as they interact with each other and through the use of various resources. During this process learners modify their understanding and if there is no conflict in their understanding then they gain new knowledge through restructuring their existing schema.

Table 5- Explanations of sub-categories used in coding the interview data

Main Category	Sub Categories	Explanations
1. Shared goals	Winning	To win is to be the most successful team in the astronomy quiz competition. Teams can demonstrate success by advancing to the next round or winning the quiz.
	Interest	Interest can be explained as a feeling that comes due to curiosity and an urge to learn about something. In the case of the astronomy quiz, learners were eager to learn new concepts and this aroused their *interest* in the subject matter.
	Careers	Learners mentioned career motivation as one of the benefits for participating in the astronomy quiz. A career is said to be an occupation undertaken for a certain period of time that can be influenced by the opportunities a person was exposed to and also the skills learnt and the ability to apply them.
2.Roles and responsibilities	Team roles	Teams have clear but not rigid roles. Learners assign roles to each other and are cooperating. The roles that members take and their relationships with one another determine the effectiveness of a team.
	Individual accountability	A measure of whether or not each group member has achieved the group goals. It is the factor that shows that students a learning better cooperatively (Johnson et. al 1998). The group success depends on the individual learning of all members.
3. Established systems and procedures	Resources	Using effectively all the resources at the learners' disposal. Every member of the team has the opportunity to contribute and their opinions are heard and considered
	Trust and Conflict resolution	The ability to openly recognise conflict and seek to resolve it through discussions is critical to a team's success. The evidence of knowledge of conflict resolution and giving each member of the group equal opportunity to speak.

	Preparation method	Methods used by learners to prepare for the quiz including planning and meeting times.
4. Effective relationships	Peer support/assistance	When a child is joined by a peer, they solve problems together by establishing a joint definition of the situation (Kruger, 1993). Learners advance more in their understanding of the problem when they support each other than when working individually.
	Teacher support	According to Vygotsky, the teacher provides support to learners when need arises. The teacher can be a facilitator or mediator and their support is aimed at helping learners within their zone of proximal development (zpd), hence offering them learning strategies which they internalise and utilise later.
	Out of school support	Support received by learners from friends and family members.
5. Knowledge restructuring and Conceptual gain	Conceptual gain and Knowledge acquisition	Conceptual gain occurs effectively when learners construct their own knowledge to achieve conceptual change through modification of their conceptual framework (Driver, *et. al*., 1994: Vygotsky, 1978).

4.4.3. Interview results

In this section I will be presenting results from learners' interviews using the categories discussed in 4.4.2.1.

4.4.3.1. Shared goals

Figure 4.1 below shows the results of reasons given by learners for participating in the quiz and also looks at the number of utterances made by learners indicating their motivation or reasons for participating in the astronomy quiz. When analysing interview transcripts I looked at the number of times that learners mentioned the three sub-categories as reasons for participating in the quiz and what benefits they hoped to gain.

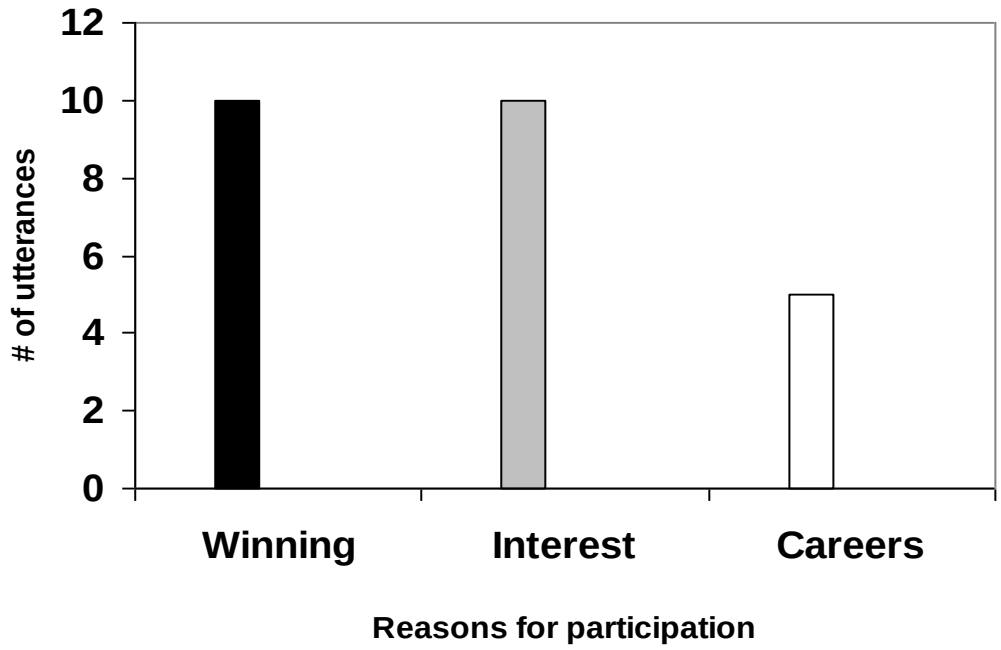

Figure 2. Graph showing number of utterances by learners (n= 10)

Winning and Interest

In order for a team to perform well it must have shared goals and objectives. In the astronomy quiz all learners have a shared goal of winning the quiz or even just getting to the next round. This is evident in the following examples of responses given by learners for the different interview questions.

Interviewer: What expectations do you have for you and your team-mates in participating in the quiz? What do you expect out of the quiz?

Learner A (LA): I expect that all of us…. all of us we have *interest* in everything and every question that we would be asked and know the answers of the questions that we will be asked.

Learner D (LD):Well I think, well we've worked very hard for this so I hope we *get to the next round***,** I think we will because we like this and we hope to get to the next round.

Learner G (LG): I expect great things; I want us to *win the competition***,** even if we become second place or third it's still fine.

From the above learners' responses it is clear that they have high expectations in entering the quiz and these expectations are driven by the fact that learners find the quiz interesting

Career Oriented

Careers can also influence learners' participation although only a few of them mentioned this but I think it's a very important point because when learners engage with each other and gain more knowledge, they get an opportunity to explore more choices which could also influence their future careers.

"I want to be a scientist" **LD**

"We have great expectations, like learning harder so to be future astronauts so that South Africa is more recognised." **LJ**

Comment

Learners' goals varied from winning, interest and some showed interest in pursuing science related careers. The essence of shared goal interdependence is that learners understand that they are working together to achieve a goal and this can be to earn recognition, rewards or to win a competition. In the case of the observed group, learners were expected to work together to win the astronomy quiz and represent their site in the national finals. Based on the responses from the interviewed learners it is evident that they all had high expectations on the results of the quiz. They were mentioning mainly winning the quiz as their goal and a few of them stated career choice as one of the benefits.

4.4.3.2. Roles and Responsibilities

The development and cohesion of a team occurs only when there is a feeling of shared leadership among members. When analysing and categorising data under this section, the information received from the interviews could not easily be plotted in a graph format as because of its nature it could not be quantified.

Team roles

Roles help group members differentiate their rights, while responsibilities help define expectations and behaviours for self and others. The group members assist each other to work on their weaknesses and by so doing their morale increases because they in turn understand their roles well. All members have to play a role and accept responsibility for task functions in order to keep the group together and interacting well.

“We observe each other and respect each other and work together.” **LA**

“We all work together” **LE**

“Yes we do take different roles especially in our group, like we will say someone is better in this, studying the moon than planets then that person will study the moon not planets.” **LK**

“No we all have our leader and our card raiser and we` all discuss, none of us are higher that the each other we are all equal” **LJ**

Learners had varied responses on the roles they play in their groups. From the above responses **LA** and **LE** were not specific in defining different roles they take but emphasised working together. According to **LK** and **LJ** they allocate roles to different members of their groups and this ensures that equal responsibility is taken.

Individual accountability

Individual accountability is a measure of whether or not each member of the group has achieved the goals of the group. It is the factor that shows that learners are learning better cooperatively. Learners are expected to be fully committed to the group in order to assist each other and share ideas. They learn to do things together so that it is easier to do them when they are alone. This is evident in the learners’ responses below;

“Well, if we have different views on an answer or question or something we give a reason why we say that is the answer and somehow we come to a conclusion.” **LH**

“She gave us all some, because we use the small booklet she gives us, every one of us little parts with what we have to learn and we expect the other one who learnt the part to give the answer” **LF**

Learners were given similar material to help them prepare for the quiz and this allowed them an opportunity to share and discuss the given task amongst each other.

Comments

In collaborative learning groups, there must be a sense of interdependence that holds learners accountable for their contributions and for their peers (Slusser and Erickson, 2006). Individual accountability can be structured by assigning roles to learners such that they take different responsibilities which then assist them in sharing information to ensure better understanding. This is evident from the interview extracts above. Lack of individual accountability reduces feelings of personal responsibility. Learners can also teach what they have learned to someone else or edit each other's work (Johnson, Johnson and Halubec, 1994) and this behaviour was observed in 3 out of five schools that participated in this study. 8 out of 10 interviewed learners indicated how they have shared responsibility to ensure that their groups work effectively.

4.4.3.3. Established Systems and Procedures

When learners work together they have an opportunity to decide on the procedures to use and also the processes established to maximise the use of group resources. This has to do with operational procedures that the group undertakes and this enables them to engage more with each other and develop trust in order to avoid conflict.

Utilisation of resources

Every member has the opportunity to contribute to the group by utilising different resources. When the group uses all the resources at their disposal this enables them to establish a suitable environment for their use. Below is the graph showing different resources that learners used during their preparations for the astronomy quiz.

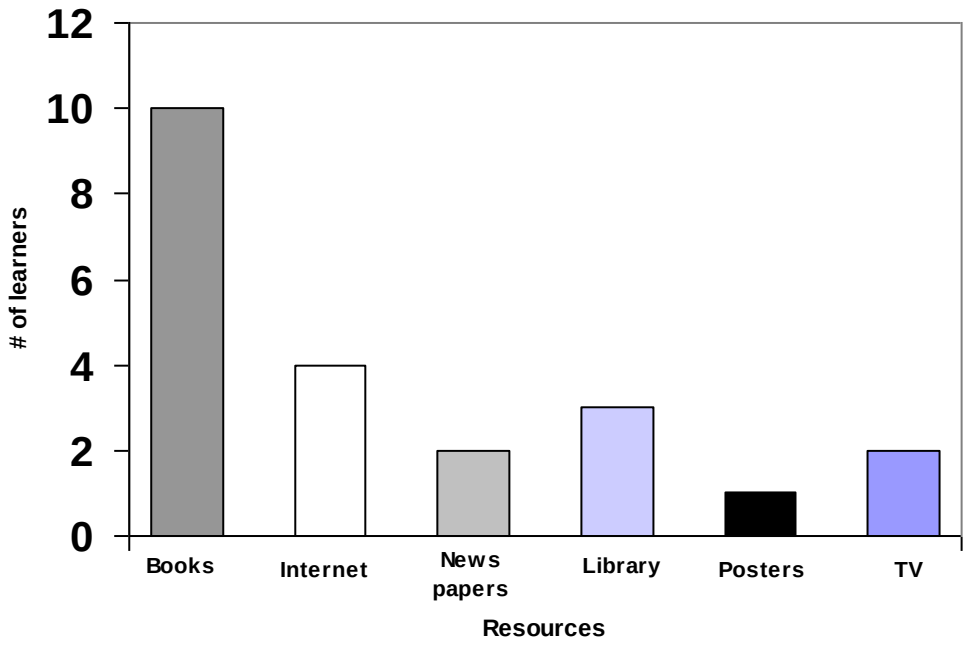

Figure 3 Resources used by learners during the astronomy quiz preparations

From the above graph all learners mentioned the use of a book because they were all provided with a book in the beginning of the quiz, which then served as a common resource but only a few learners used other resources such as posters and TV. As the quiz progressed learners were allowed to use additional material that could assist them and this worked at an advantage to those learners who had access to computers and could also get to the library.
The evidence of using other resources is seen in the following learner responses;

“Every day one or two periods when we can… we get together here or in the auditorium where the *computers* are and we go through the whole *book* that we have to learn and the teacher helps us a lot and we watch videos.” **LE**

“Except for this *book*, I do watch some *television* and read *local newspapers*.” **LG**

“From the starting after we won the fourth round when we got our *books* as prizes, we already said we are going to study during holidays and our teacher said everyone has their categories to study and from Tuesday we've been sitting in this class and studying.” **LJ**

Learners used various resources to assist them during the quiz preparation and this gave members an opportunity to participate freely and to share information.

Trust and Conflict Resolution

Trust is a very strong component in collaborative learning because learners know that they have to develop a sense of interdependence which allows them to expect dedication from each member of the group. The ability to maintain trust and avoid conflict is a strong attribute to maintain a strong team. This consequently allows a team to be able to resolve conflict through discussions which is critical to a teams’ success.

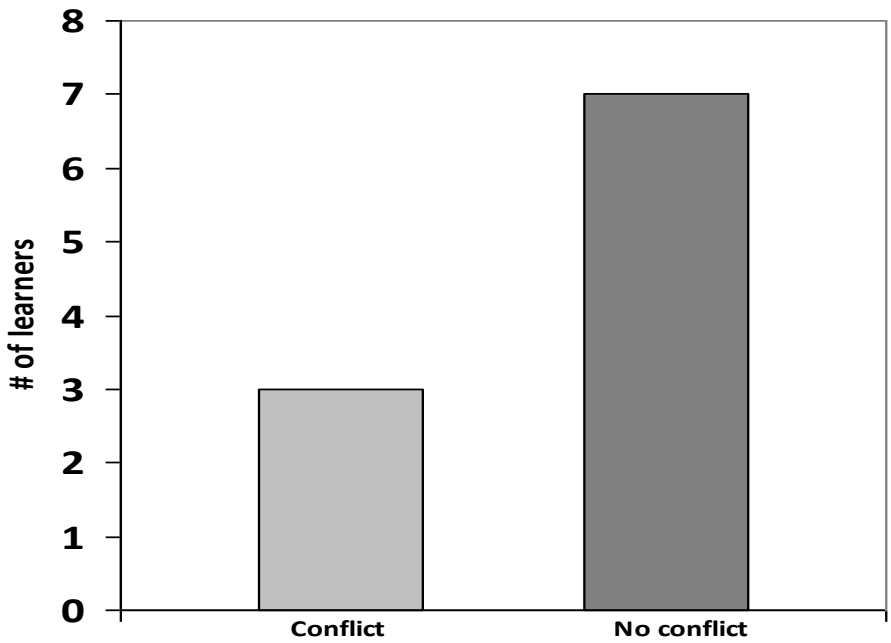

Figure 4. Graph showing number of learners who experienced conflict in their groups and those who did not

From the above graph and the following interview extracts it is evident that some learners had conflicting ideas during their preparations while some groups did not experience any problems. It is important for teams to recognise conflict and try to resolve it through discussions in order to ensure team success such as in LB's team.

"Yes we have, we like, we had a conflict on choosing an answer and one of us took a book to show us that it's the correct answer is to solve that problem" **LB**

"We fight a little but then we like, we have to remember the answers correctly we give each other reasons why we say this answer and not the other" **LC**

"So far we haven't had conflict that we are united as a group we are like best friends. There's no conflict really." **LF**

Conflict and division are common in teams (Kozlowski and Ilgen, 2006) and if not dealt with they can result in interfering with information processing, and limiting flexibility in a team which will result in affecting their performance. According to LF they have created good relationships with each other and this has helped in ensuring that there is more trust among each other hence minimising chances of conflict. It is important for learners to know each other so as to form a strong team; this is because a strong team identity plays an important role in attaining optimal team performance in the sense of motivating each other. In the schools where learners said they

did not have conflict with each other it was noted that they had good relationships with each other; e.g. LF mentioned that they were united and were “like best friends”.

Preparation method and how often learners meet

The way learners prepare for the quiz plays an important role in ensuring that they perform well in the competition. How often they meet and how they prepare is also a contributing factor in ensuring that their team succeeds.

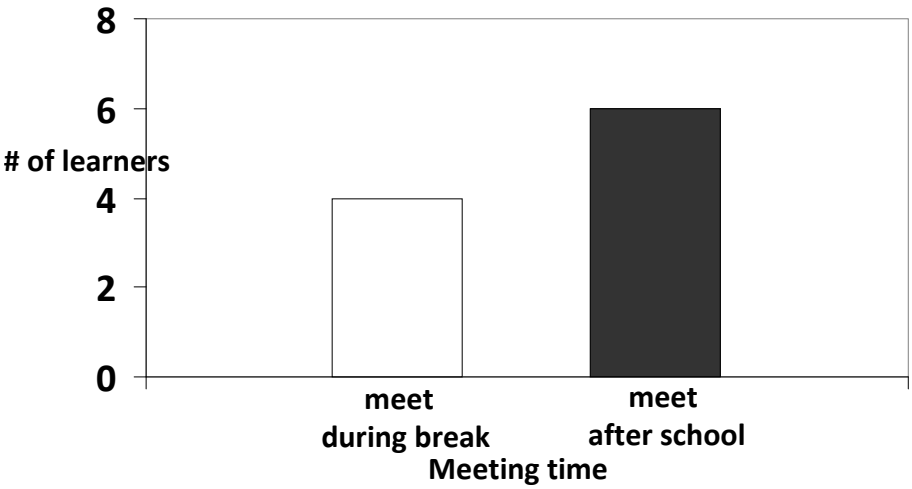

Figure 5. Preparation methods used by learners

Proper planning and task division is also important in strengthening relationships among members. If learners meet often they get a chance to know each other better and develop trust and respect for each other.

During the learner interviews some learners mentioned how often they meet to prepare for the quiz.

“As a group we meet every after school and come with our books to see which part we can read.” **LB**

“Everyday one or two periods when we can we get together here or in the auditorium where the computers are and we go through the whole book that we have to learn and the teacher helps us a lot and we watch videos.” **LE**

“We all sit together and we ask the teacher to explain it to us all again and we discuss until we understand.” **LF**

“We've been studying like, frequently, from Tuesday we've been studying almost every day fully we've been sitting with our teacher in the class and studying step by step and book by book**.**” **LH**

From the above responses it is evident that when learners meet frequently there is an increased chance of better performance. When learners prepare for the quiz they are expected to meet regularly in order to share ideas and this gives them a better opportunity to collaborate and learn from one another.

Comments

Teams with access to sufficient material resources required to accomplish the task have shown to be successful and this is supported by LJ's and LE's response which shows that with additional books for the preparation of the quiz, the school got a better advantage. The availability of additional resources also enabled learners to prepare sufficiently and to meet regularly in order to exchange ideas better and more frequently. This gives the groups a high possibility of high achievement because it encourages frequent repetition of information and explanations (Baloche, 1998).

When people work in a team they bring different opinions with them and this can lead to conflict amongst members. When learners argue and negotiate, this takes them towards a productive interaction because they are given a chance to exchange ideas, which then leads them to developing more trust and confidence in one another. This is also evident in the learners' responses on their preparation methods and on how they resolve conflict. Team trust also plays an important role in how teams manage different forms of conflict and may have the potential to be an important conflict management tool (Kozlowski and Ilgen, 2006).

The way the team is designed, in terms of its composition and members is also essential as it helps in avoiding conflict among members and regulates team members' behaviour. This also allows activities to be coordinated and planning of strategies to be active. When teams engage in discussions, this brings conflicting ideas together and this leads to increased understanding and integration of different points of view. Learners from Universe PS indicated that they do not have conflicts in their groups because of their good relationships with each other which enables them to discuss ideas amicably and come up to a joint agreement. By so doing they also are able to realise their weak points and work on them in order to improve their performance.

Good preparation methods coupled with good planning increases team morale and this is evident in most learners' responses that when they meet regularly and use various resources their performance improved tremendously. Tudge (2000) in his studies asserts that with a good setting and planning when learners work together there is a sense of connection established and this can produce considerable positive energy and high levels of motivation.

4.4.3.4. Effective relationships

Relationships among team members can affect the quality of service the team provides and the achievement of their goals. Learners participating in the quiz, establish relationships that enable them to interact and cooperate with each other successfully.

The graph below shows the comparison between the three different kinds of support that learners were getting as they prepared for the quiz. Learners were working together most of the time and received assistance from their teachers followed by minimal assistance from their families and friends.

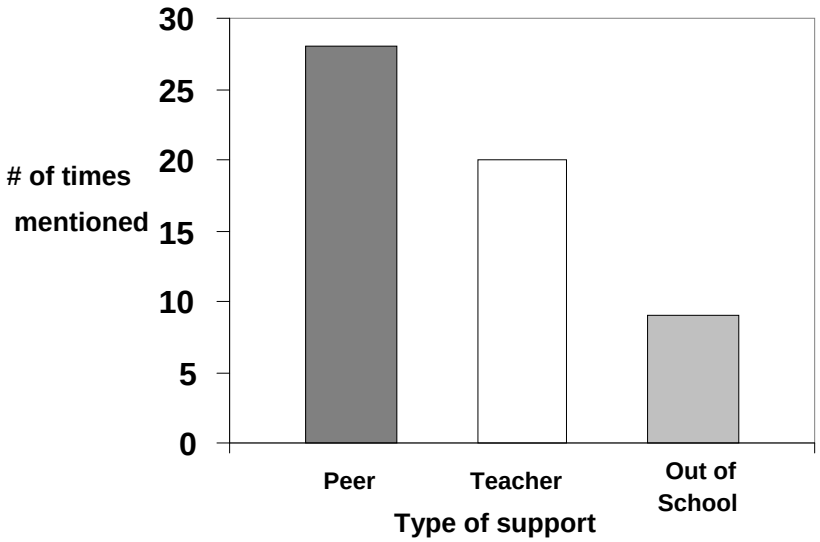

Figure 6 Types of support learners received during the Astronomy quiz preparation

Peer Support

When learners work together they are provided with an opportunity to be actively engaged in the reasoning and application of concepts. This is evident in the following learners' utterances:

"No, we just listen to each other and listen which one is the best." **LG**

"If none of us know anything we either come to our teacher or we discuss amongst ourselves, we ask each….. If one person knows it and we don't know it we ask them what it is and how does it work." **LH**

How well the task is carried out is influenced by the interaction between team members. This is evident when learners coordinate their activities well and provide each other with mutual support. During their preparation learners interact with each other and they rely on each other's' understanding of concepts and this is indicated by their responses on how they assist each other in a group.

Teacher Support

Teachers can act as facilitators to help learners focus on the task and move forward toward the desired goal. Facilitators attend to team processes such as communication, meeting management, decision making, and problem solving and conflict management (Baninajarian & Abdullah, 2009). From figure 4.5, it is evident that the teacher played an important role in facilitating learners during their preparations and this is also supported by the learners' responses below.

"Yes in some place she (teacher) has helped us. She (teacher) started to show us how we can do it and then she waited for us to see if we can do it on our own. **LE**

"I think all credit is due to our teacher because he has really helped us, in preparation, the stuff that we don't understand. He's made it learning so much easier for us has explained stuff in an easier words for us to understand." **LF**

"He has dedicated most of his time mostly to us for this astronomy, he is a Maths teacher but he has dedicated it for our astronomy." **LJ**

LJs' response shows that even though the teacher is not their Natural Science teacher, because of his passion for astronomy he has dedicated most of his time to assisting them in their preparations for the astronomy quiz.

Out of school support

Learners do not have to share ideas with each other or with the help of the teacher alone, but they can get assistance from any other knowledgeable person. The extracts below show that learners discuss issues related to the quiz after school with friends or family.

"I have some friends who are really interested in astronomy it's just unlucky that they couldn't get the chance to be part of the group." **LG**

"Yes we do, like at home me and my family and sometimes with my friends." **LJ**

“Yes with our parents, they also didn’t know much about astronomy until we were there.” **LH**

Nine out of ten learners interviewed indicated that they get some form of support from their friends and family. This is also evident from the learners’ responses and they also admit that even their families have benefited from their knowledge.

Comments

According to Vygotsky (1978), learners are guided by their teachers, parents and peers who have a better understanding of the concepts. Learners are then able to formulate their own path towards a solution and by doing this, eventually think and solve problems without any further assistance. When learners work together they establish a joint definition of the situation and this reflects on each members’ perspective, which then becomes of great assistance to their performance. Peer collaboration is said to develop or improve reasoning ability because the collaborative engagement and the continuous attempt for shared meaning that the learners practice as they prepare for the quiz, contribute to learning. From the interviewed learners it is evident that they had the same goal and they were expected to contribute equally to the groups’ success by being interdependent.

Research has shown that peer interaction can result in both regression and development in their knowledge acquisition (Tudge, 2000) and when learners interact at the same level they yield most effective results. In the school situation the presence of a teacher helps in promoting individual effort and also congratulating them when they are doing well so the presence of a teacher when learners prepared for the quiz is of high importance. Tudge (2000) and Baloche (1998) suggest that the design and composition of a group affects how members interact with each other which in turn affect their performance. This is evident from the learners’ responses on how they work together and how they encourage and motivate one another as a team.

According to Vygotsky (1978) interaction with peers is important in social transmission as it promotes better achievement. When children have the opportunity to share experiences within the cooperative context, they continuously help each other expand their capacity for understanding Kruger (1993). Constructive peer relationships are critical in the development and socialisation of children and adolescents because if learners have poor relationships this can affect their performance (Baloche 1998).

4.4.3.5. Knowledge Restructuring and Conceptual gain

Conceptual gain occurs effectively when students construct their own knowledge to achieve conceptual change through modification of their conceptual framework (Driver, *et.al*., 1994: Vygotsky, 1978).

Knowledge Acquisition and Conceptual Gain

During learners' preparations they use various skills to assist them in knowledge gain and there is evidence indicated from their responses. All learners also indicated that they would advise other schools to participate in the quiz because they have acquired knowledge.

"They would learn lots of information that they wouldn't have known before." **(LI)**

"I would advise them to participate because it's definitely a learning experience. You learn a lot of new stuff and it's a learning experience for you and your teacher" **(LF)**

"First of all its really fun we get to really learn more about, you don't just learn about earth, you learn about other planets and galaxies, stars and you learn about other people who discovered things" **(LJ)**

"There are a lot of South African astronomers that we hear about and learn about and I think it's important because we are bidding now for that thing in the Karoo they want to put. It's very interesting that South Africa is in it" **(LF)**

From the learners' responses it is evident that the participating learners benefited from the quiz and they would advise more schools to also participate in future quiz competitions. LI indicates that participating in the quiz helped them understand things that they didn't know at first and they would also encourage other schools to participate. All learners agreed on the benefit of the quiz as a platform for learning more astronomy that is not taught in detail in their classrooms.

Comments

Jean Piaget (2003) in his work was mainly concerned about how scientific thinking came about and how knowledge grows He rejected many assumptions that were made by previous researchers that children are miniature adults but instead he claimed that each particular age has a distinct quality of thought. Piaget's theory is based on the idea that as the child develops he builds or constructs cognitive schema or mental structures for understanding and responding to physical experiences within the environment. Their knowledge acquisition is then shaped by experience and the surrounding environment. People construct knowledge everyday but not all of

it is useful and mainly it has to be influenced by the environment. In order for knowledge to be meaningful, learners must be given an opportunity to engage in knowledge construction and this is evident in the way learners prepared for the quiz.

In order for learners to successfully construct meaningful knowledge they need building blocks such as concepts so as to acquire knowledge. It is clear from Ozdemir & Clark's (2007) review of conceptual theories and Duit & Treagust (1995), that conceptual change is viewed as an internal cognitive process that happens in broader situational, cultural and educational context and is influenced and facilitated by social processes. The teacher can provide a socio-cultural environment to encourage collective participation from learners by engaging them in a more interactive lesson. Principles such as scaffolding, co-constructed knowledge, dialogue and cultural tools (Mercer, 2005) are all important components of a learners' knowledge acquisition. Tudge & Winterhoff (1993) assert that peer collaboration may lead to cognitive development and this is fundamental to learning.

When learners are in small groups, deep understanding and comprehension is enhanced and this leads to the likelihood of information being exchanged between learners which can the lead to conceptual gain. In this study it was not easy to measure the impact of the quiz in learners' conceptual change as only a few questions were used to identify if learners gained any new concepts.

4.4.4. Summary of Interview data

In section 4.4 I have described the data collected during the research and presented an analysis of the data collected from interviews.

When looking at motivational aspects that influenced learners' participation in the quiz, we find that learners from all the five schools had shared goals and objectives. These goals are an overall understanding of the role of the team, its responsibilities and the things the team wants to accomplish. Learners had high expectations in participating in the quiz. They stated mostly reasons around interest, winning and knowledge acquisition. According to Henderson and Walkinshaw (2002) effectiveness pertains to the accomplishment of the goals and objectives as defined by the requirements of the project, while performance pertains more closely to how well the task-work and teamwork is carried out. Effective relationships between group members can yield positive results in terms of performance in a set task (Giuliodori, Heidi, Lujan and Di Carlo, 2006; Rao & Di Carlo, 2000). From the learners' responses they showed commitment to their goals and support to each other in order to achieve the set goal. With the facilitation from the teacher it was easier for the teams to function effectively and learners learnt new skills and in those teams which were more effective the output was enhanced.

The interview results suggest that collaborative testing may be an effective strategy for improving student learning and potentially for the retention of content. The results also suggest that children can assist each other's thinking in the course of collaborative problem solving, as predicted by Vygotsky and Piaget. Piaget argues that what distinguishes successful from unsuccessful peer collaboration is the presence of socio-cognitive conflict. In most studies, success is predicted by engaged discussion of the issues, including explanation, clarification or revision of ideas. For an effective team there should be a compelling and dynamic picture of the desired end result created by the participants.

In Chapter 5 I present the discussion and findings of the study and the conclusions.

Chapter 5: Discussion and Conclusions

5.1. Summary of the Study

The research has examined how the participation of selected learners in the quiz promotes learning about astronomy.

In chapter 1, I laid the foundation for the work done and gave some background on the research undertaken. This was done by looking at the role played by SAASTA in coordinating the Astronomy quiz and the collaboration with science centres. Science Centres act as facilitators and they are the ones who liaise with the Department of Education, schools and learners in order to ensure the smooth implementation of the Astronomy quiz project. In this chapter I also looked at our curriculum and how the use of the quiz enhances it, as well as at the status of astronomy in South Africa and how learners involved in the quiz can can contribute to the pool of astronomers in our country, in the future.

In chapter 2, I reviewed a number of literatures on conceptual change in astronomy, collaborative testing and peer collaboration. The theoretical framework was also formulated in this chapter. This was according to the work of Deutch (1949), Piaget (1964) and Vygotsky (1978).

In chapter 3 the methodology followed in the research was discussed. The qualitative research methodology was followed and the pilot study explained in this chapter. The research instruments used were also explained in detail in this chapter. When conducting research it is important to note limitations and also explain the methods used to ensure reliability and validity of the study. These are also covered in chapter 3.

In chapter 4, I then presented the data obtained from both the observations and interviews. To be able to answer research sub-question 1 I used data obtained from observations and the data from interviews was then used to also answer both research sub questions.

5.2. Answering Research Questions

The first research sub-question which guided my study is *"How does a selection of learners prepare collaboratively for the SAASTA astronomy quiz?"*

In answering this question the analysis of results show that the participating schools had different approaches when preparing, although they had a shared goal of winning the quiz. Looking at

different schools' results based on observations and interviews; learners from the Sun PS on their preparation day were given the previous years' question paper to answer individually and this did not provide them with an opportunity to interact with each other well. The other four schools were working collaboratively. Collaborative learning is a way to get learners to actively participate in their learning and the use of this strategy seemed to prepare learners well for the quiz competition. Learning is influenced by interactions, interpersonal relations, and also the way participants communicate with each other.

The aim of collaborative learning is also to help those in the group attain knowledge from the other learners, develop skills that are important for functioning in various other situations and to encourage all within the group to work towards a common goal. While collaboration can help create well rounded learners, it is still not yet sufficiently established. From their interviews, learners indicated how often they meet to prepare for the quiz and from the analysed results it is clear that when they meet frequently they have a better chance of improving their performance and attitude towards each other (Johnson and Johnson, 1989; Slavin, 1994).

Cortright, Collins, Rodenbaugh & Di Carlo (2003) in their study on collaborative testing found that it is an effective strategy to enhance learning and also learners' retention of content is increased. This was found in the learners from Universe primary who went through to the final round of the quiz. Collaborative group testing has also been found to enhance learners' performance compared to when they work individually. The questioning style used in the astronomy quiz is multiple-choice, Rao and Di Carlo (2000) in their study discovered that students perform better on these kinds of questions after discussing among each other. When learners work together they are provided with an opportunity to discuss their reasoning for an answer as well as receive feedback of their contributions and performance in the given task. This is also important in providing learners with a platform to discuss incorrect answers and fill in knowledge gaps (Cortright *et al.,* 2003). Learners are also given an opportunity to discuss questions and when they work together they get to understand the material better and enhance relations. When learners collaborate, their knowledge is shaped overtime by their successful conversations and creates an environment that motivates learning. This is because when learners collaborate, they are motivated not to just understand material but also to encourage all members to understand the fundamentals of knowledge.

Learners indicated the importance of sharing information because it allowed them to develop trust among each other and hence minimises conflict. Johnson & Johnson (1989) refers to this act as resource interdependence which is the method used in a task to share resources necessary to achieve specific goals. Resource interdependence could be in the use of identical information or complementary information (Buchs, Butera & Mugny, 2004; Ortiz, Johnson & Johnson, 1996;

Johnson, Johnson, Ortiz & Stanne, 1991). When learners use identical information this can reinforce their comparison of competencies whereas when working on complementary information they access only one part of the information and therefore become dependent on their team-mates to access the rest of information.

In the beginning of the quiz learners were given identical information in the form of booklets and this enabled them to discuss material on the same level. According to Buchs *et al.,* 2004, relying on the same material promotes confrontations among members of the team and this on the other hand can give rise to social comparisons which might not be beneficial. When learners were preparing for the second round and the rest of the quiz they were allowed to use additional material and this enabled them to be more dependent on other members. Teams have been found to work better and learn more when using different resources to enhance their conceptual understanding. Working on complementary information also strengthens the relationships amongst peers and reinforces learners' efforts while promoting cooperation.

Collaborative learning has been found to have a positive impact on many variables such as improved performance, attitudes towards school, self-esteem and the ability to work collaboratively (Johnson and Johnson, 1989; Slavin, 1991).

The second research sub-question which guided my study is *"In what ways do learners perceive the astronomy quiz to be valuable in increasing their knowledge and interest in astronomy?"*

In an attempt to answer this question, interview transcripts from all learners had to be analysed thoroughly to try and find out if there was evidence of knowledge acquisition. Learners can acquire knowledge from peers or from a more capable adult such as a teacher. Research has proven that when learners work together they learn better than when working individually (Hudgins *et al.,* 2007, Jensen *et al.,* 2002, Rao & Di Carlo 2000, Rao *et al.,* 2002; Slusser & Erickson, 2006; and Lusk & Conklin, 2003). In its simplest form, learning is associated with the acquisition and retention of knowledge and when learners prepared for the quiz there was evidence of knowledge gain from their discussions.

Several studies point out that it is through a shared activity that more complex constructs of knowledge are attained, further acknowledging that knowledge is not fixed or given but that knowledge is shaped, constructed and reconstructed in different social settings. In analysing the above statement, the following concepts are of importance, that there is equal and active participation expected from each member of the group, as well as working together to achieve a common goal.

The concept of peer collaboration has proven to be of importance in my study because it promoted learner participation and improvement in their abilities. Another benefit of collaborative learning found in this study is acknowledgement of individual differences because all learners have their own different ideas of certain astronomy aspects and when they engage in discussions they get an opportunity to hear different perspectives. They also learn to relate to their peers in a group as they work together. Furthermore, OBE emphasises the need to bring to the surface the local, hidden and silenced knowledge and everyday realities of the learners. A strong case can be made that teacher intervention is significant in the success of group learning. Success is not only dependent on learners interacting within a group but the attitude with which the learner approaches the task, the level of motivation, and interpersonal factors. Although it is not advisable to generalise these findings due to the limited number of participants, my findings agree with Zinicola (2003) and Gokhale (1995) that collaborative testing is useful in developing understandings among learners who work on the same task through sharing ideas and co-constructing explanations.

5.3. Implications and Recommendations

The study examined how learners interact in their groups and also whether there is evidence of knowledge acquisition. Science teachers all over the world are looking for ways to make science learning meaningful and more understandable to their learners and this means that various teaching strategies are employed. These strategies should employ the social constructivist approach to learning. Social constructivism claims that for knowledge to be internalised and a framework established, collaboration must first take place. Various approaches to achieve this have been put forward in literature but teachers may not be able to decide which of the methods will work for them unless they are tried out.

Several researchers have conducted studies on peer collaboration and how it enhances performance but I believe further research is needed to examine relationships between the types and methods of assistance used by peers in their groups.

The challenge in my study was to measure conceptual change as explained by Hewson (1992) and this was due to the fact that learners' understanding was not measured/ recorded in the beginning of the study. There is no clear indication that learners did not know some of the concepts prior the quiz but they mentioned this only during interviews. Learners indicated that they have gained information from participating in the quiz. It is then recommended that in these kinds of studies learners' understanding is tested before the study and after to measure impact and to be able to get all the data needed to make an argument. Further research is needed to

understand the role of each member of the team during collaboration because in this study I only looked at how they interact.

The use of an astronomy quiz to promote science has proven to be very good and this was expressed by many learners in their interview responses. With the positive results from this study I would recommend that SAASTA exposes more learners to the astronomy quiz and also competitions of this nature should be promoted to high school learners, with the aim of enticing more to follow science related fields. This will enable schools such as Universe Primary to be able to enter at a higher level of the competition. In the National finals the Universe Primary school came second out of ten schools representing various Provinces. From the observation results followed by interviews conducted with these learners it is evident that the learners' hard work and interdependence with each other paid good dividends.

According to my knowledge, this kind of study has never been done in South Africa. The study covered a small sample and hence the results cannot be generalised to all quizzes. It would therefore be important that the study be repeated at other age groups of learners from different schools to see if similar findings will be obtained.

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APPENDIX A

Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 • Private Bag 3, Wits 2050, South Africa
Tel: +27 11 717-3007 • Fax: +27 11 717-3009 • E-mail: enquiries@educ.wits.ac.za • Website: www.wits.ac.za

Student Number: 97145564H
Protocol: 2008ECE219

14 August 2008

Mrs Anacletta Koloko
4A Gamtoos Drive
Ext 4
NORKEM PARK
1618

Dear Ms. Koloko

Application for Ethics Clearance: Master of Science

I have a pleasure in advising you that the Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate has agreed to approve your application for ethics clearance submitted for your proposal entitled:

Investigating learners' participation in an astronomy quiz

Recommendation:

Ethics clearance is granted

Yours sincerely

Matsie Mabeta
Wits School of Education

Cc Supervisor: Dr. A Lelliott (via email)

SUBJECT INFORMATION SHEET

RESEARCH TOPIC: INVESTIGATING LEARNERS' PARTICIPATION IN AN ASTRONOMY QUIZ.

My name is Anacletta Koloko currently registered for Masters Degree in Science Education with Wits University. The focus of my research is on the astronomy quiz project which is funded and facilitated by the South African Agency for Science and Technology Advancement (SAASTA). The objective of the study is to investigate how learners prepare for the quiz and get their perceptions of the quiz in terms of whether there has been any evidence of conceptual gain on basic astronomy. I will also be looking at the educators' involvement during the learners' preparation for the quiz. This involves observations and interviews with learners, which will be audio taped and then analyzed.

Please take note that participation in my study is absolutely voluntary and no harm will come to you. I will treat all the information 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 which will be used will be fictitious.

Thank you

Teachers' questionnaire

This questionnaire is only for getting information about the learners participating in the quiz and is not going to be used as one of the instruments for the project. Please note that no real names of the school or educators are going to be used for recording data and reporting of the project.

Name of School: _____

Name of Educator: _____

Subjects Taught: _____

Number of learners in: Grade 6_____ Grade 7_____

Learners in the Quiz:

	Boys	**Girls**
Grade 6		
Grade 7		

Criteria used to select learners participating in the quiz:

_____

_____

_____

_____

_____

_____

_____

When do learners meet to prepare for the quiz? During school hours or after school?

If after school how many times a week _____on which days_____ and for how long _____

As an educator how do you assist learners during the quiz preparation?

_____

4a Gamtoos Drive
Extension 4
Norkem Park
South Africa
9th July 2008

The Astronomy Quiz project coordinator
SAASTA

Dear Sir/ Madam

RE: Application to conduct research using the astronomy quiz project.

I hereby request permission to use the astronomy quiz for my research project. I am enrolled for a Masters degree (Science education) at the University of Witwatersrand under the supervision of Dr. Anthony Lelliott.

The purpose of the study is to investigate how learners prepare for the astronomy quiz. The study will look at what perceptions learners have regarding the values and objectives of the astronomy quiz and what role the teacher plays during the preparation. I plan to work with this teacher and her learners who are willing to participate in the study.

During the data collection process I will observe the group of learners as they prepare for the third round of the quiz and interview them. The observation will be recorded while the interview responses will be audio taped.

All the information collected in this study will be kept confidential and used only for the purpose of this study. No names or personal details of participants or the name of the schools will be revealed in reporting the outcomes of the study. If you require more information regarding the project you can contact me or my supervisor by email or phone.
I hope my request will be successful.
Yours Faithfully

Anacletta Koloko Telephone: 012 392 9300
Email: anacletta@saasta.ac.za

Supervisor
Dr. Anthony Lelliott Telephone: (011) 717 3413

Email: anthony.lelliott@wits.ac.za
4a Gamtoos Drive
Extension 4
Norkem Park
South Africa
13th May 2009

The Principal

Dear Sir/ Madam

RE: Application to carry out study in your school.

I hereby request permission to collect my data using your school. I am enrolled for a Masters degree (Science education) at the University of Witwatersrand under the supervision of Dr. Anthony Lelliott.

The purpose of the study is to investigate how learners prepare for the astronomy quiz. The study will look at what perceptions learners have regarding the values and objectives of the astronomy quiz and what role the teacher plays during the preparation. I plan to work with this teacher and her learners who are willing to participate in the study.

During the data collection process I will observe the group as they prepare for the third round of the quiz and interview them. The observation will be recorded while the interview responses will be audio taped.

All the information collected in this study will be kept confidential and used only for the purpose of this study. No names or personal details of participants or the name of the school will be revealed in reporting the outcomes of the study. Participants are free to withdraw at any time during the study and where possible information collected on such participants will not be used in the study. If you require more information you can contact me or my supervisor by email or phone.

Yours Faithfully

Anacletta Koloko Telephone: 012 392 9300
Email: anacletta@saasta.ac.za

Supervisor: Dr. Anthony Lelliott Telephone: (011) 717 3413
Email: anthony.lelliott@wits.ac.za

APPENDIX B

Consent form for learners' participation in the study

I, ……of ……(school) have read and understood the procedures involved in the study and what is expected of me as a participant. I willingly give the following consents:

Please put a tick in the appropriate box

☐ I am willing to participate in the study
☐ I am **not** willing to participate in the study

☐ I give consent for being observed during the astronomy quiz preparation.
☐ I **do not** give consent for being observed during the astronomy quiz preparation.

☐ I give consent for part(s) of my written preparation work to be checked if necessary
☐ I **do not** give consent for part(s) of my written preparation work to be checked if necessary.

The extra copy of this form is for you to keep.

Thank you.

---------- ----------

Signature of learner ***Date***

Name *(Please print)*

Recording Consent form for Learners

Please put a tick in the appropriate box

☐ I give consent for being audio and videotaped

☐ I **do not** give consent for being audio and videotaped

☐ I give consent for audio and video tapes with me in them resulting from this study to be shown at academic conferences, workshops and seminars

☐ I **do not** give consent for audio and video tapes with me in them resulting from this study to be shown at academic conferences, workshops and seminars

☐ I give consent for audio and video tapes with me in them resulting from this study to be used for purposes of research, publications, teacher education and training programmes

☐ I **do not** give consent for audio and video tapes with me in them resulting from this study to be used for purposes of research, publications, teacher education and training programmes

☐ I give consent for audio and video tapes with me in them resulting from this study to be kept for up to five years if necessary

☐ I **do not** give consent for audio and video tapes with me in them resulting from this study to be kept for up to five years if necessary

The extra copy of this form is for you to keep.

Thank you.

---------- ----------

Signature of learner ***Date***

APPENDIX C

RESEARCH INSTRUMENTS - PILOT STUDY

Observation Schedule

Evaluation scale
1. Very evident
2. Evident
3. Slightly evident
4. Absent

Name of the School:.....

Name of Teacher:.....

Date of the session observed:.....

Name of observer:.....

SECTION A: TEACHERS' ROLE IN THE QUIZ PREPARATION.

PART 1: Introduction of the session	**1**	**2**	**3**	**4**
1. The teacher secures learners' attention.				
2. Clarify aims of the session.				
3. Issues out additional material.				
4. Provides links to previous session.				

PART 2: Organisation of the session	**1**	**2**	**3**	**4**
1. Teacher adopts a structured approach.				
2. Emphasises key astronomy points.				
3. Provides alternative explanations.				
4. Makes good use of additional resources/material.				
5. Explains learners' tasks effectively.				
6. Gives support and guidance to learners				
7. Teacher plays a supportive role when the learners are working in groups.				
8. The teacher mediates feedback from the group effectively.				

SECTION B: LEARNERS' ROLE

PART 3: Learners participation and interaction	**1**	**2**	**3**	**4**
1. Effective use is made of groups.				
2.The teacher allocates roles to the individual group members.				
3.Learners are given the opportunity to use their own words and ideas.				
4.There are opportunities for learners to explain and elaborate on their answers.				
5. The teacher restrains dominant learners.				

PART 4: Learner behaviour	**1**	**2**	**3**	**4**
1.The learners are confident to answer questions.				
2.The learners participate actively in the learning.				
3. The learners are willing to answer questions.				
4.There is evidence that the learners can work effectively in groups				

PART 5: Teacher / learner relationship	**1**	**2**	**3**	**4**
1. The teacher establishes a warm atmosphere.				
2. The teacher is open and flexible.				
3. Praise and encouragement is used appropriately.				
4. The teacher makes sure that the learners have a record of the work they have done together.				
5. Teacher ends the session positively and clearly.				

Learners' Interview Questions

Introduction:

Interviewer introduces herself, explains the purpose of the interview and goes through the ethical issues.

Questions posed to the learner by the interviewer before the third round of the Astronomy quiz..

(The interviewer writes learners' responses on a separate sheet.)

1. What are your favorite subjects? Why?
2. At what grades in the Natural Science learning area did you learn about the sun, moon, planets, galaxy etc.
3. Are you interested in anything that has to do with the universe and space science? If yes, specify?
4. Do you think there is life elsewhere in the universe? Why?
5. Can you tell me more about the role played by South Africa in Astronomy?
6. How have you been preparing for the quiz?
7. Do you think your method of preparation has helped you to get to the third round? How?
8. If there is anything you could change about the way you prepared for the astronomy quiz what could it be?
9. What expectations do you have for you and your team-mates in participating in the quiz?
10. Would you advise any other schools that have never participated in the quiz to participate? Why would you / would you not?
11. How has your teacher assisted you in your preparation for the quiz?
12. Do you prefer working individually or collaboratively in a team?
    If you prefer to work as an individual, why?
    If you prefer a team, has working together helped you in progressing until this round.?
13. You were given material to use to prepare for the quiz, have you been able to source additional material elsewhere?
    If yes, what were your sources and have they been

APPENDIX D

Observation Schedule

Name of the School: Galaxy PS

Name of Teacher: V

Date of the session observed: 28/05/2009

Name of observer: Anacletta Koloko

SECTION A: TEACHERS' ROLE IN THE QUIZ PREPARATION.

PART 1: Introduction and organisation of the session. The teacher.....	**Comments**
1. Secures learners' attention.	Yes, by making ~~to~~ sure that they ~~wde~~ have their material ready.
2. Clarify aims of the session and emphasises key astronomy points.	The session is on names of people who have made contributions in Astronomy
3. Explains learners' task and issues additional material.	Talking them through what they are supposed to do & updates them on the latest news about the space shuttle that landed on the 25th passing over South Africa
4. Plays a supportive role when the learners are working in groups.	Yes, all throughout the session the teacher was very supportive.
5. Mediates feedback from the group effectively.	Teacher was mediating in most cases and demonstrating to them so that they can get clues for the answers. Feedback was also given well.

SECTION B: LEARNERS' ROLE

PART 2: Learners participation and interaction	Comments
1.Effective use is made of groups in terms of interaction with one another. i.e Are learners group oriented or self-oriented in achieving tasks.	Learners were given list of names to work on and the teacher asked them questions. They had to come up with the correct one from discussions. There is evidence of group oriented support from learners.
2. Evidence of roles assumed by learners.	Yes, about three of the four learners assumed leadership roles & only one looked like she was more of an observer, with minimal contribution.
3.Learners use their own words and ideas, they also explain their answers with minimal assistance from the teacher.	The teacher was playing a major role and learners were more like followers but answering questions well.
4. Learners listen to each other attentively.	Yes, they were giving each other a chance.

PART 3: Learner behaviour	Comments
1. The learners participate actively in the learning and motivate each other.	There is evidence of active participation in
2. The learners are confident to answer questions.	Yes, 3 out of four seemed to be outspoken and able to answer questions.
3. The learners are willing to answer questions.	Yes, there were interesting discussions in coming up with answers & where they didnt have trouble they were very willing to answer. eg Steeve Hawking
4.There is evidence that the learners can work effectively in groups	The teacher took a leading & guiding role in order to make learners work more effectively in their group.
5. There is evidence of positive interdependence; i.e there is one set of materials for each group.	Learners all had the same copies of the notes given by the teacher and the booklet from SAASTA
6. There is evidence of individual accountability; each task is divided into jobs, with a different job for each member.	Learners had to prepare for the session individually and then the task was discussed in groups in the form of questions

PART 4: Teacher / learner relationship	Comments
1. Both the teacher and learners are open and flexible.	Yes, they were discussing the work together showing thorough preparation. From their contributions there is evidence of flexibility & the teacher was listening to them whenever they had something to say.
2. Praise and encouragement is used appropriately.	learners were commended on their good participation and praise was given for correct answers and encouraged to study hard for the 1st round.
3.The teacher makes sure that the learners have a record of the work they have done together.	All learners were given the same extra material to prepare for the next session.
4. The session ends positively and clearly.	

Observation Schedule

Name of the School: Earth PS

Name of Teacher: N

Date of the session observed: 31/07/2009

Name of observer: Anacletta Koloko

SECTION A: TEACHERS' ROLE IN THE QUIZ PREPARATION.

PART 1: Introduction and organisation of the session. The teacher.....	**Comments**
1. Secures learners' attention.	The teacher ensures that learners have all the material they need for the session.
2. Clarify aims of the session and emphasises key astronomy points.	Revises work from previous session and tells them what they should focus on today.
3. Explains learners' task and issues additional material.	Yes, revising a few astronomy concepts.
4. Plays a supportive role when the learners are working in groups.	Yes where learnes needed assistance the teacher was there to assist.
5. Mediates feedback from the group effectively.	Not much evidence of feedback

SECTION B: LEARNERS' ROLE

PART 2: Learners participation and interaction	Comments
1.Effective use is made of groups in terms of interaction with one another. i.e Are learners group oriented or self-oriented in achieving tasks.	Learners worked on the given task well in their groups. They showed evidence of being group oriented.
2. Evidence of roles assumed by learners.	All learners assumed the same roles, they were giving each other a chance to answer questions
3.Learners use their own words and ideas, they also explain their answers with minimal assistance from the teacher.	In their discussions learners were explaining concepts in their own understanding and language.
4. Learners listen to each other attentively.	Yes they were listening to each other.

PART 3: Learner behaviour	Comments
1. The learners participate actively in the learning and motivate each other.	Yes but moderately
2. The learners are confident to answer questions.	They were hesitant in the beginning but showed confidence in the middle of the session.
3. The learners are willing to answer questions.	With the encouragement from their teacher they were able to answer questions asked
4.There is evidence that the learners can work effectively in groups	Moderately because the teacher had to intervene most of the time when there were misunderstanding
5. There is evidence of positive interdependence; i.e there is one set of materials for each group.	Had similar notes provided by the teacher and the booklet. The teacher had prepared notes for learners.
6. There is evidence of individual accountability; each task is divided into jobs, with a different job for each member.	No, learners were working on the same task.

PART 4: Teacher / learner relationship	Comments
1. Both the teacher and learners are open and flexible.	Yes, the teacher guided learners through work and learners were free to ask questions and for assistance from the Teacher.
2. Praise and encouragement is used appropriately.	When the learners had provided a correct responce, praise was given.
3.The teacher makes sure that the learners have a record of the work they have done together.	At the end of the session the teacher went thrugh the summary and learners reminded of what to prepare for the next session.
4. The session ends positively and clearly.	Yes.

Observation Schedule

Name of the School: Mars PS

Name of Teacher: X

Date of the session observed: 09/09/2009

Name of observer: Anacletta Koloko

SECTION A: TEACHERS' ROLE IN THE QUIZ PREPARATION.

PART 1: Introduction and organisation of the session. The teacher.....	**Comments**
1. Secures learners' attention.	Yes, getting them to settle down
2. Clarify aims of the session and emphasises key astronomy points.	Learners are reminded of the aim of the quiz and emphasis is put on important aspects of astronomy.
3. Explains learners' task and issues additional material.	Yes, but there was no additional material to be handed out.
4. Plays a supportive role when the learners are working in groups.	Observed learners as they engage in the preparation.
5. Mediates feedback from the group effectively.	Tried to mediate where there was a need.

SECTION B: LEARNERS' ROLE

PART 2: Learners participation and interaction	Comments
1.Effective use is made of groups in terms of interaction with one another. i.e Are learners group oriented or self-oriented in achieving tasks.	Learners interact well with each other. Very optimistic to win the astro quiz this time.
2. Evidence of roles assumed by learners.	One learner acted as a leader by finding out if other members knew their parts well.
3.Learners use their own words and ideas, they also explain their answers with minimal assistance from the teacher.	Learners tried very hard to work alone without the assistance of the teacher
4. Learners listen to each other attentively.	With one member controlling the group, it seemed easy for members to listen to each other.

PART 3: Learner behaviour	Comments
1. The learners participate actively in the learning and motivate each other.	learners were encouraging each other and they participated satisfactorily in their groups.
2. The learners are confident to answer questions.	2 of the learners were very confident and quick to answer questions asked by their teacher.
3. The learners are willing to answer questions.	The whole group ~~was~~ demonstated readiness and were willing to answer
4.There is evidence that the learners can work effectively in groups	Learners showed good control of their situation and this was evidence that they can work effectively with each other.
5. There is evidence of positive interdependence; i.e there is one set of materials for each group.	At this stage learners were allowed to use additional resources and share information with their peers.
6. There is evidence of individual accountability; each task is divided into jobs, with a different job for each member.	The task that was given to learners in the previous session was divided into ~~tasks for~~ individual tasks and learners had to report back during this session.

PART 4: Teacher / learner relationship	Comments
1. Both the teacher and learners are open and flexible.	Yes, teacher very supportive
2. Praise and encouragement is used appropriately.	Learners were encouraged to work hard as their performace depended on each ones commitment
3.The teacher makes sure that the learners have a record of the work they have done together.	Learners were told to make a summary of the work covered during this session.
4. The session ends positively and clearly.	Yes, last session before the 3rd & 4th round. Teacher motivated learners & wished them luck in the competition.

Name of the School: Universe PS

Name of Teacher: J

Date of the session observed: 21/10/2009

Name of observer: Anacletta Koloko

SECTION A: TEACHERS' ROLE IN THE QUIZ PREPARATION.

PART 1: Introduction and organisation of the session. The teacher.....	**Comments**
1. Secures learners' attention.	Yes, learners were reminded of the purpose of the quiz and their readiness.
2. Clarify aims of the session and emphasises key astronomy points.	The session is on everything learners are expected to know for the astroquiz competition.
3. Explains learners' task and issues additional material.	Learners had newspaper clippings on the latest developments in astronomy. The teacher took them through the expectations of them winning the quiz.
4. Plays a supportive role when the learners are working in groups.	At this stage the teacher didn't seem to be playing a big role. Learners seemed ~~ready~~ well trained to work alone.
5. Mediates feedback from the group effectively.	The teachers mediation was minimal.

SECTION B: LEARNERS' ROLE

PART 2: Learners participation and interaction	Comments
1.Effective use is made of groups in terms of interaction with one another. i.e Are learners group oriented or self-oriented in achieving tasks.	The learners used groups skills effectively. They interacted with each other well.
2. Evidence of roles assumed by learners.	All members played an important role in making their group function. Each member assumed a role when answering questions.
3.Learners use their own words and ideas, they also explain their answers with minimal assistance from the teacher.	From their discussions, learners have had exposure to using different ~~not~~ resources and they were able to explain concepts without assistance from their teacher.
4. Learners listen to each other attentively.	They were giving each other a chance and also listened attentively.

PART 3: Learner behaviour	Comments
1. The learners participate actively in the learning and motivate each other.	There is a positive mood in this group and all members participate actively in the group.
2. The learners are confident to answer questions.	Yes, they were willing to answer questions and all members seem confident.
3. The learners are willing to answer questions.	Yes, very optimistic
4.There is evidence that the learners can work effectively in groups	learners had structured their work in a way that shows their preparedness and divided it into sections. This shows that they were working well in their group.
5. There is evidence of positive interdependence; i.e there is one set of materials for each group.	At this stage of the quiz, these learners have additional material from library, teacher internet and the given booklet.
6. There is evidence of individual accountability; each task is divided into jobs, with a different job for each member.	Each member has a role to play. Some are card raisers but coming to the right answer was the groups decision.

PART 4: Teacher / learner relationship	Comments
1. Both the teacher and learners are open and flexible.	Yes, they have a good relationship
2. Praise and encouragement is used appropriately.	The teacher ~~pro~~ motivates them and praise is given all the time. They were also congratulated to go thus far in the quiz.
3.The teacher makes sure that the learners have a record of the work they have done together.	Teacher Summarises the session and ensures that learners are prepared for their next ~~sess~~ session.
4. The session ends positively and clearly.	Yes

APPENDIX E

Interview Schedule

Name of the School: .....

Name of Learner: .....

Date of the session: .....

Name of Interviewer: .....

	Interviewer	Learner A
Motivational	1. Okay ehm,What expectations do you have for you and your team-mates in participating in the quiz? What do you expect out of the quiz	I expect that all of us.. all of us we have interest in everything and every question that we would be asked and know the answers of the questions that we will be asked.
	2. Would you advise any other schools that have never participated in the quiz to participate? Why would you / would you not?	Yes, because this quiz gives us more information that we didnt know at first.
	3. If one member of the group has problems understanding content, How would you help them?	I will try to make sometime and maybe explain to her what.....oh try to explain to them
	4. Have you had any conflict with each other? If you had, how have you handled it?	No
	5. What motivated you to participate in the quiz? Why are you participating in the quiz?	Because I have a lot of interest in science and I want to know what is happening at the space.

	6. Do you reward each other in a group? How?	No, I don't think so.
Social Cohesion	1. How have you been preparing for the quiz? So far how have you been preparing for it?	I have been reading books given by my teacher.
	2. Do you think your method of preparation has helped you to get to this round? How?	Yes Today we wrote a test and I passed it.
	3. Is there anything you could change about the way you prepared for the astronomy quiz? So far	No there isn't.
	4. Has your teacher assisted you in your preparation for the quiz? How has he?	Yes He took all of us and read some information and explain it to us.
	5. When you have different answers to the same question what do you do? As a group.	We take one answer, if we agree to that answer
	6. Do you ever take different roles or you just observe? Do you ever like participate, umm, okay	I participate. yes
	7. Does your teacher intervene when there is conflict or does he let you resolve issues on your own?	Yes he does intervene
	1. What are your favourite subjects at school?	Maths, ehmmm, Maths, Art and Natural Science

Cognitive	2. At what grades in the Natural Science learning area did you learn about the sun, moon, planets, galaxy etc. Since you are in Grade 7 now, tell me something you learned.	At Grade 5, but I didnt learn that much cause I learned only about planets that we have 9 planets, now I know about the sun is a star not a planet.
	3. Are you interested in anything that has to do with the universe and space science? Anything you are studying now, Is there anything specific you like? You can use your language.	Yes, I'm interested in, Please repeat the question
	4. Do you think there is life elsewhere in the universe? What makes you think so?	I dont think so, because I have never seen anyone live for more than ten years there.
	5. Can you tell me more about the role played by South Africa in Astronomy? What is happening that you know of?	Hmmm.... please repeat the question No
	6. What resources/methods have you used to learn the astronomy content?	I've been reading books
	7. Do you discuss things related to the quiz outside school hours?	No
	8. What methods of practice do you use as a group. Do you ask each other questions?	We dont ask each other questions we dont do it as a group.

	Or What do you do? Okay that will be enough.	We just read books and if our teacher asks us questions we will be able to answer them.
	Interviewer	**Learner B**
Motivational	1. Okay ehm,What expectations do you have for you and your team-mates in participating in the quiz? What do you expect out of the quiz	I want to be a scientist
	2. Would you advise any other schools that have never participated in the quiz to participate? Why would you / would you not?	Yes To have information and to have knowledge about the universe
	3. If one member of the group has problems understanding content, what do you do to assist him/her?	Can you explain I would ask questions to her or him or then if they dont understand I try to give them clues
	4. Have you had any conflict with each other? If you had, how have you handled it?	Ja..everyday, but not in this group.
	5. What motivated you to participate in the quiz? Why are you personally participating in the quiz?	To know, exactly what is happening about the universe, you see. I want to have more knowledge and more information and tell people. I want to be a scientist.
	6. Do you reward each other in a group? Like if somebody is doing	Ja we do, when they pass the test I am(pause) I'm going to tell them and congratulate them

Social Cohesion	1. How have you been preparing for the quiz? Since you are part of the quiz how have you been preparing?	Can you explain I was reading books, since last year Mr X gave us books for those who are now in high school, last year I was in Grade 6 so every time when I am at home I read, especially Maths and Natural Science.
	2. Do you think your method of preparation has helped you so far? How?	Yes
	3. Is there anything you could change about the way you prepared for the astronomy quiz? So far You can speak in Sesotho	Where Yes I can, I could change and Nkanna ka change hore ke thuse batho ba kgone hoitse the way nna keitseng ka hona (I can change so that people know the way I know)
	4. Has your teacher assisted you in your preparation for the quiz? How has he?	I always work alone and when I dont understand I ask the teacher.
	5. When you have different answers to the same question what do you do? As a group.	I'm choosing two of them, let me see maybe its four different answers, I choose the two and maybe one of them is right.
	6. Do you ever take different roles or you just observe? Do you ever like participate. Ha le bereka kaofela do you take part	I dont understand I'm taking part
	7. Does your teacher intervene when there is conflict or does	Yes he does

	he let you resolve issues on your own? As I've asked earlier	
Cognitive	1. What are your favourite subjects at school?	Mathematics and Natural Science
	2.At what grades in the Natural Science learning area did you learn about the sun, moon, planets, galaxy etc.	Ja, in Grade 6 and Grade 7 and we learned most about the sun.
	3. Are you interested in anything that has to do with the universe and space science? What exactly Ke eng o e ratang mo subjecting e ya astronomy	Yes Please speak in Sesotho Mo di subjecting, Ke.. universe and in our solar system
	4. Do you think there is life elsewhere in the universe? Why are no not sure?	Nehhh, I'm not sure. Because I still remember in one other planet, I dont know, they wrote that that planet has life, I dont know because I have never visited that planet.
	5. Can you tell me more about the role played by South Africa in Astronomy? What is happening that you know of?	No
	6. What resources/methods have you used to learn the astronomy content?	I'm using my computer at home

	7. Do you discuss things related to the quiz outside school hours?	No
	8. What methods of practice do you use as a group? How do you prepare. Do you ask each other question? Or do you study alone? Okay Thank you very much.	Most I like to study alone and if I dont understand I ask others and ask the teacher.
	Interviewer	**Learner C**
Motivational	1. Okay, What expectations do you have for you and your team-mates in participating in the quiz? What do you expect out of the quiz	I expect us to get far because we learned a lot and I hope we learn a lot more and we have more insight about astronomy because its so interesting and we want to go far in life with it. It doesnt matter if we dont win the competition cause we have learnt a lot already.
	2. Would you advise any other schools that have never participated in the quiz to participate? Why would you / would you not?	Yes I would strongly, it learns you a lot and its very interesting
	3. If one member of the group has problems understanding content, What do you do to assist him/her?	We all sit together and we ask the teacher to explain it to us all again and we discuss until we understand.
	4. Have you had any conflict with each other? If you had, how have you handled it?	No ,we get along very well
	5. What motivated you to participate in the quiz?	We heard about it and we talked about who would like to be in it and

	Why are you participating in the quiz?	us four are friends in school so we get along well and we read about also
	6. Do you reward each other in a group? How?	Yes we do, we go eat together and we have a lot of fun.
Social Cohesion	1. How have you been preparing for the quiz? So far how have you been preparing for it?	Everyday one or two periods when we can we get together here or in the auditorium where the computers are and we go through the whole book that we have to learn and the teacher helps us a lot and we watch videos.
	2. Do you think your method of preparation has helped you to get to this round?How?	Yes it did
	3. Is there anything you could change about the way you prepared for the astronomy quiz? So far	No, because we all learn together and its a lot easier.
	4. Has your teacher assisted you in your preparation for the quiz? How has he?	Yes, very much. She writes it in a much easier, we have a lot of papers that she re-writes it for us so that we can understand
	5. When you have different answers to the same question what do you do? As a group .	We have two planets that each has to learn because its a lot of planets and the one who must learn the planet we go with but if three say its wrong we look
	6. Do you ever take different roles or you just observe?	Ohh.. I dont understand We all work together
	7. Does your teacher intervene when there is conflict or does	If its really ja, but we dont fight a lot so we can do it ourselves

	he let you resolve issues on your own?	
Cognitive	1. What are your favourite subjects at school?	The one about nature and I like English
	2.At what grades in the Natural Science learning area did you learn about the sun, moon, planets, galaxy etc.	In science we learnt about all that we did here also and in Grade 6 we also learned about planets, which ones are gasses and which ones are not.
	3. Are you interested in anything that has to do with the universe and space science?	Yes, I like the space shuttles when it goes up
	4. Do you think there is life elsewhere in the universe? What makes you think so?	I dont know, it doesnt say in the bible and it doesnt also say there isnt and anything is possible. I'm open to it but no one has found anything.
	5. Can you tell me more about the role played by South Africa in Astronomy? What is happening that you know of?	There is a lot of South African astronomers that we hear about and learn about and I think its important because we are bidding now for that thing in the Karoo they want to put. Its very interesting that South Africa is in it
	6. What resources/methods have you used to learn the astronomy content?	We've learned in the internet, we have looked a lot there
	7. Do you discuss things related to the quiz outside school hours?	Yes we do
	8. What methods of practice do you use as a group. Do you ask each other questions? Okay thank you	The teacher quiz us and we must decide on the answer and then we say it..

	Interviewer	Learner D
Motivational	1. Okay ehm, What expectations do you have for you and your team-mates in participating in the quiz?	Well I think, well we've worked very hard for this so I hope we get to the next round, I think we will because we like this and we hope to get to the next round.
	2. Would you advise any other schools that have never participated in the quiz to participate? Why would you / would you not?	I definitely will, because you can learn a lot about it, there's a lot of things that I didnt know and now I know because of this.
	3. If one member of the group has problems understanding content like some astronomy things, what do you do to assist him/her?	Mostly we ask our teacher and then she eh, like she explain it until we understand.
	4. Have you had any conflict with each other? If you had,how have you handled it?	No
	5. What motivated you to participate in the quiz?	Well, Our teacher, she only began teaching at the school this year again, she asked us if we wanted to do it and she told us about it sounded very fun because we learn a lot
	6. Do you reward each other in a group? Like if somebody is doing well? How?	Do we what Whats that? Yes we always do we would say “Yeh well done, Go team”
	1. How have you been preparing for the quiz? So far how have you been preparing for it?	I cant memorise, I just learn and in between periods she calls us and at break we come and then we sit down then she tells us more about

		it and then we go and learn
Social Cohesion	2. Do you think your method of preparation has helped you to get to this round? How?	I definitely think so
	3. Is there anything you could change about the way you prepared for the astronomy quiz? So far	I dont think so
	4. Has your teacher assisted you in your preparation for the quiz? How has she?	She definitely has, because like I said she helps us everytime when she calls and if we dont understand we can definitely ask her because then she tells us how.
	5. When you have different answers to the same question what do you do? As a group.	Well, we do like, because we all learn, so when I have a different answer and all three have the same answer we will go with the most because
	6. Do you ever take different roles or you just observe? Do you participate as a leader sometime or	She gave us all some, because we use the small booklet she gives us, everyone of us little parts with what we have to learn and we expect the other one who learnt the part to give the answer
	7. Does your teacher intervene when there is conflict or does he let you resolve issues on your own?	We haven't got any conflict, so I dont know really
	1. What are your favourite subjects at school?	English and Natural Science
	2. At what grades in the Natural Science learning area did you learn about the sun, moon, planets, galaxy etc. What exactly	I think it was Grade 5 or Grade 6. Not really but I think they told us about where we are in the galaxy and how many? They tell us about the milky way and the sun and

		what planet are we in that the inner is terrestrial planets and the outer gaseous planets.
Cognitive	3. Are you interested in anything that has to do with the universe and space science?	Well.. at first I really wasn't because I wanted to be like a vet, I still want to be one but this has really gotten to me cause every now and then I go out and look at the stars and then you see things from a different angle now.
	4. Do you think there is life elsewhere in the universe? What makes you think so?	I think so but not in our life our planet but maybe in one of the other galaxies.
	5. Can you tell me more about the role played by South Africa in Astronomy?	At first I dont really know much about it, I know about like SALT and stuff
	6. What resources/methods have you used to learn the astronomy content?	The teacher has given us the booklet about like what we have to learn and she made little notes about what we have to learn.
	7. Do you discuss things related to the quiz outside school hours?	We, both like after school we question each other
	8. What methods of practice do you use as a group. Do you ask each other questions? Or What do you do? Okay thank you very much	Mostly we quiz each other, the teacher gives us the little thing that we use to quiz each other.

	Interviewer	Learner E
Motivational	1. Okay ,What expectations do you have for you and your team-mates in participating in the quiz? What do you expect out of the quiz	I expect great things, I want us to win the competition, even if we come second place or third its still fine
	2.Would you advise any other schools that have never participated in the quiz to participate? Why would you / would you not?	Yes they must participate because its a very very teaching thing they can gain more knowledge than the knowledge they already have.
	3. If one member of the group has problems understanding content, What do you do to assist him/her?	I will try to explain to him or her in a language that she or he can interpret or understand
	4. Have you had any conflict with each other? If you had, how have you handled it?	No, we get along so well, there are no quarrels or anything like that
	5. What motivated you to participate in the quiz? Why are you participating in the quiz?	I felt like I had to learn something new about the world we live in.
	6. Do you reward each other in a group? How?	Yes we do, we congratulate each other
	1. How have you been preparing for the quiz?	I've been reading this book here, its very full of resourceful information
	2. Do you think your method of preparation has helped you to get to this round?	Yes it has because the last time we were contesting there we tied with the other schools there; we were in the first place.

Social Cohesion	How?	
	3. Is there anything you could change about the way you prepared for the astronomy quiz? So far	No, I don't think there is anything to be changed, but we can add something, just like have some archives so that we can learn from them
	4. Has your teacher assisted you in your preparation for the quiz? How has he?	Yes she has, she has been teaching us the right things, she is the one who told us what to do when we didn't know what to do.
	5. When you have different answers to the same question what do you do? As a group .	No, we just listen to each other and listen which one is the best
	6. Do you ever take different roles or you just observe?	No, we just go with the flow, you know take it one step at a time.
	7. Does your teacher intervene when there is conflict or does he let you resolve issues on your own?	There hasn't been any conflicts
Cognitive	1. What are your favourite subjects at school?	Maths and Natural Science
	2.At what grades in the Natural Science learning area did you learn about the sun, moon, planets, galaxy etc.	I learned about the moon in Grade 4 and the sun I learned about it at Grade 5 and 6 and all the planets and galaxies
	3. Are you interested in anything that has to do with the universe and space science?	I love the universe because every time I study about it I just feel Oh.. its so amazing to know that the universe is so big, its infinite.
	4.Do you think there is life elsewhere in the universe? What makes you think so?	No, I don't really think so because I havent heard anything

	5.Can you tell me more about the role played by South Africa in Astronomy? What is happening that you know of?	We are just fine, even though we dont have the Albert Einsteins of the world but we are trying as a developing country to produce more and more astronomers.
	6. What resources/methods have you used to learn the astronomy content?	Except for this book, I do watch some television and read local newspapers
	7. Do you discuss things related to the quiz outside school hours? Like at home	I have some friends who are really interested in astronomy its just unlucky that they couldn't get the chance to be part of the group.
	8. What methods of practice do you use as a group. Do you ask each other questions? Or What do you do?	Well, we just ask each other if they did this or that and then we ask each other questions.
	Interviewer	**Learner F**
Motivational	1.Okay ,What expectations do you have for you and your team-mates in participating in the quiz? What do you expect out of the quiz	Well, we've got a lots of great expectations, like we expect a lot of stuff we are quiet confident and positive in what we do. We expect great stuff
	2.Would you advise any other schools that have never participated in the quiz to participate? Why would you / would you not?	I would advise them to participate cause its definitely a learning experience. You learn a lot of new stuff and its a learning experience for you and your teacher
	3. If one member of the group has problems understanding content, what do you do to assist him/her?	We explain to each and if its like, we divide our work like fairly we study we cover up for that person, we are quite united as a team

	4. Have you had any conflict with each other? If you had,how have you handled it?	No, Not necessarily, like I said we are quite close together, we..not share our problems.. we are united as a team.
	5. What motivated you to participate in the quiz? Why are you participating in the quiz?	Well, ehh our teachers were really exceptionally motivating, clearly in a way that they were enthusiastic and that really motivated us, and like before we we studied astronomy we really knew like nothing, I remember there was this test we wrote when they were choosing who is going to be part of the quiz. After studying from everything step by step we really gained a lot of knowledge.
	6. Do you reward each other in a group? How? Like if somebody has done exceptionally well.	Compliments are something that we keep on passing to each other and that, just like we motivate each other and our teachers motivate us too.
Social Cohesion	1.How have you been preparing for the quiz?	We've been studying like, frequently, from Tuesday we've been studying almost everyday fully we've been sitting with our teacher in the class and studying step by step and book by book.
	2. Do you think your method of preparation has helped you to get to this round? How?	Yes it has helped us a lot but if we haven't been studying so much I guess we would be with all the studying and all that we have gained a lot of knowledge
	3. Is there anything you could change about the way you prepared for the astronomy quiz?	I don't think there is anything we could change; I think the way we prepared is good enough.
	4. Has your teacher assisted you in your preparation for the quiz?	I think all credit is due to our teacher because he has really helped us, in preparation, the stuff that we don't understand. He's made it

	How has he?	learning so much easier for us has explained stuff in an easier words for us to understand.
	5. When you have different answers to the same question what do you do? As a group.	Well, if we have different views on an answer or question or something we give a reason why we say that is the answer and somehow we come to a conclusion.
	6. Do you ever take different roles or you just observe?	We do have our roles, We've got our leader, our card raiser
	7. Does your teacher intervene when there is conflict or does he let you resolve issues on your own?	You mean conflict between us four. So far we haven't had conflict that we are united as a group we are like best friends. There's no conflict really.
Cognitive	1. What are your favourite subjects at school?	English and Science
	2. At what grades in the Natural Science learning area did you learn about the sun, moon, planets, galaxy etc. Tell me some things you learned	Well, we learnt a bit of it this year in science, I don't think we learnt much last year about astronomy. Last year we done more in crops and farming, this year we did more on solar system and the milky way
	3. Are you interested in anything that has to do with the universe and space science?	Well there's lots of stuff that keeps us interested. A book on astronomy grabs our attention any minute, there's a lot of stuff, the study of the universe, milky way, planets are something else and the pictures are like something else to mesmerise you.
	4. Do you think there is life elsewhere in the universe? What makes you think so?	So far, I dont know what Baenstein has found. I dont think so There are no signs from what we've learned about life elsewhere only Mars can have a possibility of life.
	5.Can you tell me more about the role played by South Africa	I think South Africa has made its name quiet famous in astronomy.

	in Astronomy? What is happening that you know of?	Portrayed a good amount of knowledge, it's the only country in Africa that has a Radio Telescope. We are on our way in becoming as famous as America and Russia
	6. What resources/methods have you used to learn the astronomy content?	Books, learning books, articles, ….
	7. Do you discuss things related to the quiz outside school hours? Like at home or with your friends.	Basically what we discuss is the fun part of it.
	8. What methods of practice do you use as a group? Do you ask each other questions, quiz each other? Or What do you do?	We do quiz each other we like read out loud and then we like read out loud so its like you memorise so that its there in your brain.
	Interviewer	**Learner G**
Motivational	1.What expectations do you have for you and your team-mates in participating in the quiz? What do you expect out of the quiz	Me and my team mates when we started the first round we've always wished to come to the nationals of this astronomy quiz, we wanted to win the telescope for our school and we are hoping for our science teacher he is making a programme for our school its like an astronomy night so we have big expectations.
	2.Would you advise any other schools that have never participated in the quiz to participate? Why would you / would you not?	I would say they should participate, because astronomy there is a lot to learn like how the universe began and like the atoms, what we are made up of
	3. If one member of the group has problems understanding content,	If none of us know anything we either come to our teacher or we discuss amongst ourselves, we ask each if one person knows it and

	What do you do to assist him/her?	we dont know it we ask them what it is and how does it work.
	4. Have you had any conflict with each other? If you had, how have you handled it?	We've never had any conflict, like we joke around with each other and that like builds our relationship.
	5. What motivated you to participate in the quiz? Why are you participating in the quiz?	From this year, I saw last year how well they did and they got awards so this year before even our teacher gave us the test I want to take the test so I can do astronomy.
	6. Do you reward each other in a group? How?	Yes, we tell each other we are doing great, well done, we are going to win the quiz.
Social Cohesion	1. How have you been preparing for the quiz?	From the starting after we won the fourth round when we got our books we already said we are going to study during holidays and our teacher said everyone has their categories to study and from Tuesday we've been sitting in this class and studying.
	2.Do you think your method of preparation has helped you to get to this round? How?	Yes I think it has helped. In the first round we used to sit break time every time at break time we study and when it's like the last moment when we need that time we sit in our teacher's class and he teaches us and he explains to us that's how we learn.
	3. Is there anything you could change about the way you prepared for the astronomy quiz? How could you	I think that we need a bit more time so there is not much pressure like if we had more time to study and if there are more questions in the quiz so then we can answer them.
	4. Has your teacher assisted you in your preparation for the quiz?	He has dedicated most of his time mostly to us for this astronomy, he is a Maths teacher but he has dedicated it for our astronomy

	How has he?	
	5. When you have different answers to the same question what do you do? As a group .	We discuss it amongst each other and look for the logic in all the answers in all the answers to answer the question.
	6. Do you ever take different roles or you just observe?	No we all have our leader and our card raiser and we all discuss none of us are higher that the each other we are all equal
	7. Does your teacher intervene when there is conflict or does he let you resolve issues on your own?	Like I've said it earlier, we don't have any conflict in our team.
Cognitive	1. What are your favourite subjects at school?	Maths, Science, Arts and Culture
	2.At what grades in the Natural Science learning area did you learn about the sun, moon, planets, galaxy etc.	Well. In grade 4 we learnt a little about the moon like the phases of the moon and in Grade 7 we've had a few assignments about the sun, the earth and we are learning more.
	3.Are you interested in anything that has to do with the universe and space science?	I think that I am interested in a few things in space
	4.Do you think there is life elsewhere in the universe? What makes you think so?	I don't think so because they have sent things up, they have looked for signs but still nothing from what I've learnt I don't think there is.
	5.Can you tell me more about the role played by South Africa in Astronomy?	South Africa did a great role from Astronomy in South Africa with the places like HartRAO and all other places like the astronomy quiz we are doing can help the youth of South Africa maybe when they grow up can become the best astronomy place in South Africa.

	6. What resources/methods have you used to learn the astronomy content?	We've used our books we have even the ones from prices, libraries, internet, our teachers some of them have little knowledge in that so we discussed it and put all the information together
	7. Do you discuss things related to the quiz outside school hours? Like at home	Yes we do, like at home me and my family and sometimes with my friends
	8. What methods of practice do you use as a group. Do you quiz each other or ask each other questions?	Well, we sit together at break times and we quiz each other with the group and we ask each other questions.
	Interviewer	**Learner H**
Motivational	1.Okay ,What expectations do you have for you and your team-mates in participating in the quiz? What do you expect out of the quiz	We have great expectations, like learning more harder so to be future astronauts so that South Africa is more recognised
	2.Would you advise any other schools that have never participated in the quiz to participate? Why would you / would you not?	I would like to encourage them to participate in astronomy because they really have to know where they come from exactly.
	3. If one member of the group has problems understanding content, what do you do to assist him/her?	Better explanation, making it more easier
	4. Have you had any conflict with each other? If you had,how have you handled it?	No
	5. What motivated you to participate in the quiz?	Most probably the teachers, like firstly I knew nothing but they saw

	Why are you participating in the quiz?	that I've got potential for something, like when you teach me something I'm like very interested to know more about it so like the teachers really helped me a lot.
	6. Do you reward each other in a group? How?	Yes we do, with compliments
Social Cohesion	1.How have you been preparing for the quiz?	Studying hard and coming to class each break instead of going and eating and gossiping we like here and studying and learning
	2.Do you think your method of preparation has helped you to get to this round? How?	Yes it has because of like we've been sitting down and whoever has new information comes in, guys come I have something new; discuss the matter with us so that we can also understand the latest information.
	3.Is there anything you could change about the way you prepared for the astronomy quiz?	When I like reach home, instead of playing or doing something I would take a newspaper and get more information from a newspaper
	4.Has your teacher assisted you in your preparation for the quiz? How has he?	Yes he has, like when he is teaching he like sits down and instead of relaxing he takes an astronomy book and sets questions for us.
	5. When you have different answers to the same question what do you do? As a group.	We explain how you get different answers so that we can get an equal answer all together.
	6. Do you ever take different roles or you just observe?	Yes we do take different roles especially in our group, like we will say someone is better in this, studying the moon than planets then that

		person will study the moon not planets.
	7. Does your teacher intervene when there is conflict or does he let you resolve issues on your own?	As I have said we have no conflict, no problems.
Cognitive	1. What are your favourite subjects at school?	My favourite subjects are Maths, English and Science
	2.At what grades in the Natural Science learning area did you learn about the sun, moon, planets, galaxy etc.	Most probably Grade 7 like the milky way. I didnt even know that the milky way is a galaxy actually, I didnt even know that I live in the milky way, when I knew about the milky way I was asking “can I see the Milky way , Can I see the Milky way” but not knowing that I live in the milky way.
	3.Are you interested in anything that has to do with the universe and space science?	Yes, I am like interested in a lot of things because obviously in every term there is a different theory, so I would also like to put my theory in.
	4.Do you think there is life elsewhere in the universe? What makes you think so?	I dont think there is life as we have been studying everyday we see that Pine new 1011 went to go search but still we dont get the solution that there is life out there
	5.Can you tell me more about the role played by South Africa in Astronomy? What is happening that you know of?	It played a good role for and newspapers because like in 2002 Mark Shuttleworth was the first South African to go to space and atleast we also learn from him and we also want to become future astronauts.
	6. What resources/methods have you used to learn the astronomy content?	Internet, Charts, libraries, books that we have won, magazines
	7. Do you discuss things related to the quiz outside school	Yes with our parents, they also didn’t know much about astronomy

	hours? Like at home	until we were there.
	8. What methods of practice do you use as a group. Do you ask each other questions? Or What do you do? Okay, thank you very much.	Ja, we ask a lot of questions to each other and then suggest answers.
	Interviewer	**Learner I**
Motivational	1.Okay ,What expectations do you have for you and your team-mates in participating in the quiz? What do you expect out of the quiz	Well we hope that we win it because my team has been studying for a long time and we hope that because we've been studying a lot so we hope to win, supposedly the Muslim school are the best so we want to beat them is far,
	2.Would you advise any other schools that have never participated in the quiz to participate? Why would you / would you not?	Yes because there is a lot of talent out there that we don't know about.
	3. If one member of the group has problems understanding content, what do you do to assist him/her?	Well the whole group will assist them explaining how and what it is and she must do to understand
	4. Have you had any conflict with each other? If you had,how have you handled it?	Once when we had a break to study one of our team mates brought a friend who was very irritating so we couldn't study so what we did was we said that if she did it again she is out of the group.
	5. What motivated you to participate in the quiz?	I am very passionate about astronomy

	6. Do you reward each other in a group? How?	We applaud each other and say we, we don't do much we… say "nice job"
Social Cohesion	1. How have you been preparing for the quiz?	We get together , we study and then we ask each other questions
	2. Do you think your method of preparation has helped you to get to this round?	Yes, very much because they ask us questions and we ask each other questions and we can understand better
	3. Is there anything you could change about the way you prepared for the astronomy quiz? So far	We would like that we could spend more time together.
	4. Has your teacher assisted you in your preparation for the quiz? How has he?	Yes , he has given up his periods of teaching so that we can study
	5. When you have different answers to the same question what do you do? .	We all like ask each other if this is right and if they say yes then we all agree
	6. Do you ever take different roles or you just observe?	We do take different roles
	7. Does your teacher intervene when there is conflict or does he let you resolve issues on your own?	He lets us resolve issues on our own
	1. What are your favourite subjects at school?	Natural Science, Maths and Technology
	2.At what grades in the Natural Science learning area did you learn about the sun, moon, planets, galaxy etc.	I didn't learn much at school, my uncle is very good in astronomy so I learned a lot from him about galaxies, names of galaxies and planets.

Cognitive		My favourite planet of all is Mars, I know a lot about Mars
	3. Are you interested in anything that has to do with the universe and space science?	Yes, mostly planets, what has happened on planets, what is happening on it and what will happen of them
	4. Do you think there is life elsewhere in the universe?	Yes I do because if it was just us, how can it be just us. If we formed how we formed why cant another person in another planet
	5. Can you tell me more about the role played by South Africa in Astronomy?	Well, South Africa, we can telescopes because we have a lot of space. There's lots of people in South Africa we can try to have more people in astronomy
	6. What resources/methods have you used to learn the astronomy content?	We've gotten a lot of posters and material that has a lot of information on them.
	7. Do you discuss things related to the quiz outside school hours? Like at home	Yes we do.
	8. What methods of practice do you use as a group. Do you quiz? Okay, thank you very much.	We quiz each other
	Interviewer	**Learner J**
	1.What expectations do you have for you and your team-mates in participating in the quiz?	Okay my expectation is that we do very well hopefully we even win because of the way we've been studying a lot.

Motivational	2.Would you advise any other schools that have never participated in the quiz to participate? Why would you / would you not?	First of all its really fun we get to really learn more about, you don't just learn about earth, you learn about other planets and galaxies, stars and you learn about other people who discovered things
	3. If one member of the group has problems understanding content, what do you do to assist him/her?	You first make sure that you understand it and then you try to explain to each other
	4. Have you had any conflict with each other? If you had, how have you handled it?	We have had conflict between each other but then we try to resolve it by talking it through and agreeing to one thing
	5. What motivated you to participate in the quiz?	The stars, I love stars, I like the way they look at night, and my little sister.
	6. Do you reward each other in a group? How?	We don't really like reward each other but we do say, ja if you we not here we wouldn't have answered the question so we do applaud each other
Social Cohesion	1. How have you been preparing for the quiz?	We have been coming together in groups during school times after school reading through with each other and asking each other questions
	2. Do you think your method of preparation has helped you to get to this round? How?	Yes, by how much we've been reading and asking each other questions If you would not have known the answer to a certain question your group mate would have answered it then you learn from your mistake the next time you go and do research
	3. Is there anything you could change about the way you	No, there's nothing really I could change, if it has taken us this far.

	prepared for the astronomy quiz? What could it be	There is nothing really we could change.
	4. Has your teacher assisted you in your preparation for the quiz? How has he?	Yes, he has. After school he makes sure that we come together as groups and if we dont understand something we would go ask him and then he would go do research and explain it to us.
	5. When you have different answers to the same question what do you do? As a group.	We ask each other questions that how do you know this is the right answer and whenever we think its right we agree to one thing and that's the answer we take.
	6. Do you ever take different roles or you just observe?	We take different roles
	7. Does your teacher intervene when there is conflict or does he let you resolve issues on your own?	There's not as much conflict that needs our teacher, we can just try to resolve issues on our own.
Cognitive	1. What are your favourite subjects at school?	Arts,& Culture, Natural Science and Social Science
	2.At what grades in the Natural Science learning area did you learn about the sun, moon, planets, galaxy etc.	Actually it started this year that I knew more about galaxies, stars comets, asteroids and all..
	3. Are you interested in anything that has to do with the universe and space science?	Yes I am interested in galaxies and stars, and when they formed and how they form
	4. Do you think there is life elsewhere in the universe? What makes you think so?	I don't really think there's life elsewhere in the universe cause like on the moon you can't really breathe there but here there is oxygen and people can live here.
	5. Can you tell me more about the role played by South	I think South Africa really plays a major role in astronomy because we

	Africa in Astronomy?	have these main observatories, like Radio Observatories that can help us learn more about astronomy.
	6. What resources/methods have you used to learn the astronomy content?	We have come together as groups and we ask each other questions go to the internet find more information about observatories and astronomy
	7. Do you discuss things related to the quiz outside school hours?	Yes we do, a lot.
	8. What methods of practice do you use as a group? Do you ask each other questions? Thank you very much, that will be it.	Yes we quiz each other.