✍ Chapter 2 - Literature Review

This chapter presents the literature survey and the theoretical framework that was used in this study. The history of intelligence and measurement tests, the theory of multiple intelligences as well as the implications of the theory in school were reviewed. The assessment process using performance assessment or the use of technology and multiple intelligences are discussed. An overview of learning using multiple intelligences in the science classroom is presented in the chapter before concluding with some of the critiques of the theory of multiple intelligences.

2.1 Introduction

The role of teachers in classrooms equipped with computers remains crucial. They are especially needed, firstly, to frame the structure of learning activities and, secondly, to identify and continuously assess the processes and activities with which their learners are engaged in the classroom. Such processes and activities that have to be chosen by the teachers, depends on the initial selection of activities that will allow teachers who chose them had been of the opinion that they had at least some potential to capitalize on the inherent abilities of the learners.

Hawkridge (1990) suggests that teachers have to look out for an instructional base that will put emphasis and draw attention to possible improvement in the instructional processes and learning outcomes as learners continue using computers. McCombs and Stiller (1995) also suggests that a necessary condition that can lead to learners' success in learning using computers, is to use learner-centred instruction. Learner-centered instruction enables teachers to create situations in which rich diversity, uniqueness and individual differences in learners' talents can all be maximised for solving complex problems in the so-called real world (McCombs & Stiller, 1995). Because it has shown that in traditional educational contexts that are not learner-centred but mostly teacher-centered, the diversity, uniqueness and individual differences of learners are regarded as obstacles to learning. In view of the fact that, in such situations, it is the ability of learners

to reproduce authoritative discourses uncritically and is regarded as the one most important indicators of learning.

For the purpose of this study, an instructional base that is based on the learning activities and that is also supported by computer application considers using learner-centered instruction. Learners' distinctness and uniqueness will be attended to and taken into account, learners unique differences will include learning styles, abilities and talents as indicated by some educational psychologists and educators (Armstrong, 1994; Gardner, 1983; Piaget, 1952; Slavin, 1994; Visser, 1993; and Vygotsky, 1978). They all argue that the most meaningful learning takes place in learners if the environment encourages self-motivated and self-driven learning. Moreover, relevant and meaningful learning activities (authentic tasks) have to be used so that each individual learner can actively engage in creating his or her own knowledge and understanding. In addition, the learning environment has to be conducive where interpersonal relationships among all participants, whether teachers or learners feel appreciated and acknowledged (McCombs & Whisler, 1997).

Learning that involves learner-centered instruction also considers different ways of assessment processes of learners activities. The assessment process suggested for this type of instruction includes the use of performance assessment or alternative assessment. Performance measurement calls for learners to demonstrate their capabilities directly by creating some product or engaging to some activity (Haertel, 1992). In such kinds of performance measurement, there is heavy reliance on observation and professional judgment of the assessor in the evaluation of the responses (Mehrens, 1992). The development of performance assessments that are intended data and information on which to base the reform of curriculum and instruction are different from traditional tests. In performance assessments that are a preliminary step in curriculum and instructional reform, performance tasks will consist of open-ended tasks that require learners to write explanations, carry out a set of procedures, design, investigate, and give reasons for performance that are based on the targeted subject matter. These are then used in conjunction with innovative, multilevel scoring rubrics that give consideration to

procedures, strategies and quality of responses. Such a method of assessment is favoured over any that scores in terms of right or wrong (Pellegrino, Baxter & Glaser, 1999, p. 321).

The approach described above is located within the theory of multiple intelligences put forward by Howard Gardner (1983), in which the theory contrasts with the dominant psychometric model of assessment, and in which performance assessment is also treated with particular reference to performance abilities and open-ended digital learning tasks (Pellegrino et al., 1999). **The aim of the study is to use learner-centered instruction and performance assessment as a means of investigating the interaction between multiple intelligences and performance of the learners in open-ended digital learning tasks in a classroom situation.**

In the following sections, the literature survey focuses on the history of human intelligence and the different measurement procedures that were being used, to the exploration and development of the theory of multiple intelligences.

2.2 History of human intelligence and measurement procedures

The process of learning is always associated with intelligence. Different researchers have been trying to get the right definition of intelligence and identify the different components of intelligence in relation to learning. Traditionally, intelligence has been measured through intelligence tests and scales as shown in table 2.1. It has never been easy in understanding the nature of human intelligence and devising methods to assess it, and ever since, it has been the central problem in psychology since its inception. Hence, the definition of intelligence and measurement methods has been changing ever since with the aim of getting the right instrument to measure intelligence. Table 2.1 below shows the different intelligences and how these intelligences were measured in the modern definition of intelligence.

Table 2.1: Different intelligences and how they are assessed and measured

Psychologists /year	Intelligence	Assessment
Galton, F. (1892)	Assumed that intelligence was a function of peoples sensory apparatus and believed that intelligence was inherited.	Devised a series of tests to test reaction time, and other sensorimotor tests. Then he looked out for relationships in the contexts of individual differences. Then he started using correlation coefficient for analysis process.
Binet, A. (1905)	Intelligence is the ability to make sound judgment in a certain age – the mental age. That is the ability to judge well, comprehend well and to reason well.	Assessment was a relative measure of mental growth, where the person was scored on the basis of the number of items a child passed with reference to age.
Binet, A & Simon, T. (1905)	Developed the first intelligence test instrument for the purpose of identifying learners' intelligence.	Discarded Galton's measurement process of intelligence through sensorimotor tasks, and developed series of intellectual tasks.
Terman, L.M (1916)	Introduced the concept of Intelligence Quotient (IQ). IQ – was determined by dividing mental age (MA) and chronological age (CA) and multiplying by 100 to remove decimal points.	Lewis Terman, working at Stanford University, revised and improved Binet's tests, and were standardized, finally calling them: Stanford-Binet Test. These tests have been revised several times that is in 1937, 1960, and again in 1985.
Spearman, C. (1927)	Theorized that intelligence is a general factor 'g'. The general factor as a driving force of special skills unique to specific situations e.g. verbal ability, mathematical ability and musical ability. Believed that intelligence is inheritable.	Developed factor analysis, a statistical technique used to quantify a phenomenon which he termed positive manifold – a tendency of individuals to perform similarly across tasks. Which Spearman called 'general intelligence' or 'g'.
Thurstone, L.L (1938).	Supported the 'g' concept, but suggested instead that intelligence is always a composite of special factors, each peculiar to a specific task. He identified eight different factors of the mind – verbal comprehension, word fluency, numerical ability, spatial visualization, rote memory, inductive reasoning, deductive	Used factor analysis, a statistical measure for all the different mental abilities in form of clusters or groupings of tests.

	reasoning and perceptual speed.	
Wechsler, D. (1939 & 1949)	Intelligence is an aggregate capacity of an individual to act purposefully, to think rationally and deal effectively with the environment.	Developed a series of standardized individualized tests to measure adult intelligence – (WAIS scale) and children's intelligences (WISC scale). The tests used deviation IQ with three scores – verbal IQ, a performance IQ, and a full scale IQ.
Anderson, (1992)	Introduced the theory of intelligence and cognitive development supports reality of general intelligence.	Used psychometric tests and correlations to determine inspection time tasks, choice reaction time tasks, and average evoked potentials. Ranked by IQ scores.
Goleman, D. (1995)	Emotional intelligence - is a kind of intelligence or skill that involves the ability to perceive, assess, and positively influence one's own and other people's emotions. Emotional intelligence focuses on non cognitive aspects i.e. self awareness, self-management, social awareness and relationship management. Believes that emotional intelligence capacities are not innate talents but learned abilities.	Emotional intelligence can be measured or assessed by instruments such as – (i) Emotional Competence Inventory (ECI). This instrument works with the competencies that Goleman's research suggests and are linked to the different emotional domains, and (ii) Multifactor Emotional Intelligence Scale – tests the ability, as the person performs a series of tasks that are designed to assess how the persons ability to perceive, identify, understand, and work with emotion.
Emphasis on multiple intelligences		
Gardner, H. (1983, 1993)	Introduced the Theory of Multiple Intelligences – as the capacity to solve problems or fashion out products that are valued in one or more cultural settings. Has eight intelligences – verbal linguistic, visual spatial, logic mathematical, bodily kinaesthetic, musical, interpersonal, intrapersonal, and naturalistic.	Assessment of learners was emphasized on learners' performance strengths and weaknesses (intelligence profile) in a number of settings. Learners have to solve problems and fashion out products where multiple measures have to be used, including: portfolios, projects, journals, creative open-ended tasks. This shifts assessment away from a single quantifiable measurement of intelligence.

Sternberg, R (1985)	Identified the Triarchic Theory of Intelligence that has three components: (i) *Practical intelligence* – the ability to do well in informal and formal educational settings; adapting to and shaping one's environment; (ii) *Experiential intelligence* - the ability to deal with novel situations; the ability to effectively automate ways of dealing with novel situations so they are easily handled in the future; (iii) *Componential intelligence* – the ability to process information effectively. Includes metacognitive, executive, performance, and knowledge –acquisition components that help to steer cognitive processes.	He assesses these intelligences by using tests that allow the examiner to model each examinee's performance on tasks that represent fluid and crystallized abilities, so that component scores and solution strategy may be estimated for each individual. Tasks should include and require practical or real world intelligence.
Ceci, S. (1990).	Established the Bio-ecological Framework of Intelligence. This framework encompasses multiple cognitive potentials, context and knowledge all interwoven together. The bio-ecological framework grows from that of Sternberg's triarchic theory where Ceci argues against the notion of a single underlying 'g' (general intelligence).	Ceci argues that IQ is a score on a test intended to measure 'g' intelligence. But combines psychometric tests and various forms of evidence to support the notion of multiple cognitive potentials.

In the analysis of the human intelligence from the early definition (general intelligence) and modern definition of intelligence (multiple intelligences), there is a coherent picture of distinguishable ability factors emerging as indicated in table 2.1. These distinguishable ability factors can be arranged in three levels of hierarchical order (Snow, 1996, p. 650). These are:

- General intelligence ('g') is at the top of the hierarchy; implying that this central ability is involved in all cognitive test performances.

- Fluid and crystallized intelligences from ('g') or generalized educational achievement. Reflects the ability in cognitive tasks that impose figural spatial imagery demands.
- Multiple intelligences, that moves away from defining intelligence as general and single intelligence, with single quantifiable measurement scale (IQ).

Currently, much of the modern research on intelligence, are now more concerned with the processes of intelligent thinking than with the organization of traits that define it (Lohman, 1996). Since traditional intelligences have always focused on rather narrowly cognitive ability on particular tasks rather than on patterns of performance abilities across tasks (Lohman, 1996). Because of this focus, general theories of intelligence have been relatively rare, and sporadically in use. One notable exception is the work of Gardner (1983, 1993), who hypothesized eight different intelligences. Although Gardner's theory has received considerable popular attention, Sternberg's (1985) Triarchic theory is perhaps closer to the mainstream of modern research on intelligence (Lohman, 1996, p. 662). Both of these psychologists believe that intelligence is not unitary but is exhibited in multiple ways as summarized in Table 2.2.

Table 2.2: How the definition of intelligence has changed

Old view of intelligence	**New view of intelligence**
▪ Intelligence was fixed	▪ Intelligence can be developed
▪ Intelligence was unitary	▪ Intelligence can be exhibited in many ways-multiple intelligences
▪ Intelligence was measured by a scored number	▪ Intelligence is not numerically quantifiable and is exhibited during a performance or problem-solving process
▪ Intelligence was measured in isolation	▪ Intelligence is measured in context/real-life situations
▪ Intelligence was used to sort students and predict their success	▪ Intelligence is used to understand human capacities and the many and varied ways students can achieve or perform

Source: Silver, Strong, & Perini (2000). So each may learn: Integrating learning styles and multiple intelligences.

In all the studies that were done in finding the early definition of intelligence as shown in table 2.1, learning was estimated by performance gains on simple laboratory tasks. However, with more studies on intelligence in modern definition of intelligence, especially the theories of multiple intelligences has shown somewhat that there is strong relationships between intelligence and learning as learning tasks increase in meaning and complexity. The measurement of different learners' performance levels in different learning tasks then has to be moderated by many factors, particularly task complexity, task novelty and transfer (Ackerman, 1987; Gardner, 1983, 1993; and Sternberg, 1985). The assessment of learners' performance abilities using different methods, attempts to investigate patterns of individual differences across learning tasks.

The works of these different theorists provide summaries of varied approaches to understanding intelligence. Nevertheless, in this study, I have selected the theory of multiple intelligences because it considers learners' with diverse intelligence profiles, emphasizes the tasks that provide opportunities for learners' to work in a variety of ways and assessment of learners has to be 'intelligent fair', with emphasis on performance assessment. The assessment tools should not evaluate the learners through the lens of one or two valued intelligences which are mostly verbal linguistic and logic mathematical. Second, because the study will be conducted in secondary schools, there have been extensive empirical data showing how the theory of multiple intelligences has been used in schools and has shown positive results (Armstrong, 1994; Campbell, 1997; Gardner, 1987b; Gardner & Hatch, 1989; Hoerr, 1992; Kallenbach, 1999; and Krechevsky, 1991). The following sections consist of in-depth discussion of the theory of multiple intelligences by Howard Gardner (1983) and its application in schools.

2.3 Theoretical framework

In 1983, Gardner posited that the theory of multiple intelligences is pluralistic. He hypothesises that everybody has at least eight intelligences which reflect different ways of interacting with the world. In school situation, teachers have to structure learning activities *around* in such a way that they develop strategies that will allow learners to demonstrate multiple ways of understanding and valuing their uniqueness. In this chapter,

I will discuss the origins of the theory of Multiple Intelligences, the definition of intelligence, how the theory of multiple intelligences may be used to revolutionise the school curriculum, and how a reliance on the theory of multiple intelligences may be used to transform instruction and the alternative assessment of the curriculum and learning instruction.

2.3.1 Theory of multiple intelligences

The theory of Multiple Intelligences is a psychological theory about the nature of the human mind. It came to being as a critique of the dogma that there is a unitary intelligence which people are born with and that this unitary intelligence which psychologists measure what is loosely called intelligence (the well-known intelligence quotient or IQ), cannot be changed to any significant degree.

2.3.1.1 Origin of the theory - diverse sources of evidence for multiple intelligences

Gardner's theory of multiple intelligences is based on the synthesis of evidence from diverse sources. The theory of multiple intelligences originated from research into other cultural definitions of intelligence, evolution, biology, neurophysiology, anthropology, developmental and cognitive psychology, and psychometrics, and his experimentation and observation of children with autism.

Gardner drew upon his findings from these studies and offers instead eight different criteria to judge whether a candidate's ability can be counted as intelligence. These criteria that Gardner used to judge the existence of the intelligences are:

- Potential isolation by brain damage. Intelligence is autonomous when it can be obliterated or preserved in isolation after the brain has been subjected to trauma.
- The existence of prodigies. This refers to mentally handicapped individuals who manifest savant behaviours and other exceptional abilities.
- An identifiable core operation or a set of operations.
- A distinctive developmental history along with a definable set of expert, end state performances.

- An evolutionary history and evolutionary plausibility.
- Support from experimental psychological tasks.
- Support from psychometric findings.
- Susceptibility to encoding in a symbol system.

After this, Gardner defines intelligence in his own idiosyncratic way.

2.3.1.2 Definition of intelligence in the theory of multiple intelligences

In Gardner's classic work, *Frames of Mind: The Theory of Multiple Intelligences* (Gardner, 1983), defines intelligence generally as 'the capacity to respond successfully to new situations – to tackle a task demanded by life' (p.8). Gardner (1999b) elaborates on this general definition by further defining intelligence in *Intelligence Reframed: Multiple Intelligences for the 21st Century* as 'a bio-psychological potential to process information in a cultural setting to solve problems or create products that are of value in at least one culture' (pp. 33-34).

In these two definitions, as elaborated in these texts, Gardner asserts that intelligence is pluralistic and that it can be located in at least seven intelligences which he lists as: verbal linguistic, logic mathematical, musical, bodily-kinaesthetic, visual spatial, interpersonal, and intrapersonal. In the second book work quoted above, Gardner (1999b) added three other intelligences to the seven intelligences mentioned above. These are naturalistic, moral intelligence and existential intelligences. Gilman (2001) notes that Gardner is comfortable with declaring that a naturalistic intelligence meets the criteria that he has set himself, he is less sure about how to define and incorporate moral and existential intelligences. Naturalistic intelligence for Gardner conforms to the criteria of existence as intelligence. He therefore adds it to his list and ends up with eight kinds of intelligences. It is important for Gardner's plausibility to note that the majority of existing empirical research and available measurement tools, including Teele Inventory of Multiple Intelligences (TIMI) developed by Sue Teele (1992) and Multiple Intelligences Developmental Assessment Scales (MIDAS) developed by Brandon Shearer (1997), are based on Gardner's original theory of seven multiple intelligences.

This pluralistic definition gives us an understanding of intelligence that differs greatly from the traditional view which usually recognizes only two intelligences, namely verbal linguistic and logic mathematical intelligence. Gardner (1983) however, emphasized that although there are a number of distinct forms of intelligences that each individual possess, these intelligences can be explained as follows:

- All human beings possess all eight intelligences in varying degrees (called intelligence profile).
- Each person's intelligence profile is configured in a different way.
- Multiple intelligences can operate independently or in combination. Every individual has a unique profile of intelligences that may be manifested as different kinds of strength and weakness. These multiple intelligences can be used singly or in various combinations to solve problems and fashion products.
- One can improve the quality of education by placing learners in situations that challenge, extend and exercise their multiple intelligences (Gardner & Walters, 1985).
- A person's relative strengths and weaknesses, as reflected in the multiple intelligence profile, help to account for individual differences (Gardner, Kornhaber, & Wake, 1996).

The application of the theory of multiple intelligences tends to emphasize processes of *learning* rather than teaching. White (1988) defines learning as an active rather than purely receptive process in which people construct their own meanings and so obtain new information or knowledge. This process of construction brings all the characteristics in people that have their roots in multiple intelligences, such as existing knowledge, abilities and attitudes, into play. Because of this, the theory of multiple intelligences challenges a teacher to notice and take into account the diverse skills, abilities, talents and preferences that learner's exhibit in the classroom and to present their material in ways that will allow the multiple intelligences of learners to be recognised. This can be achieved in practice because each of the multiple intelligences has a specific set of abilities that can be observed and measured (Gardner, 1983, 1999b).

2.3.1.3 Summary of eight intelligences and their definitions

Gardner defines *intelligence* as a term under which we subsume a rational taxonomy that organizes and describes human capabilities rather than some commodity inside the head (Gardner, 1983, p.70). Intelligence is not a 'thing' but rather 'a potential, the presence of which allows an individual access to forms of thinking appropriate to specific kinds of content' (Kornhaber & Gardner, 1991, p. 155). Gardner lists the following eight intelligences and their potentials:

- *Verbal-linguistic* – This is the capacity to use spoken and written language in various settings, the ability to learn languages, and the capacity to use language to express oneself and to understand others.
- *Logical-mathematical* – This is the capacity to analyse problems logically, carry out mathematical operations and use quantitative and mathematical reasoning to investigate issues scientifically.
- *Visual-spatial* – This is the capacity to perceive visual or spatial information, to transform and modify this transformation, and to recreate visual images even without reference to an original physical stimulus. Core abilities of this intelligence include the capacity to construct images in three dimensions and the ability to draw and use visual images in ways that are similar to the ways in which airplane pilot navigators, sculptors, architects or chess players use this kind of intelligence.
- *Bodily-kinaesthetic* – This is the capacity to use all or part of the body to solve a problem, make a product, or perform in ways similar to athletes, actors or dancers. The core operations associated with this intelligence are control over fine and gross motor actions and the ability to manipulate external objects.
- *Musical* – This is the capacity to create, communicate and understand meanings embodied in sound, the ability to mentally process music, recognize pitch, rhythms, timbre (sound quality) and manipulate music to solve problems or to express understanding.
- *Interpersonal* – This is the capacity to understand the intentions, motivations and desires of other people and meaningfully relate to them: to identify what they are able to do, how to approach the world and others, what their reactions are likely to be, what they are like, and what they might be feeling. This intelligence includes the

ability to understand, act on and shape the feelings and attitudes of others for good or otherwise.

- *Intrapersonal* – This is the capacity to understand oneself, to know who one is, what one's strengths and limitations are, what one's goals and aspirations are. It is also the capacity to know what one is feeling and what one should avoid, and one's ability to distinguish between pleasure and pain and to act on that discrimination. This intelligence enables individuals to know their own abilities and perceive how best to use them.
- *Naturalistic* – This is the capacity to understand nature and the modern world by discriminating among and classifying living things (flora and fauna) as well as non-living or 'natural' things, as well as the capacity to discriminate among human beings (Checkley, 1997; Gardner et al., 1996; and Gardner, 1999b, p. 41-48).

As I have already noted above, the acceptance of Gardner's theory of multiple intelligences in an education system has several important consequences for teachers and providers of classroom instruction alike. Gardner stated that all eight intelligences are needed to productively function in a society. This is in great contrast to traditional education systems, which typically places a strong emphasis on the development and use of verbal and mathematical intelligences.

The following list of intelligences according to Kornhaber and Gardner (1991) did not include the ninth intelligence the spiritual intelligence. Gardner (1996b) made it clear that spirituality is not one of the intelligences (Emmons, 2000; and Vaughan, 2002). But later, Gardner stated clearly that, spiritual intelligence can be considered in favour of a ninth intelligence or existential intelligence, only to conclude that this putative form of intelligence is problematic. He states that:

> I have become convinced that there may be an existential intelligence that captures at least part of what individuals mean when they speak of spiritual concerns (p. 28).

Vaughan (2002, p. 19) later defines spiritual intelligence to be a concern to the inner life of mind and spirit and its relationship to being in the world. Spiritual intelligence implies a capacity for a deep understanding of existential questions and insight to multiple levels of consciousness. The fundamental questions to existence according to Gardner (2000) include - Who are we? Where do we come from? What are we made of? and Why do we die? Vaughan (2002) Who am I? Why I am here? What really matters?. Perhaps with spiritual intelligence, it can help a person to discover hidden wellsprings of love and joy beneath the stress and turmoil of everyday life (Vaughan, 2002, p. 20). From these literatures it obviously shows that spiritual and existential intelligences can not be applied easily in all the schools maybe it can be applicable in seminary schools.

2.4 Implication of multiple intelligences in schools

The reason why the theory of multiple intelligences was accepted and incorporated by many educationists and is still being used widely today, is because Gardner expanded the concept of intelligences to include areas such as music, spatial and interpersonal knowledge in addition to mathematical and linguistic ability. His theory also has numerous practical applications in the classroom because it supports and recognizes individual strengths in learners that are based on a variety of intelligences. Despite intensive critique, Gardner's theory of multiple intelligences has been widely accepted for more than twenty years now.

According to Gardner (1983, p. 390), everyone possesses eight different intelligences. Learners therefore come into a classroom with different sets of developed intelligences. This means that each learner has his or her own unique set of intellectual strengths and, by implication, weaknesses. These sets of intelligences determine how easy (or difficult) it is for a learner to learn information when it is presented in a particular manner and format. Gardner (1983) devised three main principles that we have to consider when we apply the theory of multiple intelligences in classrooms. These three principles are:

- Individuals should be encouraged to use their preferred intelligences in learning because the preferred intelligences decisively influence how a learner learns.

- Instructional activities should appeal to different intelligences.
- Assessment of learning should measure multiple intelligences (p. 390).

These are some of the obvious reasons why the theory of multiple intelligences has been used to restructure several schools curricula and their domains. For example, The Key School in Indianapolis (Blythe & Gardner, 1990), the Mather School in Boston (Hatch, 1993), and the New City School in St. Louis, Missouri (Hoerr, 1994) are schools that have used Gardner's theory to reform and restructure their curricula. Thomas Hoerr, who is also the principal of New City School in St. Louis, Missouri, says that changing his school's curriculum has had positive effects on how teachers teach, how they assess, and how they communicate with parents. In addition, the teachers in New City School are deeply committed to implementing the principles of the multiple intelligences theory and they have accepted ownership of this unique curriculum (Hoerr, 1994).

Another significant study was that conducted by Mettetal, Jordan and Harper (1997) about the attitudes of teachers, parents and learners towards the implementation of the multiple intelligences principles into their curriculum. The study was conducted at Farmington Elementary School [a pseudonym], located in North-central Indiana, which involved 520 learners. Their findings showed that the theory of multiple intelligences exerted a powerful influence on many aspects of school life, ethos and performance quite apart from the most obvious and direct way in which it changed and influenced the school's curriculum (Mettetal et al., 1997, p. 120). Learning about the theory of multiple intelligences, for example, changed the way in which teachers thought about their learners' abilities. The theory of multiple intelligences influenced teachers at Farmington to embrace the idea that their learners have diverse talents and that these talents and abilities need unique avenues of expression. It was moreover observed at Farmington that the test scores in 1995 (the year of testing) were higher than they had been before. Furthermore, scores were even higher in the second year of testing at Farmington in 1996, once the curriculum based on the theory of multiple intelligences had been implemented in all classes. A comparison between Farmington and three other elementary schools in the same school district in an eight-year period (1989-1996)

showed that only Farmington exhibited a dramatic increase in scores after the multiple intelligences curriculum had been implemented (Mettetal et al., 1997, p. 121). The increase in school scores in Farmington Elementary school can be seen in figure 2.1.

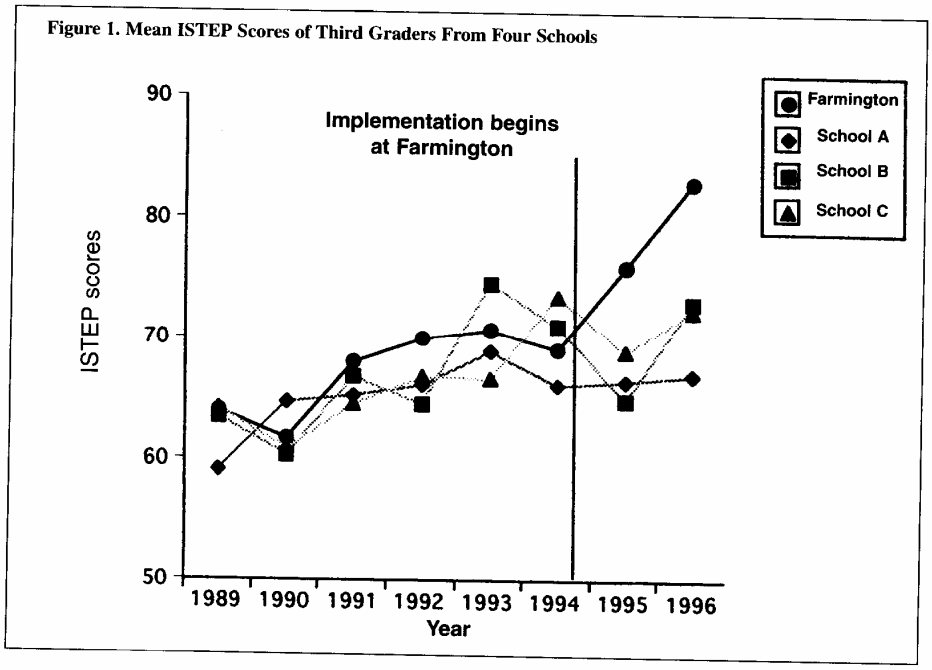

Figure 2.1: Increase in school scores in Farmington Elementary School.
Source: Mettetal, G., Jordan, C., and Harper, S. (1997).

2.4.1 Implementation of multiple intelligences in schools through the use of projects

In 1999, Kornhaber of Project Zero reported on various long-term projects from 40 different schools in the United States that have used the theory of multiple intelligences to change their curricula and didactic practice. Kornhaber, Veenema, & Fierros (2003) set up Project Zero to study 41 elementary schools in the United States for a period of more than three years (Kornhaber, 1999; Kornhaber et al., 2003). The results of the project indicated that majority of the schools linked *improvements* in the performance of the learners with learning *differences* in relation to standardized test scores, learner discipline, and parent participation in learner development after the theory of multiple intelligences had been implemented in the schools that had been surveyed.

Feldman and others initiated Project Spectrum in 1984 at the Eliot Pearson Children's School in Medford, Massachusetts (Krechevsky, 1991). The project was based on activities that used only inexpensive or otherwise easily acquired or utilised 'found' materials and inputs. Project Spectrum was a collaborative project that was undertaken by several researchers at Harvard called Project Zero in conjunction with David Feldman at Tufts University and children in schools in Medford, Massachusetts. The purpose of the project was to assess different intellectual strengths or intelligences in a representative group of three- to four-year-old children. In the end, they developed a pre-school curriculum with assessment features that were folded in at various points – that is, curriculum activities and assessment options (Hatch & Gardner, 1986; Malkus, Feldman, & Gardner, 1988; and Wexler-Sherman, Gardner, & Feldman, 1988). The focus of the curriculum incorporated authentic assessment that was located within the context of learners' work and linked to adult competences in particular domains (Cannela, 2004, p. 208).

In another study which was a replication of the study, using the instruments from Project Spectrum, was carried out in Israel by El Hassan and Maluf in 1999. It was an application of the theory of multiple intelligences in a kindergarten in Lebanon, Middle East, using Project Spectrum protocols. The study revealed that distinctive profiles of intelligences could be compiled for each of the learners who were studied. This study however, did not show that an application of the theory of multiple intelligences to the curriculum produced a significant effect on achievement as measured by the end of the year's teaching ratings (El Hassan & Maluf, 1999). The effectiveness of such applications is an important source for the validation of the theory of multiple intelligences in the education system.

Another research project, called Arts PROPEL, was undertaken by Zessoules, Wolf and Gardner in (1988) at a junior and senior high school level. The Arts PROPEL project was set up in collaboration with the Educational Testing Service, the Pittsburgh Public School system, and Harvard Project Zero. The project sought to assess growth and learning in areas such as music, imaginative writing and visual arts, all of which were said to be

neglected by most standard measures (Zessoules, Wolf, & Gardner, 1988, cited in Gardner & Hatch, 1989). The aim of the project was to develop new means of assessing intellectual competencies, particularly in the domain of arts for learners whose ages ranged between 11 and 17 years. The project also set out to identify learners who possessed intellectual strengths that are not detected by standard scholastic aptitude tests (Gardner, 1987c; Zessoules, Wolf, & Gardner, 1988). In 1990, Hatch and Gardner confirmed that children could perform differently in activities that require the use of different intelligences that are not routinely measured by standard scholastic aptitude tests. This seems to suggest that such children have distinctive intellectual profiles that would reveal strengths and weaknesses in different areas of intelligence.

The theory of multiple intelligences is not applicable and relevant only to elementary, junior and secondary schools alone. Diaz-Lefebvre (2004) noted how a project that applied the theory of multiple intelligences transformed Glendale Community College. The project was based on a practical application of teaching and authentic assessment to post-secondary learners. Diaz-Lefebvre established that the implementation of a didactic design different from the conventional one that had hitherto prevailed in that college had a noticeably beneficial effect on learners. The main reported advantage was that learners became more aware of the relevance of the materials that they were using and the knowledge content that had been selected for their curricula to life and the world beyond the college (Diaz-Lefebvre, 2004). Such assessment projects that have been established at different levels of schooling have provided evidence that reflects favourably on the application of multiple intelligences.

What therefore becomes obvious is that if schools are to benefit from an application of the theory of multiple intelligences, then all concerned should acknowledge both in teaching and in learning that *all forms of the intelligences are equally important* (Brualdi, 1996). If, for example, an individual learner possesses strong spatial and musical intelligences, that learner should be encouraged to develop those abilities (Gardner, 1983). Gardner points out that the different intelligences represent not only different content domains, but also different learning modalities. The theory of multiple

intelligences therefore implies that teachers should teach in such a way that they will elicit appropriate and creative individual responses from learners who, by Gardner's definition and according to his working hypothesis, possess a range of talents and skills that extend along the whole spectrum of the eight multiple intelligences (Brualdi, 1996).

2.5 Multiple intelligences and assessment

Because learners do not all learn in the same way, they cannot be assessed in a uniform fashion by using traditional tests (such as multiple-choice inventories, short answer questions, and matching item tests). These tests usually require learners to reveal their knowledge and skill in a manner predetermined (and therefore limited) by the tester. Advocates of Gardner's theory of multiple intelligences believe that this such tests are essentially unfair or at least extremely limited in what they can reveal, and they suggest that a better approach to assessment would require learners to explain, describe or otherwise elaborate on materials by demonstrating the proficiency with which they can apply their own unique range of intelligences to a problem. Preferred assessment methods in such cases would include learners' portfolios, independent projects, learners' journals, and authentic tasks in conditions that simulate the 'real-world' outside the educational milieu (Armstrong, 1994; Lazear, 1992). Collectively these forms of assessment are called *authentic assessment* or *performance assessment*. Alternative assessment or performance assessment is regarded by proponents of the theory of multiple intelligences as an alternative method to assessment to traditional standardized multiple-choice tests because all of them require learners to perform significant tasks and directly demonstrate competence by constructing rather than selecting responses (Worthen, 1993). The underlying premise is that, if one is to assess intelligences fairly, assessments should look for signs or evidence of all eight intelligences directly rather than through the lens of linguistic or logical intelligences.

When it comes to applying the theory of multiple intelligences in traditional educational contexts, assessment remains one of the greatest challenges in schools and the classroom situation. It is important for assessment to be integrated into the learning process and for learners to be given opportunities to demonstrate their understanding of the subject matter

and the ways in which they understand the material in the normal course of everyday teaching and learning. Teachers need to make their expectations clear and may do so in the form of a detailed rubric. Gardner believes that the use of performance assessment or alternative assessment is able to demonstrate and evaluate learners' achievements and intelligences in several different ways. Gardner asserts that the emphasis on performance assessment is well supported by the theory of multiple intelligences. He writes:

> One let us not look at things through the filter of a short-answer test. Let us look instead at the performance that we value, whether it is linguistic, logical, musical or spatial; two, let us never pin our assessments of understanding on just one particular measure, but let us always allow learners to show their understanding in a variety of ways (Gardner in Checkley, 1997).

In the following sections, I will discuss performance assessment or alternative forms of assessment that are able to assess the whole range of intelligences fairly and adequately.

2.5.1 Multiple intelligences theory and performance assessment

Thomas Hoerr (1994), the principal of New City School in St Louis Missouri, and those in his school, have integrated multiple intelligences theory into their curriculum. Hoerr argues that paper and pencil assessments do not allow one to capture or comprehend the range and diversity of learner's intelligences. He therefore works on the assumption that different forms of assessment are needed. Learners, for example, need portfolios to collect their significant work and their progress reports – all of which will profile their strengths and weaknesses (Hoerr, 1994). In such a context, the term *performance assessment* is used to describe a wide range of learner testing instruments (open-ended tasks, projects, portfolios, presentations, and the use of rubrics).

Making the right answers in a test or answering a question correctly provide some measure of performance which cannot be neglected. But, they are not authentic assessments. For a performance to be authentic, it needs to have some connection to the 'real-world' or at least a simulation of real world conditions. In other words, it must be an *application* of the learning process. A good authentic performance assessment has three qualities. These are:

- It is integrative, that is using many aspects simultaneously.
- It is applied by virtue of possessing the same complexity as do real-world roles.
- It may be individualized, although it is often group-based. Although performance assessment may be individual, it is often a group based activity in which the performance of every group member is essential for the success of the task, because both individual and group performances are evaluated for effectiveness (Bergen, 1993, p. 100).

In an actual classroom situation, teachers cannot individualize instruction for each learner. A workable alternative is for teachers to prepare activities that will offer an exciting range of activities for all the learners, activities that will allow learners to use their multiple intelligences. Different societies value different types of intelligences. Each society places a cultural value on the ability to perform certain tasks rather than others and this provides the motivation for members of a certain society to become skilled in those areas. But not everyone is equally skilled in such particular tasks. Thus, while some intelligence might be highly evolved in many people in one culture, those same intelligences might not be as developed in the individuals in another culture (Brualdi, 1996).

The reasons for selecting the use of performance assessments include the following:

- They reflect real life or authentic challenges (Hart, 1994).
- They make allowance for learner differences in performance abilities and interests (Michelle, 1992; Wiggins, 1989).
- They permit learners to engage in collaborative learning as well as other forms of assessment (Wiggins, 1991).

A change from traditional to alternative assessment practices in the assessment process requires a reconceptualization of how learning occurs (McLaughlin & Vogt, 1996; Perrone, 1991). This reconceptualization focuses specifically on the overuse of the lecture

format as a primary teaching method and on objective tests as a primary assessment measure. Where the conventional lecture format predominates, evidence for learning is generally obtained from objective tests. Because lectures consist of factual information, objective tests may indeed be the most appropriate way to assess that form of instruction (Anderson, 1998). However, objective tests may not be appropriate if instruction is more broadly based than merely dispensing information. Such more broadly based formats would include many different styles of writing, notation and transmission of information, project-based instruction and perhaps even online dialogues that promote active learning and higher order thinking skills (Sternberg, 1994).

Some researchers are of the opinion that alternative assessments should not totally replace the traditional forms of assessments such as standardized, objective tests in one fell swoop. Schools should continue concurrently to use multiple objective and subjective measures to obtain a fine distinction and a complete picture of each learner's performance abilities (Johnsen, 1996). Despite their limitations, standardized tests remain society's education gatekeeper. It is therefore important for learners to be able to do well on them. These tests, therefore, along with traditional measures of achievement such as formal essays, multiple-choice questions, portfolios, projects, exhibitions and presentations will then offer a rich comprehensive picture of a learner's progress (Hoerr, 1994). **It should be noted that alternative assessment as discussed in this study is about assessing the learner's performance (abilities) while he or she works on open-ended learning tasks in the context of a theoretical understanding and appreciation of the theory of multiple intelligences.**

The following section contains a discussion about how authentic tasks enhance multiple intelligences in classrooms.

2.5.1.1 Authentic context to enhance multiple intelligences

The classroom that I set up for my research was one in which learners were free to explore and express their multiple intelligences as they worked through the open-ended digital learning tasks. Physically, it provided learners with sufficient quantity of reading

resources that could be freely consulted and with a sufficient number of computers and basic running programmes. In this context, I used the knowledge base as indicated in the school biology syllabus and asked learners to solve realistic problems based on this knowledge base.

In a study conducted by Kallenbach and Viens (2004), provides evidence of the application of the theory of multiple intelligences in a non-traditional adult learners' class with the purpose of developing literacy skills and academic knowledge. Kallenbach and Viens used multiple intelligences-inspired instructions to effectively develop adult literacy skills. Their findings were that many adult learners possessed extremely negative self-images and that they were at first quite resistant to using apparently non-academic, unconventional and unfamiliar learning strategies (the authentic tasks). Not surprisingly, after getting engaged and involved, these adult learners had experienced repeated successes with using multiple intelligences-inspired activities in authentic tasks and multiple intelligences reflections. They came to see themselves in a more positive light as learners and this effected some profound changes in their self-concepts and contributed to their academic success.

It should be noted that authentic task is not a property of a problem but of the relation between the problem solver to the problem (Kramarski, Mevarech, & Arami, 2002). Authentic tasks are those which portray common contexts and for which there are no ready-made answers. Many learners' lower as well as higher achievers, face difficulties in solving authentic tasks (Verschaffel, Greer & De Corte, 2000). The difficulties always emanate at all stages of the solution process from the very first stage of understanding what the problem is all about, through planning the solution process and selecting appropriate strategies, to reflecting on the solution and deciding whether or not it makes sense (Verschaffel et el., 2000). Although authentic tasks are important, little is known at present on how to enhance learners' ability to solve such tasks (Kramarski et al., 2002). This is not surprising given the fact that solving authentic tasks is time consuming and therefore teachers have reservations about introducing such tasks either in ongoing instruction or in testing situations. Since many of the difficulties associated with authentic

tasks lie in the hands of teachers knowing how to design and select authentic topics that can stimulate learners participation on the task. The present study examines the use of authentic tasks in open ended digital learning tasks and learners' performance.

2.5.1.2 Use of rubrics in assessing multiple intelligences in classrooms

Rubrics are a relatively new tool that can provide alternative measures to a one-size-fits-all way of thinking while one engages in assessing the performance of learners and in identifying the strength of their different intelligences. A rubric is a set of guidelines for comparing and judging learners work. Rubrics provide descriptors of varying levels of performance and rubrics answer these questions: (1) By what criteria is performance judged? (2) What does a range in the quality of a performance look like? (3) How are the different levels of quality described and distinguished from one another?

When one has given learners open-ended tasks to complete, one judges learners' performance abilities by rubrics that are designed to assess the various proficiencies embedded in the task. As the case with most real-world tasks, performance tasks do not have a single binary-type 'answer'. Consequently, learner's performances have to be judged by one or more assessors who are guided by well-defined criteria which are spelled out in the form of a rubric.

A scoring rubric usually consists of a fixed scale and characteristics that describe performance for each point on the scale. It is the use of such performance assessments that ensures the reliability of the scores. In this case *reliability* refers to the extent to which independent raters agree on the scores assigned to learners on the various proficiencies measured within performance assessments. This is called *inter-rater reliability*. At present, because most teachers test and grade in isolation, they often end up with widely varying grades for what is really the same quality of work (Wiggins, 1992).

Although it has been suggested that alternative assessment (i.e. performance-based) can provide a more accurate measure of learner achievement and ability, problems have been cited that relate to cost, bias, training, scoring using rubrics and a deficiency in sound

psychometric characteristics (Plucker, Callahan & Tomchin, 1996). Educators need instruments for the assessment process that are quickly executable, reliable and easy to use.

In the following sections, I will discuss two assessment tools (measuring multiple intelligences) that are currently in use in many schools and have shown positive results. These tools are the Multiple Intelligences Developmental Assessment Scales (MIDAS) developed by Shearer Brandon (MIDAS for KIDS, 1997), and the Teele Inventory of Multiple Intelligences (TIMI) developed by Sue Teele (1992).

2.5.1.3 Multiple intelligences other assessment tools – MIDAS and TIMI

With increased interest in the theory of multiple intelligences, a need has arisen to identify ways that can be used to assess these intelligences at classroom level. The role of assessment in relation to learners' performances in open-ended digital learning tasks is important. In spite of this, the development of standardized, reliable assessment tools for assessing multiple intelligences has lagged behind the development of theory (Klein, 1997).

McMahon & Rose, Parks (2004) argue that if multiple intelligences concepts need to be used in classroom situations that are tailored to identify performance abilities in open-ended tasks, projects and portfolios, it is vital to develop and use reliable and valid ways of assessing learners' preferences and performance abilities. At present there are two assessment tools that are widely used in the assessment of the multiple intelligences of learners. These tools are the Multiple Intelligences Developmental Assessment Scales (MIDAS) developed by Shearer Brandon (MIDAS for KIDS, 1997), and the Teele Inventory of Multiple Intelligences (TIMI) developed by Sue Teele (1992).

2.5.1.4 Reliability of the instruments

(1) Teele Inventory of Multiple Intelligences (TIMI)

The TIMI inventory was developed by Teele (1992) to assess the preferences of learners as they adapted to a didactic format that applied the concept of multiple intelligences. This inventory tool purports to measure verbal-linguistic, logical-mathematical, visual-

spatial, musical, bodily-kinaesthetic, interpersonal and intrapersonal learning preferences (McMahon et al., 2004). Teele (1995, 1996) also indicated that the TIMI instrument has proven reliable in test-retest studies. At present, the use of TIMI has been proven by more than 1,000 schools in the United States and seven other countries (Teele, 1996). According to McMahon et al., (2004), however, the results that have been reported from using the TIMI inventory do not indicate the internal consistency of the data. Because of the widespread use of this assessment tool and the popularity of applications of the theory of multiple intelligences in educational practice, it was necessary further to assess the reliability of the Teele inventory because educators need instruments that are reliable and easy to use (McMahon et al., 2004).

To investigate the reliability of the inventory tool, McMahon et al., (2004) conducted a study in Evanston and Chicago school districts in Illinois, USA. Fourth-grade learners from three Chicago schools (nine classes) and two Evanston school (six classes) participated in the study. There were 288 learners who completed the TIMI inventory (McMahon et al., 2004, p. 45).

The results of the study after applying the Cronbach alpha test which is used to reveal the internal consistency of each intelligence subscale indicated that the internal consistency was in fact very low and therefore unacceptable (McMahon et al., 2004, p. 46). Logical-mathematical intelligence demonstrated the highest coefficient alpha (**.**61), while intrapersonal intelligence demonstrated the lowest coefficient alpha (**.**22). A correlational analysis was conducted to examine the relationship between each of the intelligence scores between the multiple intelligence scores and reading comprehension skills. Correlational analyses revealed three statistically significant positive associations between the intelligences: verbal-linguistic and logical-mathematical, visual-spatial and intrapersonal, and interpersonal and bodily kinaesthetic intelligences were positively correlated (McMahon et al., 2004). Apart from these positive correlations, most of the intelligences demonstrated statistically negative correlations with one another. In sum, reliability analyses for each of the subscales of the TIMI inventory tool suggested that the instrument does not provide consistent measurements and that it therefore needs further

development and refinement. This leaves us in a position in which a valid, reliable assessment tool is needed if multiple intelligences concept and interventions are to be used in schools (McMahon et al., 2004, p. 51).

(2) Multiple Intelligences Developmental Assessment Scales (MIDAS)

Multiple Intelligences Developmental Assessment Scales (MIDAS) was developed by Shearer. MIDAS is a self-reporting measure of intellectual disposition that may be completed by either the user (Shearer, 1998a), or, in the case of a young child, by her/his parent (Shearer, 1998b). MIDAS tool is not a decontextualized test of abilities. It is instead a systematic strategy for describing a person's intellectual and creative life in the real world. After completion, the learner is assisted to validate the information by means of reflection, feedback and discussion. The resulting 'verified multiple intelligences profile' then serves as a 'self-discovered' focus for curriculum development, instructional approaches and career planning.

Accompanying interpretive materials were uniquely designed to promote the development of interpersonal understanding for this instrument. Additional materials were devised to assist teachers, parents and counsellors to understand, teach and guide learners. The overall goal of the MIDAS project was to see how multiple intelligences assessment could enhance classroom instruction and self-directed learning (Shearer, 1999).

Numerous studies of its reliability and validity (Shearer, 1991; Shearer & Jones, 1994) have indicated that the MIDAS scales can provide a reasonable reflection of a person's multiple intelligences, strengths and weaknesses that also correlates coherently with external rating and criteria. The MIDAS scales have been translated into Spanish and Korean and completed by approximately 10,000 people worldwide. In short, the MIDAS provides an effective method of obtaining a self-descriptive profile of one's 'multiple intelligences'.

What matters is that learners be given opportunities to use their multiple intelligences and thus be *seen* to be successful in carrying out tasks that require multiple intelligences. Such assessments would bring us closer to a conception of intelligences as 'actual live operations in the world' rather then latent or theoretical potentials in the brain.

2.5.2 Standardized tests and their problems

Testing dates back to the early years of the 20th century when Alfred Binet was asked by the French government to devise a test that would distinguish those children likely to need remedial help from those likely to perform well in school (Gardner, Kornhaber, & Wake, 1996) as quoted by Feldman (1998). These intelligence tests that were developed by Binet were soon succeeded by the Intelligence Quotient (IQ) test which attempted to calculate a child's mental age versus chronological age. Over the years, these IQ tests have come to be regarded as an all purpose measure of an individual's intellectual worth and potential (Feldman, 1998, p. 4). In fact, however, because of the original brief given to Binet, namely to predict academic performance, they reflect that narrow band of verbal linguistic and logic mathematical skills that have traditionally helped learners do well academically (p. 4). Hence, learners who possess strengths that are different from these types of reasoning had little opportunity to demonstrate what they know or can do (Feldman, 1998).

Critics are currently pointing out that intelligence tests are culturally biased and that they require a familiarity with the vocabulary, phrasing, concerns and social conventions of the hegemonic culture in which they find themselves (traditionally a Western European culture but latterly the dominant 'Anglo' culture of the United States). Furthermore, intelligence tests require individuals to perform mental functions outside of a context, rather than in the course of normal ('real life') activities. In addition, many traits that individuals use for solving problems such as determination, imagination, leadership, and social understanding, cannot be addressed by intelligence tests (Feldman, 1998). Because standardized tests are generally in the form of multiple-choice questions so that they may be scored by a computer, only one right answer is admissible. This is also quite unlike real-life situations in which solutions cannot be framed in a binary form. Questions are

thus presented out of context and tend to emphasize recollection of fact and isolated computations or simplistic deductions, rather than the kind of higher order thinking and problem solving skills that learners will need for the market place of their future (Feldman, 1998, p. 5).

Although standardized test scores have been criticized by many scholars, they have remained as the essential yardstick of learner and school success. Additional basic research into alternative approaches to assessment has shown the potential to move the field of education forward. Researchers such as Gardner (1993), Krechevsky and Gardner (1990) support alternative assessment procedures that take the biases of standardized tests into account, that are based on ranking and comprehensively measuring what learners have learned. Since alternative assessment has shown that intelligences can be identified and brought into everyday teaching and learning, more likely schools should be in a position to adopt alternative assessment methods as a way of assessing the performance of the learners who are gifted because their intelligence is spread over a wider range of multiple intelligences rather than being confined to the verbal linguistic and logic mathematical part of intelligence spectrum.

2.6 Multiple intelligences and technology

Technology is increasingly becoming an integral part of teaching and learning in educational institutions. The realistic question in such circumstances is: ‘How can we use technology more effectively for learning?’ (Olina & Sullivan, 2004). With the introduction of computers in schools, there is need to free learning from its unproductive and essentially sterile didactic design in which learners absorb knowledge and then reproduce it and establish it in terms of teaching and learning paradigms that require learners to grapple with real-world conditions (or simulations thereof) and so actively construct their knowledge in ways that people do in real life (Kirschner; 2004, p. 42). Learning needs to be situated in problem solving activities that reflect real-world contexts (Brown, Collins, & Duguid, 1989) where the environment is rich in information and where there is no one right answer (i.e. where knowledge is ‘embedded’) (Kirschner,

2004). It has long been evident that meaning can be negotiated through interactions with others and that multiple perspectives on reality harmoniously can co-exist given the right attitude, understanding and conditions (von Glasersfeld, 1988).

As stated earlier technology already exists in schools, however, to completely fulfil the requirements of learning for all the learners who have different intelligences, there is need to increase potential systems to support teaching and learning by using multiple intelligences theory. Since technology is changing the nature of personal existence, society and future employment opportunities, there is an increasing pressure on schools to reflect such changes and so at least be relevant to the changing personal needs and vital interest of individuals and the requirements of society beyond schools (Murphy & Greenwood, 1998).

Schools need to commit themselves unequivocally to preparing learners to function adequately as self-realising human beings and professional workers in an evolving technological society. Such a commitment obviously requires a radical change in pedagogy. Attention therefore needs to be given the possible improvement of instructional process, to the handling of information, to problem solving and to the achievements of learning outcomes by the use of computers (Blom & Smolenaars, 1992). At present learners who have chosen ‘computer subjects’ are only being taught how to use various computer applications. Such minimal operations include how to start the program, how to create a file, and how to save their work. But the main reason for having computers in schools at all is *not* to train learners in the many features of various software programs (which they might more efficiently learn from a good Help function), but rather to make these powerful tools accessible by and usable to learners so that they can collaboratively construct their own knowledge and extend their repertoire of skills (Muir, 1994). Learners, for example, would be far better employed in using computers to write stories with word processors, illustrate science diagrams with paint utilities and clip art, and create interactive reports with hypermedia and graphing data they have gathered by using spreadsheets. Learning to operate a computer and to perform basic software move

is only a secondary objective that most computer-literate learners achieve somewhat effortlessly (Muir, 1994).

The primary objective of higher-order learning is to construct knowledge and learn different ideas through projects, open-ended tasks and collaboration. This will allow learners to become more actively involved in their work as each learner brings his/her own abilities and strengths to the projects and products (Muir, 1994). Since learning through projects has been proved to be didactically effective, computers can be used as a tool to help learners to construct their own knowledge while using new information.

2.6.1 How can computers in schools be effectively integrated into teaching and learning so that they reflect multiple intelligences?

The multiple intelligences of the learners can be enhanced by using technology. If we can base our practice on Gardner's theory of multiple intelligences, we will encourage teachers to use authentic assessment to provide enrichment opportunities in each of the areas of the intellect. Teachers therefore do not have to change what they teach in basic computer skills. They are but the tip of the didactic iceberg. But teachers should ideally be able to adapt teaching techniques so that they are suited to the needs and mentality of the present-day learners. They do this by using authentic tasks that are relevant to real-world situations, tasks that are, moreover, both interesting and stimulating to learners. In addition, assessment must also be authentic and predicated on real world criteria.

2.6.1.1 Integrating technology and multiple intelligences

The application of multiple intelligences to technology is discussed as follows:

- *Verbal-linguistic* – This kind of intelligence is stimulated by the use of word processing operations that teach and vitalise language, writing, editing and rewriting skills. The Internet is also invaluable as a learning tool. Learners can use e-mails to improve their language skills by rediscovering the ancient human art of letter writing. Other applications from which learners can benefit from include programs that allow learners to create stories, poems, and essays.
- *Logical-mathematical* – This kind of intelligence is stimulated by computer programs that teach logic and critical thinking skills. Many of these are in game formats that

stimulate learner interest. There are also mathematical programs that coach learners in drill and repetitive auto-evaluating practices. Other programs from which learners might benefit include database programs such as spreadsheet programs that help learners to explore, organize and manipulate data and information. Even use puzzles that work in numbers and be able to explore patterns and relationships.

- *Visual-spatial* – This kind of intelligence is stimulated by graphic programs that help learners to develop creativity and visual skills. Browsing the Internet and organizing files may also develop spatial understanding. Other programs which learners can use to develop their visual-spatial intelligence are drawing programs such as Corel Draw, image composing programs, build designs that use 3-D modelling, paint programs (Photo Paint, Microsoft Paint), spreadsheet programs that allow learners to see and manipulate charts, graphs, maps and diagrams, and Word Art and Clip Art.
- *Musical* – This kind of intelligence is stimulated by programs that help learners to write or play music. There exists, for example, music composing software, programs that integrate stories with songs and instruments, and reading programs that relate letter/sound with music. There is also software that integrates music and musical instruments with word processors and so allows the user to write songs or combine what is thus written with input from video cameras, stereo, and multimedia.
- *Bodily-kinaesthetic* – This kind of intelligence is stimulated by using computers to help develop hand-eye coordination of the kind that is most evident in computer games. Other applications from which learners may benefit include software games that are controlled with a keyboard, a mouse, joysticks and other devices. There are also other animation programs in which objects move in various ways on the screen.
- *Interpersonal* – This kind of intelligence is stimulated when learners work collaboratively in groups of two to three on computers. Working in groups strengthens a learner's communication and cooperation skills. Other applications that can stimulate this kind of intelligence are computer games that require two or more persons, programs that allow one to create group presentations (*Microsoft PowerPoint*) be able to organize and lead others, and the many programs that facilitate interchanges and the discussion of ideas like chat programs that allow learners to exchange ideas.

- *Intrapersonal* – This kind of intelligence is stimulated by computer programs that help learners to build their individual skills. They are useful because they accommodate differences in learners learning styles and abilities. With such programs, learners who need to do so may work at their own on computers for example individualized projects, self-paced instruction. Applications that stimulate this kind of intelligence include any program that allows learners to work independently, games that involve only one person, brainstorming or problem solving software, instructional games for individuals, and word processing programs for journaling and the recording of feelings and ideas for example writing their personal diaries.

What has emerged from this discussion is that when teachers integrate technology in classroom situations, they have to remember that learners have different abilities and that teachers therefore have to use various methods and techniques for teaching and also allow learners use various methods they can and be accepted during the assessment process. In the following sections I will discuss the implications of using applications of the theory of multiple intelligences in the teaching of science subjects in schools, because open-ended digital learning tasks in this study were developed using topics from the Biology Syllabus for Secondary Schools of Tanzania.

2.7 Multiple intelligences and the teaching and learning of sciences

Hodson (1998) contends that the development of science learning and understanding requires appreciation, an awareness of the complex interactions that occur among science technologies, society and the environment, and engaging in science in such a way that expertise, scientific inquiry and problem solving are all developed (p. 5). Multiple intelligences theory has shown a potential to enhance conceptual understanding in science teaching, and has fostered positive attitudes towards science, increased enjoyment of the participation in science by creating more authentic learning experiences in science (Goodnough, 2001, p. 181). Driver and Bell (1986, p. 454) hence suggests that it is necessary “to consider a new view of pedagogical strategies which would enable learners to reflect, to construct meanings and to encourage conceptual change”. If learning has to

be encouraged in every learner, then their diverse learning needs have to be reflected through their interests, learning styles, language and culture when planning a curriculum (Goodnough, 2001). Multiple intelligences theory therefore provides a framework to help teachers make informed decisions about curriculum building activities.

Gardner's theory of multiple intelligences is a *pluralistic* conception of intelligence that offers teachers a common sense framework in which to explore their beliefs about learner abilities and science instruction, as well as opportunities to make decisions about how they should structure learning experiences for their learners and examine their own strengths and weaknesses and realise how these will impact on what they do in classrooms (Goodnough, 2001). Multiple intelligences theory is therefore a viable approach for exploring teaching and learning styles, developing curriculum, and improving assessment literacy (Goodnough, 2001).

Moreover, it is demonstrated that children perform differently on activities that require the use of different intelligences. This suggests that they have strengths and weaknesses in different areas with distinct and varied intelligence profiles (Hatch & Gardner, 1990).

2.8 Critiques of the theory of multiple intelligences

When the theory of multiple intelligences began to receive wide credence and had to be applied in practice, some scholars in the field of cognitive psychology began to question its status as a scientific theory. Some of these criticisms include the following. (1) No empirical data has been assembled to validate the theory. (2) The independence of multiple intelligences has not been tested empirically. In the process of developing his multiple intelligences theory, Gardner (1993a) considered a wide range of adult end states that are valued in diverse cultures around the world (Chen, 2004, p. 17). In order to identify the abilities that support these end states, Gardner examined empirical data from disciplines that had not previously been considered for the purpose of defining human intelligence. Gardner's comprehensive and systematic review of empirical data was from studies in biology, neuropsychology, developmental psychology and cultural anthropology (Chen, 2004). According to Chen (2004), the results of Gardner's analyses

consistently supported his emerging notion of a specific and relatively independent set of cognitive abilities. These he called *multiple intelligences*. In the end, as I have already noted, Gardner came up with eight criteria that he used to identify intelligence. As categorized by (Chen, 2004, p. 18), these are as follows:

- Two criteria derived from the evidence of biology. Intelligence has to be isolable in cases of brain damage, and there should be evidence for its plausibility and autonomy in evolutionary history.
- Two criteria derived from developmental psychology: intelligence has to have a distinct developmental history with a definable set of expert end-state performances and it must exist within special populations such as *idiot savants* and prodigies.
- Two criteria emerged from traditional psychology: intelligence needs to demonstrate relatively independent operation through the results of specific skill training and also through a low correlation to other intelligences in psychometric studies.
- Two criteria derived from logical analysis: intelligence must have its own identifiable core operation or set of operations and must be susceptible to encoding in a symbol system such as language, numbers, graphics or musical notations.

On the theoretical front, Scarr (1985) has criticized Gardner for constructing multiple intelligences on the premise that psychology regards intelligence as a unitary ability that is reflected by IQ scores. Moreover, she argues that labelling diverse abilities (or talents) such as bodily-kinaesthetic, musical or interpersonal (to name but three) as intelligence does not advance the understanding of intelligence. Instead it muddies the distinctions between intelligences and human characteristics (Scarr, 1989; Herrnstein & Murray, 1994, in Gardner et al., 1996, p. 212). Scarr (1985) argues that Gardner's claims for the various intelligences are motivated more by social than by scientific considerations. In supporting this critique, Sternberg (1998) also argues in favour of using the word 'talents' rather than the word 'intelligences'. Sternberg asks why Gardner includes some human

abilities as intelligences in the process of omitting other human abilities. Gardner's counter argument is that the common practice of regarding only skills in language and logic as intelligence reflects a well-rooted Western tradition and cultural development and that this influences intelligence testing. If we are to extend our vision and practice beyond this persistent and well entrenched bias, it is reasonable to call all these 'diverse faculties' or 'intelligences' (Gardner, 1993b, 1993c).

Other scholars question the validity of the theory of multiple intelligences on the basis of its lack of supporting scientific data (Ceci, 1996). Ceci (1996) points out that Gardner's approach of constructing criteria and then running candidate intelligences through them provides no hard evidence – no test results, for example – that his colleagues could evaluate. Brody (1992) claims that it is difficult to evaluate Gardner's theory because his book, *Frames of Mind*, presents no specific studies in support of his claims. Brody argues that a fully developed argument in favour of Gardner's theory would require the presentation of evidence establishing that each of his intelligences fulfils each of the eight criteria that are assumed to define intelligence (Brody, 1992, p. 36).

Harry Morgan (1992) argued that Gardner's index of intelligences contradicts some of the already available evidence that these kinds of intelligences resemble cognitive style constructs and intelligence quotients that were identified by Carl Jung and Jerome Kagan. Gardner (1999b), however, argues that the concept of *style* designates a general approach that an individual may apply to an infinite range of content. In contrast, intelligence is a capacity, with its demonstrable component processes that are geared to a specific content in the world (Gardner, 1999b, p. 84).

With regard to the *application* of the theory of multiple intelligences, Gardner has been criticized for not offering a clear programme for educators to use in implementing multiple intelligences theory in schools (Levin, 1994). In his own defence, Gardner notes that theories may be put into practice in different ways: some with direct guidance, and others – like those of John Dewey and Jean Piaget – by practitioners with little direct guidance from the originators. The theory of multiple intelligences has been adopted in

the latter way and numerous schools have used the theory in diverse ways (Gardner et al., 1996). Campbell and Campbell (1999) agree that the multiple intelligences approach to teaching and learning can take many formats, and that it can be implemented in many different ways and at many different levels.

Klein (1998) and Granat (1997) address the issue of the assessment of multiple intelligences. They both argue that there is not yet a recognized way to measure or assess many of the postulated intelligences within the ambit of the theory. Furthermore, they argue, some of the proposed assessments are both expensive and difficult to design, for example MIDAS and TIMI assessment scales.

However, despite critiques of the theory of multiple intelligences, it remains firmly in current use. Three main reasons have been advanced as to why the theory is still considered to be valid and why it can be used for educational purposes. These are:

- It retains a wide practical application, especially in classroom situations. Because it supports and recognizes the individual strengths and weaknesses of learners on the basis of a variety of intelligences.
- Gardner postulates more than three intelligences and explains why they are all supremely important in education.
- The theory of multiple intelligences has been successfully and creatively used in many different contexts for more than twenty years to date.

2.9 Why integrate multiple intelligences in the learning process

The reason why the theory of multiple intelligences was accepted and incorporated into school curricula and is still being used today for teaching and learning purposes, is because Gardner expanded the hitherto dogmatically limited concept of intelligences to include intelligences such as musical, spatial, kinaesthetic, intrapersonal and interpersonal intelligence (among others) in addition to the widely accepted and institutionalised mathematical and linguistic intelligences (Wilson, 1998, 2002; Brualdi, 1996; Campbell, 1991). The purpose of learning is to provide learners with guidance and

opportunities for learning academic material in different ways. Three basic premises of learning noted by Diaz-Lefebvre (2004, p. 51) are also be used in this study:

- It is accepted that not all learners learn or understand academic materials in the same way. In spite of this, many people accept only limited testing methods (such as single-answer tests) as the only valid means for testing human intelligence. In such circumstances, an alternative method of performance assessment is urgently needed.
- The use of alternative assessment in this study will provide choices and creative options that accentuate different intelligences. Creativity and use of personal imagination will be greatly encouraged and rewarded. The written and reflective component of the learning option format is an integral part of the learner's learning experience.
- Learners will be provided with opportunities to explore various ways of learning, of getting out of their 'comfort zones', of being creative and of having fun. The teacher is there to provide encouragement, support and confidence in the learner's ability to succeed. Ultimately, the learner is challenged to become accountable for his or her own learning behaviour.

Blythe and Gardner (1990) noted that the theory of multiple intelligences suggest some compelling alternatives to current educational practices in several areas. They impinge on:

- *Range of abilities*. It is vitally important for the theory of multiple intelligences in education to address a range of learner abilities and talents other than the linguistic and logical-mathematical intelligences that have for so long been the primary focus in most schools (Gardner, 1987b).
- *Learning environment*. By acknowledging the wide variety of variables and independent domains, multiple intelligences theory calls for an accompanying shift in instructional conditions. Typical classroom procedures rely heavily on the linguistic and logical-mathematical symbol system. A sustained hands-on practice with procedures, materials and problems in any domain are crucial to achieving deep

knowledge and skill within it. The theory of multiple intelligences theory therefore places an emphasis on learning in context and particularly on learning by means of apprenticeship.

- *Assessment measures*. Multiple intelligence theory challenges the viability of those standardized machine-scored, multiple-choice assessments which by their very nature appraise learner's knowledge through the filter of the linguistic and logical-mathematical intelligences. Each intelligence needs to be assessed directly in those contexts that call it into play.
- *Concepts of learner*. By proposing that each person possesses a distinctive combination of intelligences, multiple intelligences theory emphasizes the highly individualized ways in which people learn. For example, for a learner with high degree of spatial intelligence, the history of an area might best be introduced through art, architecture, maps and/or geography (Gardner, 1987a).

While it is accepted that Gardner's theory may be flawed, it still forms the basis for this study as it is the most widely recognized, broadening of the traditional theories of intelligence, and thus allows for more creative options in teaching and learning.

2.10 Multiple intelligences and assessment process

The purpose of this study does not only want to identify those areas in which learners are particularly strong. The open-ended digital learning tasks that have been built into the research design do indeed allow learners to demonstrate their individual learning strengths, whether strong or weak. But it also enables the researcher to obtain information about how learners manifest themselves over a variety of different tasks. This process is guided by one main question: **How do learners with different intelligences engage with or execute open-ended digital learning tasks?**

Because it is self-evident, even to the casual, non-scientific observer, that human abilities or talents are distributed unevenly among the population, the term *intelligence* is used to describe the apparent endowment that any particular individual with those gifts that what people generally understand as intelligence (Child 1997). But psychologists who have

studied the phenomenon of human intelligence in various ways agree firstly that individuals are unique. Second, people differ in their ability to understand abstract ideas, to reason in critical and logical ways, to express themselves creatively, to adapt themselves effectively to environmental challenges, and to apply information that they have obtained from dealing with one situation to other situations (Teele, 2000, p. 1). Teele (2000) points out that intellectual performance may vary on different days and in different ways when we measure them with a variety of criteria. Being able to identify and measure differences is important to teachers and parents because they should be able to recognize learners' and children's cognitive strengths and weaknesses since many learners and children possess special skills and particular abilities that are not readily evident (Feldman, 1998).

Child (1997) notes that it is difficult to discover the scholastic potential of a learner from simple observation of schoolwork or from the use of standardized tests of intelligence because such tests focus primarily on the kind of *verbal-linguistic* and *logical-mathematical* intelligence that are currently so highly valued in our civilisation. And as for observing a learners' performance in schoolwork and school room tasks, it is well known that many highly gifted and talented learners perform very poorly in such tasks for a variety of reasons that have nothing to do with intelligence, talents or abilities. There is a real danger that the teachers will continue to use the combination of observation of schoolwork and standardized tests of intelligence together as the benchmark for measuring a learner's intelligence and therefore his or her worth when both these forms of assessment have been shown to be seriously inadequate and certainly deficient as a means for understanding the wider concept of intelligence that is suggested in the theory of multiple intelligences (Child, 1997). Teachers can obtain a far more inclusive and revealing idea of learners' capabilities by using authentic alternative assessments that allow learners to use learning resources in their own ways and as an expression of their unique combination of intelligences (Lazear, 1992).

Teele (2000) also noted that because individuals are both complex and unique, they cannot be defined by using only one kind of assessment method. Wiggins (1998) supports

this point of view when he notes that assessment can only be authentic when it is anchored in the kind of work that real people do in what by common consensus, we rightly call the 'real' world rather than in scored responses to simple questions in formats that reveal none of the complexities of real life. Because valid assessment is a true assessment of performance, it should tell us whether learners can *intelligently* use what they have learned in their learning situations and whether they can innovate in new situations (Wiggins, 1998, p. 21). In clarifying his theory of multiple intelligences, which supplies the theoretical scaffolding for this study, Gardner (1983) indicated that if we hope to obtain an inclusive understanding of learners' intelligence, the tests that we utilise should be fair in the sense that they should present learners with formats that are sufficiently open-ended and rich in potential for them to express the complexities of the multiple intelligences that each of them possesses (Gardner, 1985, 1996; Armstrong, 1994).

My study, which is based on a qualitative design, intends to use Gardner's theory of multiple intelligences, to design and create a learning environment that will foster the application of different intelligences. This process is managed by the development of three different learning tasks for the purposes of alternative assessment that utilises a performance assessment format.

2.10.1 Performance assessment approach

According to Gipps and Stobart (2003) *performance assessment approach*; *authentic assessment* and *alternative assessment* are terms that researchers use interchangeably. They variously indicate the *processes* of learning in terms of which learners are judged in the actual *tasks* that permit multiple intelligence assessment, as well as the *end performances* that are the goals of instruction (Shepard & Bleim, 1995, p. 25). In terms of this paradigm, learning is viewed as a process in which the learner actively constructs meanings by engaging in tasks that require the learner's participation in the assessment process. By engaging in these tasks, learners come to grips with the standards of performance by which they are assessed and with the need to engage in self-monitoring activities as they perform such tasks (Sadler, 1998).

The use of performance assessment therefore does not simply mean the use of alternative forms of assessment. It also means the use of alternative assessment when it is part of a carefully considered learning process (Gipps & Stobart, 2003). This section therefore begins with a review of some of the assumptions underlying alternative assessment.

Gardner (1983) locates performance assessment within the theory of multiple intelligences by contrasting the dominant psychometric model of assessment and open-ended digital learning tasks in which assessment is predicated on particular performance abilities (Pellegrino, Baxter & Glaser, 1999). The aim of the study is to use performance assessment as a means of investigating the interaction between multiple intelligences and performance of the learners in open-ended digital learning tasks in a classroom situation.

2.10.2 What is performance assessment?

Performance assessment is defined by Stiggins and Bridgeford (1982) as a systematic attempt to measure learners' abilities by using previously acquired knowledge in solving novel problems or completing specific tasks. Lazear (1992), Teele (2000), and Zeliff (2000) suggests on the use of *performance assessment* as a preferred assessment method because it includes not only standardized and criterion referenced tests, but because it also uses alternative means of assessment such as authentic and open-ended tasks and performance in independent projects in which learners are given sufficient scope for revealing the full range of their multiple intelligences. Such alternative assessment combinations give the assessor a much better chance of obtaining a systematic and detailed assessment of learners because they include checklists, scoring guides (rubrics) that are used to evaluate learner performances as they work individually and in groups, video-taped performances by learners, and academic documents that learners have completed at their leisure in an unthreatening environment. To this catalogue of assessment modalities, Lentz (1988) adds the interview process. He suggests that, assessors may also use interviews with learners, teachers and parents to gather information that are discernible through other means of assessment. It is important to note that differences between learners can be deduced from their academic performance and

their demonstration of precise performance skills that can be observed and documented outside the school walls (McEwen & McEwen, 1996; Zeliff, 2000).

Nowadays, performance assessment requires learners to demonstrate their capabilities directly by creating some *product* or engaging in some *activity* (Gardner, 1983; Haertel, 1992). Mehrens (1992) notes that alternative performance methods rely heavily on observation and professional judgment in the evaluation of the responses. The development of performance assessments that are directed at the reform of curriculum and instruction differs from traditional tests in that such performance tasks consist of:

(1) Open-ended tasks or exercises that require learners to write explanations, carry out sets of procedures, design, investigate or otherwise show evidence of reasoning as they grapple with problems inherent in the subject matter.
(2) Authentic tasks which are tasks that simulate real-world conditions and which require learners to provide evidence of skills that people use in the real-world situations
(3) Innovative multilevel scoring criteria or rubrics that take careful account of procedures, strategies and quality of responses. This method replaces methods that use only binary or right-or-wrong scoring techniques (Pellegrino et al., 1999, p. 321).

Performance assessment approaches in such cases make assessment an integral part of the teaching and learning process (Shepard, 2000). In such cases, also, the focus is directed towards the *performance* of learners (Kane, Crooks & Cohen, 1999). In the following sections I will discuss open-ended digital learning tasks, authentic tasks, and scoring rubrics.

2.10.3 Open-ended digital learning tasks and multiple intelligences

Zevenbergen, Sullivan and Mousley (2001) define an open-ended task as a task that has the potential to include a *range* of 'correct' responses so that 'correctness' in such situations encompasses a far wider range of potentials than the typical closed questions.

Closed questions are used in most teaching situations and that typically have only one 'right' answer or response. In open-ended tasks however, a variety of responses can be used as a catalyst for discussion, either among the whole class or in small groups. In such groups, learners are able to discuss not only on their responses, but also the *process* by means of which they arrived at their responses and their preferences and the contextual matrix out of which such responses arose (Goodnough, 2003). This format sets up multiple potentials and pathways that learners can explore to negotiate and arrive at co-constructed knowledge and success in performance.

When such a system is operating smoothly, learning is rescued from the rigid and often tedious formats in which there is **one** authority (the teacher) and **one** 'right' response or answer (the response or answer that the teacher has predetermined from the syllabus or other sources of authoritarian dogma). Such a multi-faceted system that draws so many different possibilities for learners to express their multiple intelligences permits learners to become more effective, efficient and responsible. What is equally important is that learners can be *seen* to be effective, efficient and responsible in those areas in which they are most capable and talented (Zevenbergen et al., 2001, p. 5). A system such as this enables even 'weak' pupils to shine and gain access to forms of knowledge and understanding from which they would have been disbarred by conventional authoritarian educational methods.

What is crucial in the assessment and learning format is that they be designed in such a way that they are *open-ended*. This requires teachers to construct and maintain pleasant, non-judgemental and yet carefully contained environments in learners will feel safe enough to expose their individual talents and abilities without fear of retribution or hostile criticism. This is vitally necessary in situations in which learners are proposing that there may be many 'right' answers and in which learners are being encouraged to demonstrate talents and abilities that are not usually paraded in conventional learning situations.

In this format, learners are encouraged to use any source of information. Even computers may be used to assist them to solve open-ended tasks. For open-ended tasks to be

interesting to learners, they have to be authentic, that is to say, they have to engage the imagination of learners so that they are able to make the necessary identification that arouses their interest. If this can be done, learners will become active in exploring possible solutions and finding possible solutions, if more than one solution is possible, which ideally should be the case. In this format, learners communicate with each other, discuss and experiment and they demonstrate what they know rather than what they do not know (de Lange, 1987).

Computers are ideal for giving learners opportunities to engage intellectually with technologically advanced tools, demonstrate personal expertise and make interpretations and representations of what they know of the world (Jonassen, 1995). Open-ended tasks also can help learners to move away from low-grade learning that is demonstrated by memorization and the mechanical recitation of facts to realms in which they use higher order thinking and processing of skills and knowledge to express different intelligences (Gardner, 1993). It is vital also to have a format that requires teamwork so that interpersonal intelligence can be expressed through collaborative learning (Goodnough, 2003).

Hannafin, Land and Oliver (1999), in Oliver and Hannafin (2001), propose four determining elements of open-ended learning environments that can enhance learning by means of learner performances. These four elements are (1) enabling contexts, (2) resources, (3) tools, and (4) scaffolds. *Enabling contexts* provide realistic (authentic) frameworks wherein problems are situated. *Resources* allow learners to frame and resolve problems. *Tools* assist learners to process, manipulate and discuss information. Teacher and tool-based *scaffolds* guide learners' problem-solving strategies and processes.

The open-ended learning environments that I have described give the *learner* central importance by allowing learners to make decisions about what information they need from different sources of information and what approach they should take to solve problems. The enabling contexts, resources, tools and scaffolds that are characteristic of these environments are in marked contrast to what prevails in traditional instruction

where content is selected and transmitted through lectures and assigned readings in textbooks (Morrison, Lowther, & DeMeulle, 1999). In order for performance assessment approaches based on open-ended tasks to be effective, they need to be diversified. In other words, they need to incorporate performance-based tools and authentic problems that support a variety of intelligences from learners. I shall discuss authentic tasks in the following section.

2.10.4 Authentic tasks and multiple intelligences

The main components of learning are learning tasks. Such tasks must be designed with care, skill and consideration. The tasks that learners are asked to perform have to provide learners with opportunities to explore, inquire and reflect as they generate ever more refined understandings of the context (Oliver, 2000). In performance assessment approaches, teachers have to strive to construct ever more creative, original and inspired learning settings that provide simulacra of authenticity in the learning outcomes that have to be achieved (Herrington & Oliver, 1999). In the process of developing learning tasks, teachers have to devise activities that reflect real-life settings and authentic tasks by considering how learning is used in real-life and thus replicate such forms of activity (Oliver, 2000).

The Science, Technology, and Society (STS) movement advocates the use of interesting problems or contexts that reflect the local or personal interests of learners in a way that learners can understand (Oliver & Hannafin, 2001; and Morrison et al., 1999). This may require some degree of simplification and extrapolation. Morrison et al. (1999) argues that when the knowledge that learners need to learn is placed within a meaningful context, learners are more likely to understand and construct meaningful responses. These learning formats ideally make learners better able to cope with present and future real life situations (Kotovsky, Hayes & Simon, 1984; Lesgold, 1988, in Morrison et al., 1999). Appropriate contexts are thus crucial factors in learning (Morrison et al., p. 9).

One way of making learning authentic is by devising tasks that reflect skilful and challenging replications of real-world situations (Bryce, 1997). In this way, tasks will

become more like gaming situations and so will demonstrate a close relationship to real world problems in home, the community and schools. According to Ryser (1994, p. 63), learners should ideally be required to perform, create, produce or make something by applying their knowledge to convincing replicas of real-world situations. Such tasks are more likely to focus on only one kind of problem even though they will provide larger scope for a variety of approaches and solutions (Bryce, 1997).

The reasons for using authentic tasks in the classroom, especially to teach an academic subject like science, is to support learning and to give it a central place in the schooling system rather than to support *a culture of schooling* – something that is rather different from learning and often unsympathetic to it (Selinger, 2001). Authentic learning implies several things. These are that learning be centred on authentic tasks, that learning be guided by teacher scaffolding, that students be engaged in exploration and inquiry, that students have opportunities for social discourse, and that ample resources be made available to learners as they pursue meaningful problems (Nicaise, 1997).

Linn and Baker (1996) have outlined the characteristics of 'authentic' tasks. Such tasks reveal the following characteristics:

- They are usually open-ended.
- They involve complex skills such as formulating problems and reasoning – and not just remembering and repeating material that has been memorised.
- Work on such tasks may extend over a considerable period of time.
- Learners may work collaboratively together on these tasks in groups or in pairs.
- Learners and teacher may negotiate the tasks that need to be performed (this means learning by facilitation and guidance).

Wiggins (1989) emphasises that tasks may be made more authentic if assignments are selected that require learners to write, speak, listen, create, undertake original research and solve problems. Tasks may therefore be classified as 'authentic' in terms of the following typology suggested by Wiggins (1998, p. 22-24).

Wiggins affirms that an assessment task, problem or project will be authentic if it conforms to all or most of the criteria listed below:

1. *An authentic task is realistic*. The task concerned replicates the ways in which a person's knowledge and abilities are tested, extended or challenged in real-world situations.
2. *An authentic task requires judgement and innovation.* The learner demonstrates judgement or innovation by using knowledge, skills and ingenuity to solve problems when a procedure must be designed or plan of action devised. Such solutions involve more than following well-established formulas or guidelines, pursuing tried and tested routines, or applying rote learning.
3. *An authentic task assumes that learners will 'do' the subject.* Instead of merely reciting, restating or replicating what is already known by everyone, learners engage in exploration and work in a unique and self-paced way within the subject that they are learning.
4. *An authentic task replicates or simulates the contexts in which adults are 'tested' in the workplace, in civic life, and in personal life.* Contexts are always unique situations that have particular constraints, purposes and audiences. Typical school tests are without context and often float in a kind of amniotic fluid of disengaged and disembodied knowledge that has no relevance to post-school life. Learners need to experience what it is like to *do* tasks in conditions that simulate a workplace and in other real-life contexts. Such tasks are often 'untidy', need-driven and open-ended.
5. *An authentic task assesses the learner's ability to efficiently and effectively use a repertoire of knowledge and skills to negotiate a complex task.* Most conventional test items are isolated elements of performance somewhat similar to sideline drills in athletics rather than to the integrated use of skills that a real game requires. Performance always amounts to more than a sum of the drills.
6. *An authentic task allows learners appropriate opportunities to rehearse, practice, consult resources, and get feedback on refined performances and products.* Although there are certainly occasions for the kind of conventional 'secure' tests

that keep questions and resource materials secret from learners until the test begins, routine testing should coexist with educative assessment if learners are to improve their performances and if they are to have the opportunity to reiterate their learning through cycles of *performance-feedback-revision-performance* in order to produce high-quality products and standards, and if we are to help them learn to use information, resources and notes effectively to perform in context.

The point of using authentic tasks in learning is to let learners encounter and master situations that resemble or simulate real-life situations. Learners should frequently be given an opportunity to learn important skills by performing simple real-world tasks they might encounter in their daily lives when they are out of school. It is not necessary that such skills should be highly complex or take an inordinate amount of time or organizational talent to teach (Cronin, 1993). Teachers can start by suggesting small but essential (even repetitive) tasks and develop higher order skills and abilities from there.

2.10.5 Scoring rubrics and multiple intelligences

Because of certain problems inherent in scoring by using open-ended digital learning tasks, scoring rubrics have been suggested as an alternative scoring method that is effective for judging learners' performances. Scoring rubrics are used to rate the quality and appropriateness of learners' responses (Quellmalz & Kozma, 2003). The rating of learners' performance and achievements depends heavily on the teacher's judgment (Linn, 1993). If rubrics are to be effective as a means of assessment among teachers, teachers need to be trained in the use of scoring rubrics so that inter-rater reliability can be established, maintained and verified if necessary (Quellmalz & Kozma, 2003).

(1) What is a rubric?

Rubrics are scoring devices or documents that consist of lists of criteria for the correct or acceptable performance of specific assignments. They describe varying levels of quality that range from excellent to poor (Goodrich, 1996/1997). Rubrics are necessary for accurate assessment that is not merely subjective because they provide definitions that guide assessment variables and also serve as an educational tool that advances both

learning and the purposes of fair and accurate evaluation (Gardner, 1991b; Shepard, 2000; Wiggins, 1989). A scoring rubric provides assessors (in this case, teachers) with a coherent set of rules or criteria that they may use to assess the quality of a learners performance. The scoring of constructed responses devolves on the evaluative criteria that one uses to determine the adequacy of learner responses. One uses the evaluative criteria that have been selected to decide exactly how to rate the learner's responses to performance tests (Popham, 2002). According to the Webster's Dictionary (1990), a *criterion* is **'a standard on which a judgment or decision may be based'**.

Several categories of rubric are used in the rating scales or checklists that teachers use to score performances. The categories used in the scoring rubrics differ and may vary from three, five to six categories. These categories are also called *scales*. A scale consists of numerals such as 0 to 3 or 1 to 4, that reflect the quality levels of performance. The numerals match the order of the quality of performance. Thus, numeral 4 may represent the highest level of performance, 3 the next highest level, and so on. If the rubric is to be an accurate guide for scoring each learner's performance, the quality of the performance represented by each numbered level has to be clearly described in the rubric.

A three-category rubric is one of the most common, because it allows for fairly easy writing and identifying of the descriptors which are usually: below average, average and above average. With five or six point rubrics, the differences indicated by the descriptors are often so slight that it can be difficult to determine learner scores. The degrees in such scales are explained by verbal indicators or more extended descriptors where necessary.

It is important to assign numerical ratings when assessing performances of the learners, when using scoring rubrics because it provides more information in form of written interpretive summaries. Written interpretive summaries for every task are important because every task is unique and functions as its own domain (Delandshere & Petrosky, 1998, p. 18-19). Messick (1994, p.17) argues that, no matter how important a particular task is, if we score performances to measure assessment, it is necessary for us to use

constructs to do so. These constructs are evident in the criteria that are used, the language of description, and the statements that are made in narrative feedback (Brookhart, 1999).

Wiggins (1993) says that although rubrics take time to develop, they nevertheless set clear standards and expectations for the quality of work that we expect to be produced. The whole idea of using rubrics is to monitor the quality of learners' work, to provide them with feedback, and to showcase their accomplishments and what they have learnt. Scoring rubrics also enables teachers to make sound and reliable judgements about subtle, complex and educative tasks or task components as well as those that are easy and uncontroversial to score (Wiggins, 1993).

Scoring rubrics to be used for problem solving activities and open-ended tasks are most valuable instruments because they reduce the unreliable subjectivity that can contaminate the most talented teacher's judgement when he or she assesses a learner's performance, because many of these tasks do not have a single answer and human beings are by nature subjective in their perceptions. Sadler (1998) notes that it is impossible to make judgments about the quality of something purely on its own terms, unless it is compared to some sort of reference point or framework. Since subjectivity in the evaluation of the tasks is problematic but inevitable, the real problem becomes how to make the evaluation of tasks as reliable and valid as possible given their uniqueness and the ingrained subjectivity and biases of assessors (Doolittle, 1994). Wiggins (1993) insists that if scoring rubrics are to be valid, the criteria have to be more than 'face authentic'. In other words, if we hope to solve as far as possible the problem of subjectivity, our scoring rubrics need to be based on a careful analysis of *existing performances of varying quality* (Wiggins, 1993, p. 238).

Although even though we may accept that rubrics are best way to score learners' performances and abilities, we still have to consider the question of the validity and reliability of the scoring rubrics.

2.11 Multiple intelligences and learner collaboration

2.11.1 Collaboration and interpersonal intelligence

In classrooms, meaningful knowledge is often constructed through collaborative efforts as learners attempt to reach common goals. Discussions may thus highlight differences in understanding that can lead to profitable self-reflection. The understandings and insights that learners have may then provide material for the assessment of achievements and growth that are an integral part of the learning and teaching process (Slavin, 1996, p. 57).

I deliberately used open-ended digital learning tasks in this study with the intention of giving learners the opportunity to select whatever working strategies and computer application skills they preferred to complete their tasks. In addition to this, I encouraged teamwork so that the interpersonal intelligence of learners that is seen in collaborative learning might be stimulated and revealed (Goodnough, 2003). Interpersonal intelligence requires learning through interactions with others. This includes the ability to solve problems that require a division of labour, working within group projects, the sharing of skills and feedback. All such activities *anchor* information for learners (Brand & Donato, 2001). The approaches that I discuss in this section are all concerned with overt, observable processes of interpersonal interaction that occur when learners work on open-ended digital learning tasks.

With the advent of computer technology in schools, it became possible not only to promote new forms of collaborative activity among learners, but also to illuminate the nature of human capabilities of learners as they engage in collaborative learning (Littleton & Hakkinen, 1999, p. 29). One of the elements that have been shown to exert a positive influence on collaborative learning is the use of problem solving and open-ended learning tasks that require mutual interdependence and cooperation among learners (Knight & Bohlmeyer, 1990). School learning has traditionally been regarded as an isolated and individual accomplishment. In the traditional classroom, teachers teach and learners learn to work independently of one another to acquire the knowledge and skills that they need for success. This approach to learning has strongly influenced the way in which instruction is typically structured in most schools.

Collaborative activities moreover require more than the effective division of labour that constitutes cooperative work (Johnson, Johnson & Holubec, 1993). Collaboration requires participants to make coordinated efforts to solve problems and perform tasks together (Teasley & Roschelle, 1993). The results of the study done by Uribe, Klein and Sullivan (2003) on learners' work on computer mediated and problem solving activities, indicated that learners collaborated effectively if they were allowed to communicate freely among themselves. Communication between learners is evident when learners focus on asking and answering questions, when they discuss information that is relevant to the problems, and when they undertake peer coaching. It is reasonable to assume that if learners focus together on trying to perform the task in hand, the effects of their collaboration will be positive. Uribe, Klein and Sullivan (2003) concluded that *collaborative* learning is a more effective strategy than *individual* learning when one is teaching problem solving skills.

I shall now discuss communication skills and social interaction in more detail.

(1) Communication skills

Communication skills are fundamental to interpersonal intelligence**.** As learners work collaboratively in groups to solve problems or open-ended tasks, they are required to develop and practise communication skills if they are to succeed because communication skills are almost synonymous with – and certainly the most critical indicator of – interpersonal intelligence (Johnson & Johnson, 1989). Learners engage in conversations between themselves in their groups and even between groups. This gives them opportunities to find out and perhaps understand what others have mastered. Although learners still take responsibility for their own learning, the *group* format obliges them to share what they know in discussion with others. The quality of this sharing can then indicate to a qualified observer the degree of mastery that learners might have attained in communication skills in learning (Schack, 1993). It is in discussions that learners become engaged in the kind of educative dialogue that focuses on the activities with which they are engaged. It is communication skills that determine how effective such discussions may be.

It seems that communication skills are particularly important in collaborative learning as individual learners try to establish themselves through the negotiation of meanings (Nystrand, 1986). And since the negotiation of meanings require a mutual sharing of knowledge, that also becomes important in peer coaching. The theory of multiple intelligences has identified some of the features of interpersonal intelligence that are crucial in collaboration. *Interpersonal intelligence is a capacity to discern distinctions in the moods and feelings of other people* (Gardner, 1983, in Kincheloe, 2004). Gardner (1983, p. 276; 1999c; Shepard, Fasko, & Osborne, 1999; Cantu, 1999 in Kincheloe, 2004, p. 136) provides features of interpersonal intelligence which include:

- Capacity to see differences among individuals.
- Ability to detect affective changes in others (and readiness to help).
- The willingness to be ready to help others (where appropriate) when one detects such changes.
- Proficiency at reading motives and desires of diverse individuals.
- Talent to use these insights to influence people to act in certain ways.
- Ability as a student to engage successfully in peer tutoring.

In encouraging learners to use their interpersonal intelligences in classroom situation, teachers have to support learners in their communication skills and social interaction as discussed below:

(2) Social interaction

Learning has been defined as a socially mediated event (Vygotsky, 1978). Vygotsky (1978) suggested that all intellectual abilities are social in origin and operate in zones of proximal development. Real and valuable attainment in problem solving can only be accomplished with assistance from others.

Social interaction is widely practised by learners who work in small groups and also by learners who work on their computers (Means & Olson, 1997). Learners sharpen their social interaction skills as they seek help from each other as they try to solve individual

problems for themselves (Moursund, 1999). When learners give one another advice or help peers when they need help, both the giver and the receiver of advice and information learn from one another. In this process of giving and receiving, the collaborative and interactional skills of both parties are sharpened and perfected because the receiving of advice and information requires as much skill as giving it. In the accomplishment of open-ended tasks, conversations between learners, moving around, sharing, disputing and helping on another are expected features of such a format. Learners also have to learn to assess the work of their peers and provide constructive feedback both to themselves and to others (Moursund, 1999). Peer instruction should be explicitly taught and encouraged. In such circumstances, a versatile technology such as computers can serve as a stimulus for changes in the role of the teacher and the learner, and can also change patterns of interaction in the classroom for the better. Learning can become a public and visible activity wherever learners share their ideas as they use technology. The more learners manifest those human qualities that we associate with interpersonal intelligence, the more they should be able to promote and maintain healthy and constructive interpersonal relations among themselves (Sharan, 1984).

In an experimental study conducted in Israel over a period of two years, it was demonstrated that learners perceive classroom social relations in ***traditional*** classrooms to deteriorate – not only during the years of elementary schooling, but also during the course of the first academic year (Sharan & Hertz-Lazarowitz, 1981). In another study conducted in science classrooms, Johnson (1976) showed that a learner-centred inquiry-learning approach to instruction promoted a more cooperative social climate in classrooms than did a teacher-centred traditional textbook approach. Many researchers have shown that cooperative peer tutoring and sharing of information can crucially enhance learning experiences (Sharan, Hertz-Lazarowitz, & Kussell, 1984; Slavin, 1985). According to Worchel (1979), the use of small groups in classroom situations can serve as a vehicle for promoting positive interdependence and mutual assistance among all members of such groups.

The theory of multiple intelligences provides a way of understanding intelligence that teachers can use as a guide for developing classroom activities that address multiple ways of learning and knowing (Christison, 1999). But this is not enough. Teachers also need to relinquish some of the control that they traditionally exercised in classrooms. The theory suggests that teachers transfer some control to learners by giving them opportunities to make choices in such a way that they can learn and *demonstrate* their learning. By focusing on problem solving activities that draw on multiple intelligences, teachers have to be ready with proper feedback and support (scaffolding) so that learners can build on their existing strengths and knowledge and so learn new content and skills (Kallenbach, 1999).

2.11.2 Collaboration and feedback process to learners

Wiggins (1993) claims that in traditional teaching test scores were often referred to as *feedback* by those in the education system. But a better definition of feedback might be that information that provides performers with direct and usable insights into a specific performance. Such feedback furthermore would be based on important differences between a current performance and a hoped-for performance.

According to Wiggins (1993), feedback in the form of considered information is vital for learners as they work on their problem solving activities because it shows them how they are doing and how they might specifically improve on what they have already done. Kornhaber (2004) also says that ongoing formative feedback from teachers and classmates enables learners to revise their work until it embodies the necessary qualities and standards of attainment. As feedback becomes more immediate and continuous, it becomes more and more likely that learners will have the information that they need to improve their performances in a timely and effective way (Kornhaber, 2004). The importance of feedback when in the teaching and learning process is that it helps learners to produce quality work and teachers to obtain an accurate view of learner skills, abilities and performances (Wiggins, 1993). Hattie (1992) also affirms that feedback is most useful when it is well-timed.

A lot of time is spent in most schools in assessing learners by means of scores and ranking individual learners so that they can be classified in terms of percentile ranks and so that (supposedly valid) conclusions can be drawn about their scholastic merits (Wiggins, 1993). Learners seldom receive adequate information about how well they are performing. Traditional teachers often provide very little useful feedback, and what they do provide is often not helpful to learners. The theory of multiple intelligences suggests that some of the feedback could take the form of concrete suggestions (made in descriptive language) and indications of relative strengths that a learner might build on independently of that learner's rank within a comparable group of learners (Gardner, 1992; Wiggins, 1993; and Elbow, 1986).

A study by Tunsall and Gipps (1996) describes and classifies feedback from teachers to learners as *evaluative* and *descriptive*. According to Tunsall and Gipps (1996), while evaluative feedback is judgmental and implicitly or explicitly based on norms, descriptive feedback is task-related and refers directly to a learner's actual achievements and competence. If teachers use this kind of feedback, it shifts the emphasis to the learner's own role in learning and uses approaches that give the learner more control and responsibility. In such cases, the teacher becomes more a facilitator than a supplier or judge. The use of formative feedback from teachers, classmates and even parents, is one of the features that make authentic assessment a powerful tool for helping learners in the learning cycle (Black & William, 1998; Eisner, 1999; Wiggins, 1998, Pellegrino, Chudowsky, & Glaser, 2001).

2.11.3 Collaboration and scaffolding of learners

The scaffolding process is especially important when one is using technology in a classroom. Scaffolding helps learners to make use of the resources at hand. During the scaffolding process, teachers are able to clarify their requirements and reduce the cognitive load on learners. This in turn permits learners to focus on the task in hand rather than invest cognitive resources in the mere mechanics of procedure and navigation (Hill & Hannafin, 2001). Teachers for example have to be *physically* present in classrooms to assist learners with trouble shooting and problem solving because sometimes, even in

well-planned collaborative learning lessons, learners sometimes get into difficulties and need help from a teacher (Webb & Farivar, 1999). If teachers can adapt their interactions to *specific* learner needs at specific times, learners will be enabled to work productively and so reap the potential benefits of collaborative learning (Chiu, 2004). Much of what learners can learn depends on the extent to which learners are encouraged to interact among themselves and the quality of support that they receive from their teachers during cooperative work (Fuchs, Fuchs, Hamlett & Karns, 1998; King, 1994, 1999; Webb & Farivar, 1994, 1999).

Finally, open-ended digital tasks are tasks that strive to connect learners to conditions, circumstances and prior knowledge from their own lives or applying the richness of this experience and knowledge to solve new problems. The aim of such tasks is to stimulate learners to use their multiple intelligences and understandings and apply these creatively to the dilemmas and challenges that they are confronted with in the everyday world (Synder, 1997). If learners are to use their understanding and different intelligences to an optimal extent, teachers have to make classrooms instruments available that encourage initiative and exploration while teachers for their part have to provide scaffolding and conditions that are conducive to collaboration and feedback. The collaboration, communication skills and social learning that learners who use computers need are summarised in a graphic format in Figure 2.2 below.

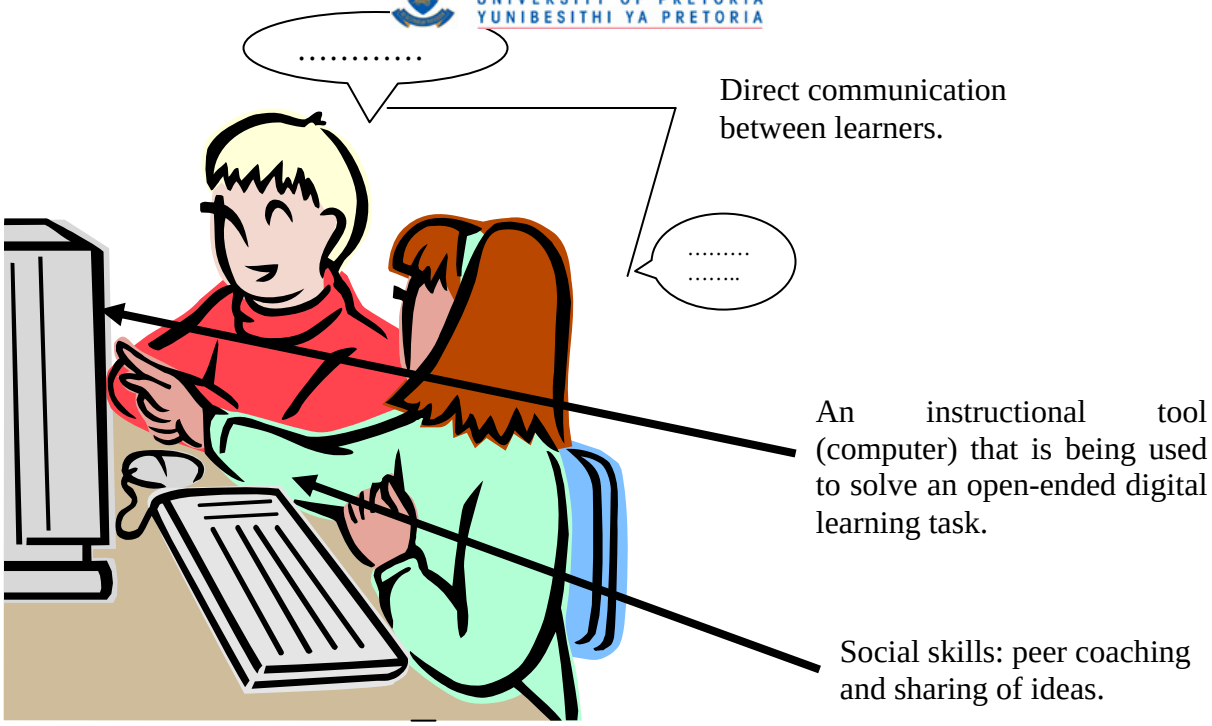

Figure 2.2: Collaborative learning and interpersonal skills

The question is: does the nature of the instructional process affect interpersonal relations among learners – their liking for one another, their desire to help a member of their class, their ability to organize teamwork. Yes, it does, because in a study of science classrooms, Johnson (1976) found that an inquiry-learning approach to instruction, compared to the traditional textbook approach, promoted a more cooperative social climate in the classroom (Johnson, 1976). Hence, there are positive results in cooperative peer tutoring instructional methods in classrooms than traditional classrooms (Sharan, Hertz-Lazarowitz, & Kussell, 1984). According to Worchel (1979) and Slavin (1985), using small groups in classroom situations can serve as a vehicle for promoting positive interdependence and mutual assistance among all members of the small groups.

2.12 Problems inherent in performance assessments

While performance assessments are beneficial if properly undertaken, one has to be alert to the problems of implementation and validity that they present (Mehrens, 1992). Linn, Baker and Dunbar (1991) propose that validity criteria for performance assessment should include criteria such as content quality, content coverage, cognitive complexity, meaningfulness, cost and efficiency, transfer and generalizability, fairness, and

consequences. Frederiksen and Collin (1989) proposed the addition of directness, scope, reliability and transparency. All performance assessments must nevertheless be evaluated by the same evidential and consequential validity criteria. Basic assessment issues that need to be taken into account thus include validity, reliability, comparability, and fairness. These criteria need to be uniformly addressed in all assessments because they are not just measurement principles. They are also social values that have universal meaning and force beyond evaluative judgments for some narrow and defined purpose (Messick, 1994).

2.12.1 Avoiding subjectivity in performance assessment

Authentic assessment is often criticised on the grounds that it is subjective. I shall discuss ways of minimising subjectivity and maximising validity and reliability in performance assessment in the following section.

2.12.2 Validity and reliability of performance assessment

Kane, Crooks, and Cohen (1999) have addressed the question of how the validity of performance assessments can be established. Their analysis identifies the following three necessary major conditions for the interpretation of performance assessments: (1) the scoring of observed performances, (2) generalisation to the domain of assessment performances like those included in the assessment, (3) extrapolation to the larger performance domain of interest. All these points are included in the discussion made on validity and reliability in the two points below, and generalizability in the next section.

(1) Validity

Validity is an essential feature of any acceptable assessment procedure. The purpose of assessment is to find out what each learner is able to do with their knowledge in a specific context. The essential purpose of assessment is to be in position to make more general inferences about achievement in a subject (Wiggins, 1996, 1997). According to Miller-Jones (1989, p. 363), tests of ability and achievement are context-specific and may be judged by how well they fit the assessment of the learner to specific cultural content and contexts.

If a class is composed of culturally diverse learners, one needs to take the diversity of their backgrounds and experience into account in standardized tests by introducing a range of different topics that are embedded in different cultural contexts. Such an approach is, if anything, more difficult to use with performance-based assessments because the time-consuming nature of the problems that have to be overcome if they are to be used efficiently (Linn et al., 1991).

Validity is always a matter of degree rather than an all-or-nothing judgment. It also requires multiple types of evidence that are needed to arrive at a sound judgment about the validity of a particular use of interpretation. The task itself should yield the kind of information that we need to judge the performances that we seek to measure.

(2) Reliability

Reliability is the degree of consistency with which a test measures whatever it is measuring (Popham, 2002). When there is consistency in the results obtained from different testing occasions over a period of time, we call this stability or reliability. A method of assessment is reliable when individuals who have approximately the same ability, knowledge and skill achieve the same scores or results whenever the method on whomever is being assessed (Cotton, 1995).

Inter-rater reliability procedures are important for obtaining reliable scores, especially when assessing learner performance abilities. Inter-rater reliability enables us to calibrate or moderate activities so that we can score assessments reliably. Wiggins (1989) emphasises this kind of reliability by cautioning that if assessors are properly trained to assess learner performances by using agreed-upon criteria, they will display a high degree of inter-rater reliability.

Performance abilities are also linked where inter-task reliability is present. Yet performance on one task may often be weakly related to performance on another seemingly related task (Linn, 1993). Inter-task reliability can be increased by increasing the number of tasks that are administered (Linn, 1993).

If proof is needed that answers were not merely accidental or thoughtless (if correct) responses, multiple and varied tests are required. In performance-based areas, assessment is proved by the competence of one's performance. Over time and in the context of numerous performances, it should be possible to observe patterns of success and failure and the reasons behind them (Wiggins, 1989). A single performance is unable to provide such information. The totality of learners' repertoires in all areas that reveal their multiple intelligences have to be observed. Regurgitated information from mere rote learning is useless for making valid or useful deductions.

2.12.3 Generalizability

The degree to which the results of the performance-based assessments can be generalised is limited by the variability that different raters effect in the sampling of tasks (Linn *et al*., 1991). Shavelson, Baxter and Pine (1990) investigated the generalizability of performances assessed by different assessors in performance tasks in science that used tasks such as experiments designed to determine the absorbency of paper towels and experiments to discover the reactions of sow bugs to light and dark and to wet and dry conditions. As, Shavelson et al., (1990) proved what others had already proved in other contexts, namely that performance is highly task-dependent. Since this is so, generalizability is limited from task to task by the context-specific nature of the task concerned (Greeno, 1989). Swanson, Norman and Linn (1995) also claim that the context in which performance-based assessment tasks are done cannot be exactly generalised because of differences in the nature of the knowledge and skills that are being tested

Lin (1993, p. 9) noted that one major stumbling block in performance assessments is the generalizability of performance from one task to another. This occurs because the ratings of performance assessments depend on the professional judgements of assessors and the comparability of ratings among judges. Although raters (assessors) do contribute to the error variance in the ratings of performance assessments, the careful design of scoring rubrics and the correct training of raters can keep the magnitude of variance caused by raters and by interactions among raters and examinees at levels that are substantially lower than the other sources of error variance, most notable of which is topic or task

specificity (Baker, 1992; Dunbar, Koretz, & Hoover, 1991; Shavelson, Baxter, Pine, 1992, in Linn, 1993, p. 10).

Baker (1992, in Linn, 1993) discovered that one way to improve generalizability is by increasing the number of *tasks* rather than by increasing the number of trained raters. How this happened is shown below in Figure 2.3 in the results of performance-based history tasks that were administered by Baker (1992).

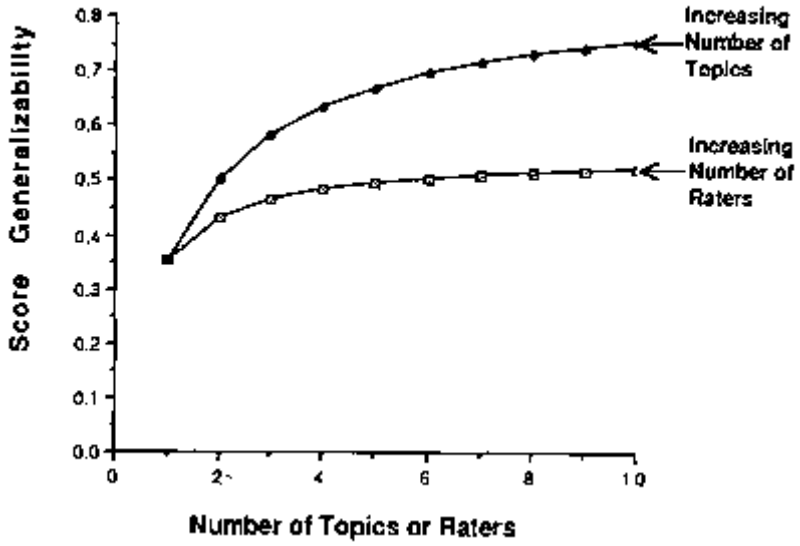

Figure 2.3: Score generalizability of general impression content quality scores of extended history tasks as a function of number of history topics and number of raters (Baker, 1992).

A similar pattern of results showing improving generalizability as a function of the number of tasks rather than the number of raters is shown in Figure 2.4 below for open-ended mathematics problems as reported by Suzanne Lane and her colleagues (Lane, Stone, Ankenmann, & Liu, 1992, in Linn, 1993, p. 10).

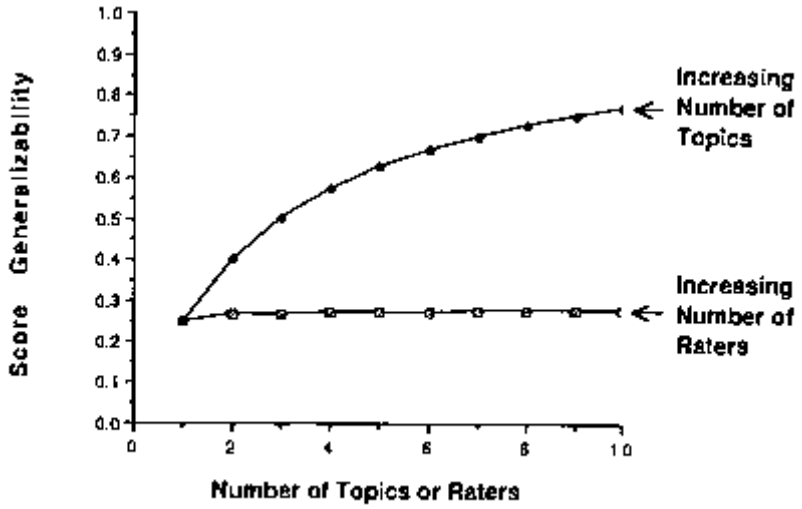

Figure 2.4: Score generalizability of QUASR Form D mathematics score estimated from rater paired 13. Based on S. Lane, C.A. Stone, R.D. Ankenmann, and M. Liu (1992).

Along with the proper selection of authentic open-ended tasks and the development of scoring rubrics; validity, reliability and generalizability are important in any performance assessment approach.

2.13 Advantages and disadvantages of performance assessment

2.13.1 Advantages

Among the advantages of authentic assessment approaches is the fact that standards can be meaningful, relevant and topical because they are generated out of the discussion of concrete examples at classroom or school level (Darling-Hammond, Ancess, & Falk, 2001; Wiggins, 1998; Zessoules & Gardner, 1991). Such examples can be made to be relevant to individual and local issues and interests if they draw upon what is most interesting topic and meaningful in a given community at any particular time. Standards that are employed in authentic assessments are also more readily owned and understood by teachers and learners (Kornhaber, 2004).

The value of a performance assessment is that when one compares it to a test score, one needs a relatively low level of inference in order to know whether or not learners have or have not mastered a particular area because a learner's performance will incorporate the

articulated qualities to a visible extent (Fredericksen & Collins, 1989). Authentic assessments therefore permit teachers to supply clear feedback on specific requirements that have yet to be mastered and the processes that are needed for mastering them. In addition, feedback can be immediate and continuous. This kind of formative assessment makes it more likely that learners will receive the information they need to improve their performances in a timely way (Kornhaber, 2004). These features make authentic assessments powerful tools for helping learners to learn (Black & William, 1998; Eisner, 1999; Pellegrino, Chudowsky & Glaser, 2001; Wiggins, 1998).

2.13.2 Disadvantages

Performance assessments do however have several drawbacks. One weakness is that locally developed standards of quality may be extremely variable (Kornhaber, 2004). What may constitute high quality work in school A might look much better or worse than what will be assessed as high quality work in school B. In addition, it is impractical for the authorities to use performance assessment to evaluate all the work of every learner in every school. It is also expensive to process very large samples of learners' work. It is also more difficult to achieve proper reliability in judging such volumes of work (Haertel, 1999; Koretz, Klein, McCaffrey, & Stecher, 1994).

Research has shown that standards are often not adopted and used in classrooms in the systematic and uniform fashion that state policy makers intended them to be used (Blank, Porter, & Smithson, 2001). In such circumstances, it is not surprising to learn that such standards are less likely to be owned or properly understood by teachers and learners (Kornhaber, 2004). Furthermore, because those who devise such standards are far removed from local communities, such standards when they ultimately arrive in classrooms, have little chance of engaging the attention and interest of learners and teachers because they are unrelated to local questions, interests, problems and concerns (Kornhaber, 2004). It is partly this defect that has caused assessments to be criticised as undemocratic (Meier, 2000).

Another disadvantage is that a very high degree of inference is required to determine whether a score truly reflects whether a learner actually appreciates the qualities that constitute good work in a given discipline and whether that learner can thereafter actually produce such a quality of work (Fredericksen & Collins, 1989; Gardner, 1999). In addition, the summative feedback process to learners, teachers and schools often takes a long time to appear. In fact feedback sometimes reaches teachers only after learners have moved on other grades or classes (Snow & Jones, 2001). Feedback to learners is always thin that is, proficiency, percentile and fail (Kornhaber, 2004). This makes the emphasis on testing less useful for informing teachers the effect of classroom practice for particular learners (Black & William, 1998; Wiggins, 1998).

In all this, the advantages of the testing approach complement the weaknesses of authentic assessments. Test-based measures of standards have a much higher reliability and allow all learners to be more easily assessed. Statistics can in addition supply useful information for comparing performances across learners, schools and districts (Kornhaber, 2004).

2.14 Rationale for using performance assessment approach

Far too few learners in many public schools receive the quality of education that they need to prepare them for a successful life and work in a rapidly changing world. This is imperative to provide the learners with a high quality education, which is more economic than moral. Thompson (2001, p. 359) asserts that “if one wants to improve the quality of learning across the board, one needs to improve the quality of instructional content and practice across the board”. This requires improvements in instruction that will lead to improvements in learning. Such improvements will be evidenced in improved learner performances that can be measured by a variety of assessment instruments.

Such advances necessitate a radical shift from focus on inputs to a focus on outcomes or performance and a general commitment to improving the performance of every learner (Thompson, 2001). The main purpose of authentic performance is to enable all learners to achieve as much of their creative, intellectual and social potential as possible. The goal of

authentic learning is therefore to enable learners to live fulfilled lives and to contribute actively to their communities both during and after their schooling (Thompson, 2001).

Psychometric tests have long been used as tools for selection and placement. Standards test theory characterises performances in terms of the level of difficulty of response-choice items and focuses primarily on measuring the amount of declarative knowledge that learners have acquired (Lane & Glaser, 1996, p. 805). Current theories of cognition, however, emphasise meaningful learning that entails reasoning and problem solving and that requires the active construction of knowledge (Lane & Glaser, 1996). Assessments that are integrated with instruction and that allow learners to display the thinking, reasoning, feeling and strategic processes that underlie their competencies can ensure more valid inferences about the nature and level of learner understanding (Lane & Glaser, 1996, p. 805).

2.15 Conclusion

Gardner's theory of multiple intelligences provides a theoretical foundation for recognising the different abilities and talents of learners. His theory acknowledges that while all learners may not be verbally or mathematically gifted, learners may possess a great deal of expertise in other areas such as music, spatial relations, moral sense, and interpersonal skills. A pedagogy that is based on the theory of multiple intelligences should approach the assessment of learning in a manner that allows a wider range of learners successfully to participate in classroom learning.

Finally, since understanding can also be demonstrated in more than one way, this pluralistic approach has opened up the possibility for learners to display their new understandings as well as their continuing difficulties in ways that are comfortable for them to reveal and that are also accessible to the scrutiny of others. Performance-based assessment is one of the most valuable tools for encouraging learners to use their multiple intelligences.