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✍ Acronyms used

AIDS	-	Acquired Immunodeficiency Syndrome
CA	-	Chronological age
CD	-	Compact Disks
ECI	-	Emotional Competence Inventory
"g"	-	General Intelligence
HIV	-	Human Immunodeficiency Virus
ICT	-	Information Communication Technology
IEA	-	International Association for Evaluation
IQ	-	Intelligence Quotient
MA	-	Mental Age
MI	-	Multiple Intelligences
MIDAS	-	Multiple Intelligences Developmental Assessment Scales
MOEC	-	Ministry of Education and Culture of Tanzania
NECTA	-	National Examination Council of Tanzania
PC	-	Personal Computer
SITES	-	Second International Technology in Education Study
STS	-	Science Technology and Society
TIMI	-	Teele Inventory of Multiple Intelligences
TV	-	Television
UDSM	-	University of Dar Es Salaam
UP	-	University of Pretoria
WAIS	-	Wechsler Adult Intelligence Scale
WISC	-	Wechsler Intelligence Scale for Children

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✍ Chapter 1 – Introduction

This chapter gives an overview of the main aim of the study. This is followed by a brief explanation of the background and the contextual situation of Tanzania where the study was conducted. The remaining sections deal with the purpose, design, and significance of the study. The main aim of the discussion in this chapter is to identify how Gardner's theory of multiple intelligences can be used in teaching and learning processes and how the performances of learners who use computers in schools may consequently be assessed and improved.

1.1 Introduction

Schools in Tanzania and around the globe are scrambling to make sure that learners do not end up on the wrong side of the digital divide (Nelson, Post & Bickel, 2003). As a result of pressure from politicians and parents and because of the imperatives of the contemporary working environment, public schools are purchasing as much computer hardware, software and Internet connectivity as they can afford to create the kind of up-to-date "wired" or "high tech" environment that learners need for their training in computer and other digital technologies (Nelson et al., 2003). What has become evident is that even in those cases where schools have been able to purchase the latest technology and provide the kind of training that such technology requires, the quality of instruction and learner participation in learning and achievement have not necessarily shown improvement (Nelson et al., 2003).

Why is this the case? The answer may be located in the fact that the technology used in such environments has been utilised and implemented in ways that have undermined meaningful learning (Newmann & Wahlage, 1993). To support and encourage meaningful learning, teachers need to select models of instructional design that might incorporate methods that encourage the use of activity teaching methods and problem solving approaches that also encourage learners to participate actively as they acquire practical experience of the various forms of technology with which they interact with (Computer Studies Syllabus of Tanzania, 1996, p. iii).

McCombs and Stiller (1995) claimed that there is a way of encouraging meaningful learning using the technology of computers as a function and means for eliciting motivation, learning and achievement among learners in schools. An instructional design that can be used is that which provides learners with opportunities to train and at the same time use computer technology in learning in learner-centred instruction. Learner-centered instruction can take care of both the design and implementation of the learning process.

One of the features of learner-centred instruction is that teachers have to be trained to regard each learner as unique and capable of learning (McCombs & Stiller, 1995). This is a necessary condition for the success of learner-centred instruction because it enables teachers to create situations in which the rich diversity, uniqueness and individual differences in learners' talents can all be maximised for solving complex problems in the so-called real-world. In traditional educational contexts that are not learner-centred, the diversity, uniqueness and individual differences of learners are regarded as obstacles to learning because, in such situations, it is the ability of learners to reproduce authoritative discourses uncritically and unquestioningly, and that is regarded as one of the most important indicators of learning.

McCombs and Whisler (1997) also pointed out that wherever learner-centred instruction is used in learning situations, learner performance or the demonstration of knowledge skills need first to be properly understood, identified and appropriately described in the context of what learners can achieve in day-to-day performances in their schools. A learner-centred perspective affirms the possibility of learning for all learners because it asserts that:

- Learners are distinct and unique. Their distinctness and uniqueness must be attended to and taken into account if learners are to engage in and take responsibility for their own learning.

- Learners' unique differences include their learning rates, learning styles, abilities and talents. These must all be taken into account if all learners are to be provided with the necessary challenges and opportunities for learning and self-development.
- Learning is a constructive process that works best when what is being learned is relevant and meaningful to the individual learner and when each learner is actively engaged in creating his or her own knowledge and understanding by connecting what is being learned with prior knowledge and experience.
- Learning is most effective in a positive environment. A positive environment is one that is characterised by positive interpersonal relationships among all participants whether teachers or learners, by interactions that are comfortable and orderly, and is such that learners feel appreciated and personally acknowledged where appropriate (McCombs & Whisler, 1997, p. 10).

The approach described above by McCombs and Whisler, is located within the theory of multiple intelligences put forward by Howard Gardner (1983). What is intelligence then? Leonard (2002) defines human intelligence as an ability to perform in problem solving activities, to use logic, to think and read critically. In the theory of multiple intelligences Gardner (1983) posits that intelligence is pluralistic and hypothesises that everybody has at least eight intelligences which reflect different ways of interacting with the world (that is multiple intelligences). These intelligences according to Gardner (1983) are verbal linguistic, logic mathematical, visual spatial, bodily kinaesthetic, musical, interpersonal, intrapersonal and naturalistic intelligences. Every individual has a unique profile of these intelligences that may be manifested as different kinds of strength and weakness, and can be used singly or in various combinations to solve problems and fashion products (Gardner & Walters, 1985).

The theory of multiple intelligences, therefore, conversely emphasizes the processes of *learning* rather than teaching, where teachers are challenged to notice and take into account the diverse skills, abilities, talents and preferences that learner's can exhibit in the classroom. Learners then can be allowed to present their material in ways that recognize and consider the multiple intelligences of each individual learner. In practice this type of instruction can be achieved because each of the multiple intelligences has a specific set of abilities that can be observed and measured (Gardner, 1983, 1999b).

Hence, 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 teachers have to honour the uniqueness of these learners. **The intellectual puzzle driving this study is to understand the interaction between multiple intelligences and learner performance in open-ended digital learning tasks.**

Gardner's theory of multiple intelligences forms the framework of this study. To be able to understand the possible interactions between multiple intelligences and learner performance in open-ended digital learning tasks, a qualitative research design is used. Most of the studies done in relation to the theory of multiple intelligences by Gardner have also been more qualitative then quantitative designs.

Even though the theory of multiple intelligences is highly recognized and widely used, it has never been accepted wholeheartedly in either the field of psychology or in the education arena. There have been serious critiques against this theory of multiple intelligences. For example, Gardner has been criticized for not offering a clear programme for educators to use as they implement the theory of multiple intelligences in schools (Levin, 1994); he has also been criticized for not providing a way to measure or assess many of the postulated intelligences within the scope of the theory (Klein, 1998; Granat, 1997). Furthermore, Ceci (1996) did question the validity of the theory of multiple intelligences on the basis of its lack of supporting scientific data (more critiques, and Gardner's counter responses are addressed in chapter 2, section 2.8).

However, despite the critiques of the theory of multiple intelligences, the theory of multiple intelligences remains firmly in current use especially in education and school systems. The main reason as to why the theory is still considered to be valid and why it can be used for educational purposes is because Gardner expanded the hitherto dogmatically limited concept of intelligences. This expanded view includes intelligences such as musical, visual spatial, bodily kinaesthetic, naturalistic, intrapersonal and interpersonal intelligence (among others). The suggested intelligences amended the widely accepted and institutionalised logic mathematical and verbal linguistic intelligences (Wilson, 1998, 2002; Brualdi, 1996; Campbell, 1991; Armstrong, 1994).

As mentioned earlier, the theory of multiple intelligences emphasizes learning process that provides learners with guidance and opportunities for learning academic material in different ways. Diaz-Lefebvre (2004, p. 51) puts forward some premises of learning using multiple intelligences and these are:

- It is accepted that not all learners learn or understand academic materials in the same way.
- Learners are provided with opportunities to explore various ways of learning, of getting out of their ‘comfort zones’, of being creative and of having fun. While the teacher is there to provide encouragement, support and confidence in the learner’s ability to succeed.
- Learning environments that are encouraged are those with sustained hands-on practice and procedures, providing materials and problems with the aim of achieving deep knowledge and skill within it.
- The use of alternative assessment to provide choices and creative options that accentuate different intelligences. Creativity and use of personal imagination are greatly encouraged and rewarded.

1.2 Aim of the study

The aim of this study is to understand the interactions brought forward by the learners in the learner-centered instruction where learners (with multiple intelligences as hypothesized by Gardner) will use computer technology in a classroom situation. These understandings will help to answer the critical research question of this study which is: **How do learners with different intelligences engage with and execute open-ended digital learning tasks?**

As with any effective integration of computers into teaching and learning processes in learner-centered instruction it has to ensure that the instructional design to be used can produce optimal effects in the use of computer in the teaching and learning environment. The learning environment is learner-centered and where learning is the focal point, learners are always engaged in complex, hands-on activities that allow them to develop their understanding of the world around them (Kovalchik & Dawson, 2004, p. 401). These activities may involve engagement in authentic research; use of technology for gathering information, communicating with experts, or developing understanding; and engagement in other real-world activities to support learning (Kovalchik & Dawson, 2004).

In learner-centered instruction, therefore, teachers have to design teaching strategies that will address diversity of learners through the belief that learners can take responsibility in their own learning processes. As each learner brings a particular understanding of the world, with particular background experiences to every learning opportunity. Gardner (1993c) therefore, recommends designs of instruction in learner-centeredness to consider not only the learner-centered environment but also the assessment process which addresses the wider range of intellect present in the classroom. As always in traditional teacher-centered teaching, instruction has always been geared toward verbal linguistic and logic mathematical intelligences, with instructors and designers failing to take into account the presence of other intelligences. Examples of evaluation that remain sensitive to individual differences include portfolio development, journaling, and other types of reflective assessment (Gardner, 1993c).

Gardner (1983) is of the opinion that intelligences can best be assessed by means of a performance assessment process. This kind of performance assessment is a valuable and creative alternative to traditional standardised multiple-choice tests because they require learners to perform significant tasks directly. This allows learners to demonstrate competence by constructing and doing, rather than by merely selecting from a range of finite responses that often provide no scope for creativity, ingenuity, courage, leadership or lateral thinking – or any of the other modes of activity and self-presentation that reveal the presence of alternative forms of intelligence in learners (Worthen, 1993). In this case, the teaching and learning of computers can also consider the effective use of assessment process that will appreciate the unique abilities of the learners, and this is the use of performance assessment or alternative assessment. Proponents of performance assessment or alternative assessment are of the opinion that the use of computers in classrooms can provide authentic learning opportunities for learners if instructional designs are well planned (Means, Blando, Olson, Middleton, Morroco, Reinz & Zorfasr, 1993).

When teachers plan a sequence of lessons, they should devise computer applications that can be used in the so-called real-world environments that use authentic tasks which are real-world examples. They should also create actual environments or simulate environments that will allow learners to complete the tasks that they have prepared – as paid workers do. If computers are optimally used by both learners and teachers, it can also be catalysts for on-going changes in classroom roles and in organizations because they tend to make learners more self-reliant. The kind of problem that a computer presents also encourages learners to work in a collaborative format and this frees teachers to function more as facilitators than as “talking heads” or lecturers (Means, 1997). To use computers as tools for accomplishing meaningful tasks is one of the many possible strategies that can help teachers to reach those learners who are unresponsive to the more traditional teaching methods of teaching that one might colloquially call the “chalk and talk” approaches (Hoerr, 2002). The theory of multiple intelligences harmonizes with teaching that is learner-centred because it suggests the use of assessment process that is more reliable and it takes the varying intelligences of the learners into account (Hoerr, 2002). Computer learning situations can provide an ideal format for assessing these multiple intelligences that are such an important part of our lives and that only now are beginning to be recognised in institutional learning situations.

Currently, the new methods of instruction that are learner-centered have become a matter of great urgency in our schools, where they have not yet been implemented because the current traditional methods, that consist mainly of drill and practice are not effective for teaching computer-assisted learning. Pelgrum and Plomp (1993, p. 6) describe how computers are used throughout the world in secondary education. Their study confirms that apart from presenting opportunities to engage in drill and practice, computers are used mainly to teach learners basic computer application skills. They (Pelgrum & Plomp) also made an important observation that most learners do not get opportunities to practise the skills they have learned in imaginative and challenging ways or to learn new and innovative skills and strategies from problem solving approaches that would encourage them to participate actively in the creation of their own learning. In other words, unique opportunities to implement activity-teaching methods that permit learners to exhibit individual drive and initiative and collaborative enterprise are being lost.

Gardner's (1983) theory of multiple intelligences is by implication critical of the deficiencies of the old-fashioned traditional view of intelligences that are skilled mainly in verbal linguistic and logic mathematical abilities. Teachers are therefore advised, on the basis of this understanding, to construct authentic tasks that will give their learners opportunities to use their multiple abilities, talents and intelligences to the full so that these less traditional modes of intelligence can be strengthened and enhanced and given their due weight and value in both personal and community life.

It is not the aim of the study either to prove or disprove Gardner's theory, but rather to use it as a framework for evaluating differences in learners' performance in the same task and identify the different interaction processes involved.

1.3 Background of the study

1.3.1 Current use of technology in schools

The use of computers in schools throughout the world is no longer confined to the major industrialized countries alone. This is evident from the 1999 International Association for the Evaluation of Educational Achievement (IEA) study as cited by Quellmalz and Kozma (2003). Also, another study conducted by Pelgrum and Anderson (1999) entitled Second Information Technology in Education Study: Module 1 (SITES M1), confirms the findings of other researchers who have shown that significant investments in educational information and communication technologies (ICT) have been made throughout the world and that a great deal of this investment has taken place in schools. This proliferation in the educational use of educational information and communication technologies has been driven and supported throughout the world by evidence that these new technologies can make schooling a much richer and more rewarding experience and so improve the quality of education that learners receive (Bracewell, Breuleux, Laferriere, Benoit & Abdous, 1998; Coley, Cradler & Engle, 1999; Means & Oslon, 1995).

These different studies however, have revealed that the benefits of educational information and communication technologies are that they can transform schools and classrooms by making it necessary to adopt new and improved curricula that focus on real world conditions and on simulations of such conditions. Educational information and communication technologies also provide scaffolding and tools for enhancing learning, and they give both learners and teachers more opportunities for feedback and reflection. The very nature of such technologies permits the creation and maintenance of local and global communities that include learners, teachers, parents, practising scientists and other interested parties (Bransford, Brown, & Cocking, 2000).

Such technologies also increase the demand for intelligent and precise accountability. Quellmalz and Kozma (2003) have noted that where public and private organizations make a major investments in sponsoring educational information and communication technologies in schools, there is a corresponding pressure to demonstrate that a worthwhile return on the investment has taken place. The attempts of documenting the real impact of educational information and communication technologies have not been significantly captured by traditional assessment approaches (Burns & Ungerleider, 2002; McFarlane et al., 2000). In support of this assertion, one may adduce the research undertaken by Crawford and Toyama (2002) who found that most of the tests that are conducted in schools tend to be techno-centric: that is to say, they test what learners know about the *technologies* and on how to operate them and little else. Forms of assessment that are not purely techno-centric are therefore required. Such forms of assessment will incorporate innovative approaches that will permit assessors clearly to discern whatever new forms of learning are associated with the use of educational information and communication technologies. What is most needed are forms of assessment that will reveal very clearly the ability of pupils to externalise the presence within themselves of the multiple intelligences that are present in all human beings. This will present a much richer, more layered and comprehensive picture of each pupil's individual worth and ability. It will therefore enable investors to obtain more detailed feedback on what their investment in educational information and communication technologies has achieved. The ability of learners to manipulate different features of a particular technology is but one small component of the bigger picture that gives an accurate reflection of what a learner has gained from a technology (Quellmalz & Kozma, 2003, p. 390).

1.3.2 Why are schools not using computers effectively?

An international survey and study undertaken in 23 countries by Pelgrum and Plomp (1991) revealed that the most pressing problem that schools encountered as they implemented the use of computers among their learners was a shortage of both software and hardware. This deficit obviously has impacted negatively on all attempts to integrate computers with existing lesson practices (Pelgrum & Plomp, 1991, p. 36). Pelgrum and Plomp also identified four problems that were most frequently mentioned in their surveys. These problems relate to

- lack of hardware
- lack of software
- the inability of teachers to find enough time to learn what they need to know about computers and to prepare adequately for lessons in which computers will be used and
- deficiency in applicable computer-related knowledge among teachers themselves.

These problems have forced teachers to fall back on a position in which they use drill and practice as their main teaching and learning approaches (Pelgrum & Plomp, 1991). Where learning about educational information and communication technologies is mostly integrated into the school curriculum as a subject that is called (variously) *computer literacy*, *computer science* or *information literacy* (Law & Plomp, 2003, p. 16). Other findings from the study by Pelgrum and Plomp, indicate that while learners are taught basic computer application skills, they do not get opportunities to use whatever other skills they may have or demonstrate other performance abilities. Apart from the fact that teaching and learning relies mainly on drill and practice procedures, the study revealed that computers are used in attempts to implement collaborative learning since teachers arrange classroom dispositions in such a way that 2-3 learners are made to share the available equipment such as a computer. Pelgrum and Plomp (1991) also found that learners are divided into groups that accommodate the availability of equipment rather than in terms of a considered didactic master plan that had been drawn up before the teaching programme commenced. This indicates how urgent is the necessity for a rational instructional process that takes all factors into account – one that will maximise the computer application skills that learners will find most helpful beyond the school system.

1.4 Tanzanian context

1.4.1 ICT status in the education system in Tanzania

Tanzania has made a remarkable progress in deploying educational Information and Communication Technologies (ICT) so as to redress unmet demands and competition in the newly liberalised markets (National ICT Policy, 2003). In the learning context however, very few educational institutions have computer laboratories or other multimedia facilities that can be used for teaching computer application skills to the majority of learners (Kafanabo, 1999). Such facilities tend to be found in private schools rather than in public schools. At universities and other higher learning institution the situation is similar: few computers are available for use by learners and the academic staff. Those that are available are too few to meet the demand for access and use. In addition, their scarcity creates numerous problems with regard to accessibility of facilities and their possible use in teaching and learning processes (National ICT Policy, 2003, p. 4).

As part of a government initiative to introduce computers in schools the Ministry of Education of Tanzania asked heads of schools to allocate and prepare a room that could be used as a computer laboratory. The main advantage of a common location remains in the cost-effectiveness in resource utilization: the evidence is that more teachers and learners use the computers for a greater fraction of the day (Becker, 1998). But the main disadvantage of computer laboratories is the inability of teachers to seamlessly integrate computer activities during a varied instructional day or period. Nonetheless, at present most government schools throughout the country have rooms that have been allocated and prepared for use as computer laboratories. But up till now, only a small number of schools have received the computers that were promised by the government (Tilya, 2003). Some schools have computers that have been donated by various organisations. Others have privately owned computers. But in most cases the computers are old models that have small memory capacities and no CD drives. Few of them are connected to the Internet and most are too slow and have too small a capacity to upload and present current educational software programmes (Kafanabo, 1999; Tilya, 2003).

Currently, the newer computers are not only faster and contain more memory for storing larger and more complex programs, but they can be equipped with features and peripherals that enable them to perform a wider variety of functions and to do so with less demand on the novice user. CD-ROMS for example, contain entire encyclopaedias and large motivating multimedia content. More exciting uses of computers for learners can be: desktop publishing, use of analytic graphing and calculating software, drawing packages, information gathering from encyclopaedias, electronic mails, and use of World Wide Web (Becker, 1998, p. 21).

1.4.2 Introduction of computers in Tanzanian secondary schools

The overall implementation of computers in schools is still in its early stages in Tanzania. Schools that have computers have between 4 and 20 and some of them have one or two computer laboratories. The infrastructure of the computer laboratories is still a serious issue because most of the computers are old and there is no networking. There are also no Internet connections or educational software in many schools. In addition, there have been no professional development in Tanzania on the educational information and communication technology front for teachers teaching subjects other than computer technology (National ICT Policy, 2003, p. 4).

In an attempt to make educational information and communication technology functional in a daily routine and in reality in the education system, the government of Tanzania, through Tanzania Institute of Education (TIE) officially introduced a Secondary School Computer Science Syllabus for Forms I to VI in 1996. Because the responsible officials knew that simply possessing the technology alone could never have any beneficial educational effect, they recognised that it was necessary to integrate educational information and communication technologies meaningfully with the curriculum and instruction. Only a few learners have up till now taken these courses. The lack of a proper and effective programme for training teachers to use computers and other multimedia has been identified as a major reason for relative lack of interest in computer studies programmes in primary and secondary schools (Tilya, 2003). In addition, the absence of well-established information and communication technologies professional profiles and standardized processes of evaluation and certification for the different courses that are offered in various training centres, have discouraged many who would otherwise have been interested. Where proper conditions prevail, the use of educational information and communication technologies is believed to enhance effective delivery in education. The benefits that accompany the utilisation of information and communication technologies in education have only been evident in some schools and colleges in urban areas of Tanzania (National ICT Policy, 2003, p. 4).

The biggest challenge that faces many schools in Tanzania now, which is the main concern of this study is how to integrate the computers that are available with teaching and learning processes in a normal classroom situation given the current infrastructure and resources. At the time of writing, there is not a single government school in Tanzania that is seriously implementing the new computer syllabus that appeared in 1996. Teachers do not take any initiatives to help learners to use the computers that are available for doing projects or for performing other educational tasks using performance competencies (other than computer skills themselves). Instead learners' are subjected to activities that include learning basic computer skills, drills, generic computer applications such as word processing for the purpose of general 'computer literacy', and more time is spent learning how to type on computer keyboards and to use word processing programs. What in fact happens now is that a handful of teachers use the computers for word processing and in some cases for processing examination results (Esselaar, Hesselmark, James & Miller, 2001, cited by Tilya, 2003). This means that no pedagogical expertise is present in most classrooms. The suggestion has been made by Means et al., (1993) that effective use of technology in the classroom is to provide learners with authentic learning opportunities and experiences. Teachers who have the necessary skills could use technological applications to simulate real-world environments and conditions for the benefit of learners who would then be able to get a taste of the kind of conditions that they are likely to encounter after they have left school.

By using computers as a catalyst for innovative learning and teaching, teachers will be able to exert a positive influence on learners who do not, for whatever reasons, flourish in the traditional time-hallowed classroom set-up with all its associated limitations and restrictions on the multiple intelligences of learners. In the computer-based teaching and learning environment, teachers can, for example, create innumerable plausible formats that simulate conditions that obtain in the world outside the school. Alternatively, teachers can arrange for their learners to work on tasks that have an immediate bearing on their own lives and the lives of those in the various communities, in which they live, work and play. Apart from the fact that a vast array of educational software already exists in various places, computers readily lend themselves to the creation of gaming formats that will if imaginatively applied, improve learners' learning skills and their awareness of their talents and potentials (Hoerr, 2002). Thomas Hoerr (2002) asserts that if teachers use a variety of formats to teach what in the past was only taught in conventional chalk-and-talk formats, the scholastic intelligence of pupils, as well as the multiple intelligences that I have referred to above, will be challenged, sharpened and extended without the excessive intervention that conventional teaching formats require from teachers. Innumerable formats are already available to teachers in the form of software. If teachers make judicious choices from among the various kinds of software that are readily at hand, they will be freed to some extent from the excessive amount of time-consuming preparation, moderation and petty administrative tasks that are part of any conscientious teacher's lot.

Teachers can then use the time that they gain in this way to work in an interactive way with learners. In a properly designed computer-assisted teaching environment, teachers become facilitators who move among learners in a helpful and supportive role rather than the sole authoritative focus of all modes of learning and achievement. The obligation for achievement in learning then shifts in a subtle but decisive way onto the shoulders of the learners themselves. They then have to make choices about what they want to learn, how they will learn it and the amount of effort that they are prepared to invest in their own learning and in interactions with their fellow learners. And then because the onus has shifted, the responsibility for learning also shifts. The teacher then becomes a facilitator and the repository (although by no means the sole one) of skills, knowledge and vision of where the teaching-learning enterprise might lead and how it can work to the learners' advantage.

In such conditions, many traditional problems are those that are historically associated with education, such as the discipline of learners and learner motivation. These problems then simply eliminate themselves over time as the purpose and ethos of a computer-based educational environment establish themselves in the teaching-learning milieu. Once a computer-based educational environment has established itself in the minds of teachers and learners alike and gripped the imagination of all concerned, the long-term value, importance and profitability of a computer-based teaching-learning environment becomes obvious to everyone, whether they are immediately involved or are merely observers. What becomes evident to all observers is that computer-based teaching and learning is not merely an extension of old, insufficient didactic methods; the old classroom in which boredom, meaningless repetition, puerility and unspeakable tedium and skewed power relations are the order of the day. What users and non-users of computer-based teaching and learning alike perceive is that the computer-based classroom (more rightly called a laboratory because a laboratory is based on hypothesis, experiment and skill) requires a radically new didactic model in which the teacher becomes a *facilitator*, and learners become self-actualising responsible citizens who are required to make their own decisions about their personal progress, application, discipline and future. Unless a computer-based teaching and learning environment operates according to this didactic model, no amount of expensive hardware and progressive software can prevent computer-based classrooms from becoming expensive failures, moribund enterprises and disappointing initiatives.

The use of multiple intelligences approach to teaching must be “learner-centred” if it is to be effective and a product of excellence. It is up to teachers to change the way in which learners acquire authentic learning, and this can only be done by changing the didactic model on which they base their teaching. The theory of multiple intelligences implies that each human being is an inexhaustible treasure house of potentials. Traditional methods of teaching in which all lines of authority, knowledge and aspiration converge on the doubtful figure of the traditional pedagogue, simply do not work effectively in a computer-based teaching and learning environment. The computer-based environment – given adequate, up-to-date facilities and properly trained teachers – permits on-going, authentic assessment that gives credit to learners in those areas where they are most powerful and effective. The theory of multiple intelligences allows teachers to move away from assessment strategies that measure primarily logic mathematical and linguistic skills. Of course such skills are important. But they need to be evaluated alongside a great number of other kinds of intelligence that the theory of multiple intelligences postulates.

It is clear that traditional teaching has failed in many ways and that it cannot deliver the kind of education that is absolutely necessary in a modern world that depends increasingly on computer-related skills, perceptions and attitudes. Computer technology, which changes and improves itself literally on a daily basis, has given birth to a new kind of human being – one who is skilled in all the arts, methods, techniques and procedures that are required in a computer-dominated world. Anyone who is not skilled in these requirements will be left behind in the race to improve the prospects for all human beings on this planet. Of course there will always be a place for the paraphernalia of the old forms of teaching. But they will be used in new and innovative ways as adjuncts to a largely computerised world rather than as the primary ritual tools in the discredited authoritarian talking-head classroom sunk in the torpor, obsolescent methods and pre-technological accessories of ages past. The old classroom was predicated on the essentially fraudulent omniscience and unquestionable authority of the teacher. The new one will be more tentative, empirical, unpretentious, inventive and democratic than the old. But everything new is built on what has gone before. When we attempt therefore to install computer-based teaching and learning on a sound basis, we will have to recycle our old ideas and premises and retain what was valuable in the past in the new and challenging world of the computer-based classroom.

1.4.3 Why has the use of technology failed to improve the quality of instruction or learner achievement?

Conventional schooling is fundamentally flawed because the work that learners are required to perform has no *intrinsic* meaning or value to learners beyond the achievement of success in school. In many schools in Tanzania, for example, in those few cases where they are actually used to teach *learners*, computers are mostly used superficially, randomly, listlessly, and with no sound didactic justification for the teaching and learning of basic techniques (Tilya, 2003). The basic techniques to which learners are exposed to, include how to utilize hardware by turning monitors and central processing units on and off, loading software, controlling input with a mouse, and manipulation of the keyboard. At present, this process is outdated as more and more learners come to school already having been exposed to the use of computers at home. Currently the challenge is on how to use these same computers in the schools in a much more meaningful and productive way. Al-Bataineh and Brooks (2003) for example, noted that the successful integration of technology requires the effective implementation of learning theories, content-specific approaches to curriculum development, and effective assessment measures that will capture evidence that learning has occurred (McNabb, 2001, p. 52).

The Computer Studies syllabus introduced in 1996 by the Ministry of Education and Culture of Tanzania supports the use of alternative assessment or performance assessment as one of the teaching strategies that should be used by teachers for the effective teaching of computer studies as a subject. The syllabus indicated that teachers are advised to use “activity-based teaching methods” and a “problem solving approach”, and that they should allow learners to obtain direct experience by working on the computers themselves (1996, p. iii). Teachers were also advised that the problem solving approach should include discovery activities and learner projects (p. iii). All these teaching methods were considered by those who compiled the curriculum to be effective in promoting higher order thinking skills. But none of these approaches are currently being used in Tanzanian schools.

1.4.4 Science education in Tanzania – the current situation

This section deals with the current situation of science teaching in Tanzanian schools. It is common knowledge that the teaching and learning of sciences has deteriorated in many schools. There is among many learners a profound aversion to science and its sister subject, mathematics. This common knowledge motivated me to devise an instructional method that can be used to improve the teaching and learning of science using computers in Tanzanian schools. The method that I developed comprised, in the main, open-ended (Zevenbergen, Sullivan and Mousley, 2001; Goodnough, 2003) digital learning tasks that I applied to selected topics from the Biology syllabus. This material can be readily integrated with the teaching and learning of computer application skills.

The current teaching and learning of sciences in Tanzania, changes in format as learner’s progress upwards through the different grades. In primary schools for example, learners are taught what is called general science, which is a combination of biology, physics and chemistry and it suits these levels. These science subjects are not taught in-depth, and usually learners are only acquainted with the basic concepts of each subject. When the learners reach the O-level grades or the junior secondary school in Tanzania, the science subjects are differentiated into biology, physics, and chemistry, and are then taught as different subjects. In each of these subjects, learners are taught theory and are given a selected number of practical activities to complete. This trend continues into A-level grades where each branch of the science is taught in greater depth and where learners are given more practicals to complete.

Science classes in Tanzania are conducted in two major ways. The first way requires learners to attend normal classroom sessions in which learners are equipped with scientific facts, concepts and principles that are given to them by their classroom teacher. Thus, knowledge is then refined and expanded by (among other methods) self-reading and group discussion. The second way requires learners to perform practicals in laboratories in different educational settings in which students, usually in small groups, interact with materials and equipment and observe various resultant phenomena.

The most recent revision of the science syllabuses in Tanzania that occurred in 1996 was necessitated by the drastic changes up to that time in science, technology and society. These changes required that radically revised curricula be produced and implemented. The curricula concerned had last been revised in 1976. The changes thus introduced were designed to satisfy the expectations of society and make learners competent in such skills as they would need in their later careers. The ultimate purpose of the new curriculum was to equip secondary school graduates with whatever skills and competencies they would need to adapt and adjust in the rapidly changing world of the competitive job market (Tilya, 2003, p. 10).

Revised curricula were produced for all academic subjects although innovations were more prominent in the sciences than in other subjects. For the science curricula, new topics that reflected the demand for knowledge about environmental issues and new technological developments were added. The addition of these new topics implied that more content would have to be covered in the same period of time allotted because very few existing topics were removed from the old curricula. In addition to existing subjects, the entirely new subjects of computer literacy and computer science were introduced. Although the implicit teaching approach in all the curricular documents was decidedly learner-centred, this approach was not overtly addressed in the new syllabuses.

Although these changes in the curricula were very progressive, they posed difficulties for the implementation. Firstly, all the science syllabuses required that a great deal of content be covered within the stipulated period. Secondly, the syllabuses were written as schemes of work. Ideally the teaching of this content required that a large number of activities be performed. But the logistics of organising and presenting such activities to the learners concerned were beyond the capacities and abilities of the subject teachers – perhaps even beyond the organising capacities and abilities of *any* human being no matter how resourceful, well meaning or well qualified. The system as defined by the new syllabuses was therefore overloaded beyond anything that it could humanly bear and so was programmed for failure.

Thirdly, very few extra supplementary readings were suggested for the teachers and the learners. As a result, teachers were forced, as they tried merely to *cover* everything required by the syllabus, to direct the attention of learners mostly to content to the detriment of giving proper attention to activities that would enable learners to understand the science concerned by means of active involvement on their part. Because teachers were compelled to rush through topics in order to "cover" the syllabus and so prepare learners for their examinations, the quality of teaching was severely compromised – and not as a result of the best intentions of the teachers concerned on whose desks the proverbial buck stopped. Teaching methods were also naturally heavily influenced by the assessment methods of the National Examination Council of Tanzania who decreed that final examinations would consist mainly of written answers accounting for 60% and practical work accounting for the remaining 40%. In the remaining 40%, it also includes project activities for the learners, which accounts for 5%.

The predominant teaching format in Tanzanian secondary schools, as well as in the schools of most sub-Saharan countries, is the traditional teacher-centred lecture which emphasizes the transfer of knowledge and skills and which rewards rote learning, drill and memorization (Chonjo, Osaki, Possi & Mrutu, 1996; de Feiter, Vonk & Van der Akker, 1995, cited in Tilya, 2003). Such a mode of teaching allows very little interaction between the teacher and the students or among the students themselves in the classrooms

(Tilya, 2003). Though such an approach, under the best of circumstances and as part of a larger didactic picture, can be said to have some pedagogical merit, it is flawed, compromised and inefficient as a general didactic and pedagogical strategy. I have dealt with the deficiencies of the traditional teaching methods at some length in the previous section (above).

The most that can be said for it is that it can be an efficient method of conveying a lot of information in situations where there are insufficient printed materials or where the teacher cannot effectively control the rate of transfer of content in a classroom. Even then, inability to grasp and transfer material can seriously compromise even talented learners, especially in subjects such as the sciences where material is frequently complex and intricate and in which it must be transferred and recorded *correctly*. Such disadvantages ensure that the school and classroom can do little to produce the type of nurturing environment that will allow learners to reach their full potential (Green, 1995).

Yet more research undertaken by Chonjo et al., (1996) confirmed that the traditional classroom is less effective because it is authoritarian (teacher-centred), dogmatic and inflexible. This kind of approach may function well in institutions such as the lower ranks of the army where blind obedience to authority is necessary if the system is to function properly. The sheet tenacity and historical durability of this blind-obedience-and-mindless-conformity paradigm in education and elsewhere can be traced back to cultural beliefs in *all* societies in terms of which people actually *prefer* not to be given any choice to think for themselves and so reach their own conclusions. One can see why this kind of paradigm is so tenaciously adhered to in authoritarian emergent societies – especially unstable societies that are in transition or under siege from the challenges of modernism. In such societies, and even in less threatening circumstances, teachers (and all leader figures) are regarded as tribal elders who must be "respected". This means that learners or dissidents must not under any circumstances challenge them.

Because the teaching process in Tanzania is based on traditional teaching methods, it specialises in transmitting to learners a body of knowledge and the study of problems that have little if any relevance to most learners. Science education in Tanzania therefore relies far too heavily on the memorization of facts and not enough on attempting to understand the relevance of knowledge and its possible application to local contexts (i.e. the use of authentic tasks) so that when learners go out into post-school situations, they will be well equipped for what they find there. Lopez (2000) asserts that it is vital for developing countries to re-conceptualise and reform science teaching by including an array of authentic tasks that come to grips with burning developmental issues such as water supply, health – HIV/AIDS, industrial development, and environmental degradation and conservation. If the knowledge conveyed to learners was conceptualised so that its application was relevant to the real needs of real people and situations in the immediate society of learners, learners would rapidly become scientifically literate and competent and the knowledge they obtain would be of immense value to both themselves and to the people of the communities to which they belong.

Biology in Tanzania is a compulsory subject for all O-level secondary school learners. The reason why it was made compulsory was because it was felt that learners should have a fundamental understanding of the more important life processes that surround them. Biology, for example, gives learners an understanding of important health issues such as the HIV/AIDS pandemic, malaria and cholera, which are endemic diseases in Tanzania. Biology subject also teaches learners about genetic engineering, environmental pollution and conservation. In the current school situation in Tanzania where authoritarian didactic modes are the norm, a great number of learners absent themselves from biology classes and even from biology examinations.

As a result, science subjects and biology in particular, are becoming more and more unpopular. Studies undertaken by Ogunniyi (1996) and Muwanga-Zake (2004) have identified some of the reasons why this is so. Problems predictably include a serious undermining of teacher morale among teachers of sciences, the overloading of science syllabuses, totally inadequate time allocated to teachers for the preparation of practical classes and the care of laboratory equipment, overcrowded (and therefore largely unteachable) classes, fewer opportunities for promotion among science teachers, and teachers doing far less than is necessary to promote in-depth science education in classroom situations. Finally, very few learners who select science as a subject in school finds themselves in schools that do not cultivate the habits of mind that are necessary for scientific literacy (Perkins, 1992).

The proper assessment of learner activities is as vital in science education as it is in other subjects. Current methods of assessment that involve paper and pencil examinations with their reliance on multiple-choice questions, matching items, and true or false questions are, as I have already noted above, totally inadequate because they cannot give a well-rounded and therefore reliable overall view of a candidate's understanding and ability. Wiggins (1997) suggests, and I am in total agreement with him, that the only kind of assessment that has any real value is one that is called authentic assessment. This is assessment in which learners reveal the whole range of their multiple intelligences by grappling in a meaningful way with knowledge, issues, problems and opportunities that are similar to those that occur in wider society and that are therefore undeniably relevant to everyone in that society.

In this study, in which I focus on the teaching of science education in Tanzania, where science is a compulsory subject from standard three of primary school to O-level secondary school, science education is beset with innumerable problems. These problems can be identified in the science syllabuses, in curriculum materials, in didactic and pedagogical teaching, and in the professional development of pre-service and in-service teachers in science education. My conviction is that by using instructional procedures and specially designed formats that have proved their worth in other subjects, situations and contexts, we can go a long way towards eliminating some of these problems and reconstructing science education so that it will benefit not only the learners themselves but also the Tanzanian society itself.

1.4.5 Current practices of assessment in computer studies in Tanzania

Assessments can take the form of tests and essays which in themselves can be an important part of instructional process (Alessi & Trollip, 2001). Instructional assessments undertaken at the end of the learning process can provide information about the level of learning that has taken place, the quality of teaching and future instructional needs. Alessi and Trollip (2001) are of the opinion that many instructors and learners alike usually place too much emphasis on assessment as a means of assigning grades.

The theory of multiple intelligences suggests an approach to assessment that does not evaluate by means of short-answer tests. Rather, it studies the performance that is being evaluated directly, whether it is verbal linguistic, logic mathematical, kinaesthetic or social presentations. Assessment moreover should never confine learners to just one mode of self-presentation but should always allow learners to demonstrate their understanding in a variety of ways (Gardner, 1997). Gardner (1995, p. 204) suggests that the following caveats should circumscribe the assessment of multiple intelligences:

> Intelligences ought to be seen at work as when individuals are carrying out productive activities that are valued in a culture. And that is how reporting of learning and mastery in general should take place. I see little point in grading individuals in terms of how linguistic or bodily kinaesthetic they are; such a practice is likely to introduce new and unnecessary form of tracking and labelling. As a parent, or as a supporter of education living in the community, I am interested in the uses of which learners intelligences are put; reporting should have this focus (p. 204).

The implementation of performance assessment in most of the school systems in Tanzania is highly problematic and unsatisfactory. All learners in schools are required to take the national examinations prepared by the National Examination Council of Tanzania (NECTA). Teachers prepare learners for these examinations by using traditional teaching strategies and assessment methods. It seems that it would be difficult to mandate performance assessment in secondary schools because in the traditional Tanzanian educational environment, teachers have always used (and been required to use) long-established modes of assessment and examination and are therefore not trained to understand and implement performance assessment. Contrary to what some may think, performance assessment is a demanding and exact skill in which teachers need precise and adequate training if it is to be the effective tool that it can be in the hands of a skilled user to teach and be assessed in traditional ways.

Schools in Tanzania are under pressure both internally and externally to abide by conventional long-established methods of evaluating learner performance. In Tanzania such methods are comprehended in the time-honoured examination system. Because no teacher would (or should) be willing to open himself or herself to criticism by departing from what heads of schools, the ministry of education and the parents of learners expect, performance assessment would have to be mandated from the top (by order of the ministry). It would then be necessary to train teachers in this mode of assessment so that it could be an effective and trustworthy tool for pedagogical purposes – one that would be sanctioned by the community, which is the end consumer of all educational services. While there will always be people who criticise innovation, it is necessary, when innovating, to train the personnel concerned as thoroughly as possible in the skill required so as to anticipate and forestall uninformed or merely prejudicial criticism.

Any operating system has its own values and procedures that make it unique on its own. Both schools and the community in Tanzania, with the government acting as agent and guarantor, reward and endorse what they value and have come to accept as the "right" way of doing things. Learners are therefore categorised at the end of each academic year in terms of the results of the examinations for which they were entered. In Tanzania this allows learners to see how they were assessed and graded, and to see also how they stand in relation to their peers, other schools in the district and in the national context.

The National Examination Council of Tanzania and schools themselves prefer to use standard examinations because they are the form of assessment that is supported by the school and the government – and the system which learners understand and expect, however flawed it may sometimes be in concept and actuality. Appendix 1.1, for example, shows an examination that was prepared by a schoolteacher for the learners who were doing computer studies. The paper consisted *entirely* of multiple-choice questions, matching items and short answer questions. This is the kind of examination paper that the learners in Tanzania have to attempt in order to be graded for their performance. Appendix 1.2 shows another example of an examination paper; this is a National Examination paper that also consists entirely of multiple-choice questions, matching items and short answer questions. It is immediately clear that examination papers set in this format support only memorization and recitation of facts and that they moreover favour those learners whose strengths lie in the areas of traditional intelligences (verbal linguistic and logic mathematical). It is also obvious that there is no scope for the presentation or appreciation of multiple intelligences in such a system of evaluation and assessment.

Gardner (1983; 1992) therefore, insists that if teaching is to be fair, just, scientific and (most importantly) *accurate*, it needs to have instruments in place that will examine and assess the multiple intelligences that all human beings possess and not just a narrow range of traditional skills (those identified above). According to Gardner (1992) and Chapman (1993), a preferable method of assessment would permit the multiple intelligences of learners to be scrutinised so that the many facets of human intelligence and endeavour that we all use in everyday life could be appreciated and credited as worthy of recognition and note. If such a system were implemented, teachers themselves would enjoy much greater scope for their own personal creativity, skill, authority and initiative. They could, for example, use still and video cameras to capture how learners interact with one another, use open-ended rubrics to assess learners' project and task documents which might include poems, stories, paintings, journals and drawings. All these modes provide evidence for how learners demonstrate their skills, understanding, as well as their creative and critical thinking (Chapman, 1993).

Learners who are blessed with this particular combination of intelligences are likely to do well on most kinds of formal test, even if they are particularly adept in the domain actually under investigation (Gardner, 1992). Paper and pencil tests do not permit the measurement of many worthwhile learning outcomes and forms of intelligence because they are not best measured with tests of this kind. Although this form of assessment is being ever more widely used by teachers and measurement specialists, Gardner (1992) advocates that alternative assessment offers the best means of obtaining information about the skills and potentials of individuals and is moreover more likely to be fair to the individual being assessed.

For instance, it has been recognized that the concept of emotional intelligence is a factor that should be considered in the development of criteria for the assessment of performance of learners. The idea of emotional intelligence is based on the links between social and emotional intelligence and educational outcomes such as learning, cognitive development and job success (Weare, 2004). It has been argued that if we look at those who do well educationally, the differences in work outcomes and personal success observed are more dependent on their emotional and social abilities than on their IQ.

Since the beginning of the 20th century, there has been an increasing focus on relationships, teamwork, communication and management skills (Weare, 2004) and these are essential features of multiple intelligences. Several researchers (Cohen, 1999, 2001; Elias et al., 1997) have noted that the ultimate aim of emotional intelligence work is to help produce more socially minded citizens as well as a more flexible, resilient and effective workforce. The concept of emotional intelligence has gained currency because of the realization of the cognitive level required in dealing with problems that are typically encountered in life such as solving conflicts, collaborating with others or adjustments to new environments that were not captured by traditional approaches to intelligence (van der Zee et al., 2002). Though these problems are social in nature, it is generally assumed that emotional intelligence is predictive of social success.

Boekaerts (1993) and Goleman (1995) opined that learning can be facilitated or hampered by emotions and that emotions drive learning and memory development. It was argued that emotional intelligence is a cognitive ability that overlaps considerably with Gardner’s notion of personal intelligences, subsuming both intra and interpersonal forms of intelligences.

1.5 Purpose of the study

The purpose of this study is to investigate the interaction between multiple intelligences and the performance of learners in open-ended digital science learning tasks.

1.6 Statement of the problem

The current traditional school curriculum in Tanzania is heavily weighted in favour of learners who score highly in verbal-linguistic and logical-mathematical intelligence tests of the kind that are widely used in secondary schools. In such circumstances, it becomes a matter of great urgency for Tanzania to offer a more balanced range of curriculum and learning activities that incorporate, recognize and respond to the different needs and abilities (multiple intelligences) of learners. The theory of multiple intelligences provides a theoretical foundation for recognizing the abilities and talents of learners that the conventional schooling system has hitherto ignored in many parts of the world.

This theory acknowledges that, while all learners may not be verbally or mathematically gifted, they may indeed possess decisively important qualities and expertise in other areas such as music, spatial relations and a whole range of interpersonal and intrapersonal skills. If protocols existed in Tanzania to permit the assessment of a much wider range of skills and personal qualities, learners who are now marginalised by an outdated and unsuitable system would be able to receive due recognition for their unique contributions and assets. This research is designed to permit learners to participate in classroom learning that is facilitated by the use of computers and thereby gives evidence of the multiple intelligences that they possess. With modifications, this design could become the prototype for implementing computer-assisted teaching and learning in classrooms throughout Tanzania and wherever else the same conditions apply.

My assumption is that the current mode of assessment is both skewed and unfair to most learners. The problem I set myself was to design a protocol that would enable me to perceive multiple intelligences directly in a classroom format, using computers with minimum technical resources that I had predetermined rather than by means of the customary time-honoured paper-and-pencil tests that is predominant in Tanzanian schools. My further assumption is that it is a matter of considerable concern for the education system in Tanzania to discover and utilize modes of assessment that make use of authentic and open-ended tasks and that are therefore able accurately to reflect those skills, attributes and qualities that each individual learner possesses.

1.7 Critical research question

How do learners with different intelligences engage with and execute open-ended digital learning tasks?

1.8 Design of the study

The study used a qualitative research design and employed several data collection instruments which are questionnaire and interviews, open-ended tasks, and observation checklist. My aim was to describe and explore the interactions between multiple intelligences and the performance of the learners in open-ended digital learning tasks in the context of computer studies and the teaching of a science subject (Biology) in a classroom situation. A descriptive approach was used to record the interactions between multiple intelligences and the performance of learners in open-ended digital learning tasks (Creswell, 1998; Merriam, 1998; Patton, 1990). The research was conducted in Dar es Salaam and the Iringa Regions of Tanzania in four selected secondary schools. A purposeful selection of the schools was done so that I would get access only to schools that had computers with floppy and CD drives, (whether or not they had Internet connections did not matter). I also purposively selected learners from form two and form three (equivalent of grades 9 and 10) for the study because these learners were taking computer studies courses in their schools.

I used Howard Gardner's (1983) theory of multiple intelligences as the theoretical framework for the study. According to the theory of multiple intelligences propounded by Gardner (1983; 1996), there are eight different intelligences, which he classified as follows: verbal-linguistic, logic-mathematical, visual-spatial, bodily-kinaesthetic, musical, interpersonal, intrapersonal and naturalistic. For the purpose of this study I focused on only four intelligences, namely logic-mathematical, verbal-linguistic, visual-spatial and interpersonal intelligences. I based the selection of these four intelligences on the performance assessment procedures that I used. These comprised three open-ended digital learning tasks that learners were required to complete with the use of computers. These tasks were executed and completed in a classroom situation, using only the available resources (computers with no Internet connection or CD drives, but with properly functioning floppy drives) and this constitutes the first criterion. The second criterion considered the expertise of the researcher and the school teachers (Wiggins, 1993).

I based the assessment of the learners' performance abilities on an interpretive understanding of the theory of multiple intelligences by looking at the strategies and skills that learners preferred and used to complete the tasks and how these abilities were reflected in their task documents and presentations. Learners' strengths and weaknesses in verbal-linguistic, logic-mathematical, visual-spatial and interpersonal intelligences were analysed in terms of scoring that had been defined in the rubrics. Different formats for gathering data included observations, interviews, learners' documents, presentations and scoring according to predetermined rubrics.

The learners were given three different open-ended digital learning tasks. Each task had to be completed within a week. The learners were asked to work collaboratively in pairs and were observed and videotaped as they interacted with their open-ended digital tasks, both in their paper work and as they worked on the computers. At the end of each open-ended digital learning task, the learners presented their work to their peers by using power point presentations. These presentations were also videotaped and were used during the analysis process. After working on all three learning tasks, a focus group interview was conducted (four learners in each group) with the researcher. Separate interviews were conducted with teachers and the parents of the learners. These interviews were face-to-face in format. All the interviews were recorded by means of an audiocassette recorder with the prior permission of those being interviewed.

I saved all learner documents that contained the record of their solutions to the open-ended tasks and those that recorded information about their presentations to floppy disks. In the document analysis process, all the documents and school progress reports of the learners in the sample were analysed in terms of the scoring rubrics. All recorded interviews and videos were transcribed and collated in appropriate forms with the analysis of the documents. Collectively, the analysis of all the data was interpretive and descriptive with the aim of identify significant patterns, constructs and interactions between multiple intelligences and the performances of the learners (Gall et al., 1996).

1.9 Significance of the study

The results of this study will contribute to relevant knowledge bases, especially to those that are concerned with the theory of multiple intelligences as it pertains to the instruction and planning of open-ended tasks. The importance of this study is to provide information for teachers and curriculum developers as to how the practical application of multiple intelligences theory may take place in a classroom situation. The aim was also to show that open-ended, mainly computer-based tasks can be used effectively in the teaching and learning processes if they are augmented with appropriate forms of learner assessment processes. This study would be able to show that learners can benefit from innovative instructional methods, where computers can be used successfully in classrooms to teach learners, and that assessment methods and protocols that are based on performance assessment process are much more comprehensive, useful and fairer to learner-centeredness than the conventional tests and didactic methods that are widely used in schools in Tanzania and elsewhere.

Assessment institutions of Tanzania and especially assessment of computer-based tasks have to consider designing tasks that will promote learners diversity that is other intelligences, and other cognitive and personal strengths that are not recognised by traditional assessment instruments due recognition and credit.

1.10 Delimitation of the study

The study is confined to learners who were taking computer subjects in the schools that participated in the study. The learners had to complete all the open-ended digital learning tasks on computers because they were required to present their documents (data) in computer-based presentation slides in order to show that they were indeed competent enough to be rated as having improved their new computer application skills. In addition, a qualitative research design was employed that made use of several data collection instruments including observations, learners' documents, presentations, completed task documents, school progress reports, and manila sheets (with visual drawings). Interviews and questionnaire schedules were also used to obtain information from the teachers, parents and learners who participated in the study. The analysis of learners' documents and school progress reports was done using scoring rubrics.

1.11 Limitations of the study

The aim of the study was to use computers to identify the instructional process that would allow me to use the theory of multiple intelligences as the framework of the study. I therefore made a purposive selection of schools that had computer laboratories and working computers that had functional floppy and CD drives. Learners were also those who were doing computer courses at the time of the research. Because of these selection criteria, only four schools were able to participate in the study.

Assessment of the performance abilities of the learners was limited to the open-ended digital learning tasks that required learners to use whatever resources were available in their schools. The resources that were available to the learners were only those that were compiled by the researcher and saved on the computer hard drives. It was not possible to use internet as all schools did not have internet connections.

Lastly, the assessment of performance abilities was limited to four intelligences listed by Gardner in the theory of Multiple Intelligences. These intelligences are namely logic-mathematical, verbal-linguistic, interpersonal and visual-spatial.

1.12 Preview of the study

A qualitative research process and findings from the investigation of the interaction between multiple intelligences and learners' performances in open-ended digital learning tasks study is presented in the subsequent chapters.

Chapter 2 presents the theoretical framework. Firstly, the origins and definition of the theory of multiple intelligences as presented by Howard Gardner in 1983 are discussed and their implications for the school curriculum are dealt with. Secondly, the assessment of learner performances are considered in those cases where the researcher devised an alternative assessment concept as the rational basis for assessing learners' multiple intelligences as they worked on the open-ended digital learning tasks that are part of the research design. The chapter also discusses the ways in which open-ended digital learning tasks can be used as an instructional method that allows learners to use their multiple performance abilities in the course of the learning process. Chapter 2 concludes with a recounting of the route that individual teachers may take if they themselves wish to prepare effective learning tasks that utilise multiple performance assessment strategies for use in their own teaching.

Chapter 3 presents the methodology that scaffolds the study. This chapter analyses the qualitative research process that is used in this study. It includes a discussion of the open-ended digital learning tasks and performance assessment strategies that were used as well as the authentic tasks, rubrics and learners' documents that were incorporated in the data collection instruments.

Chapter 4 consists of a discussion of the research findings of the study – the performance abilities of the learners, variations in intelligence profiles, and the interaction between multiple intelligences and performance of the learners.

Chapter 5 concludes with reflections on the study itself, with the conclusions that can be drawn from a consideration of the research question, and the implications of the findings and recommendations for future research.

✍ 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.

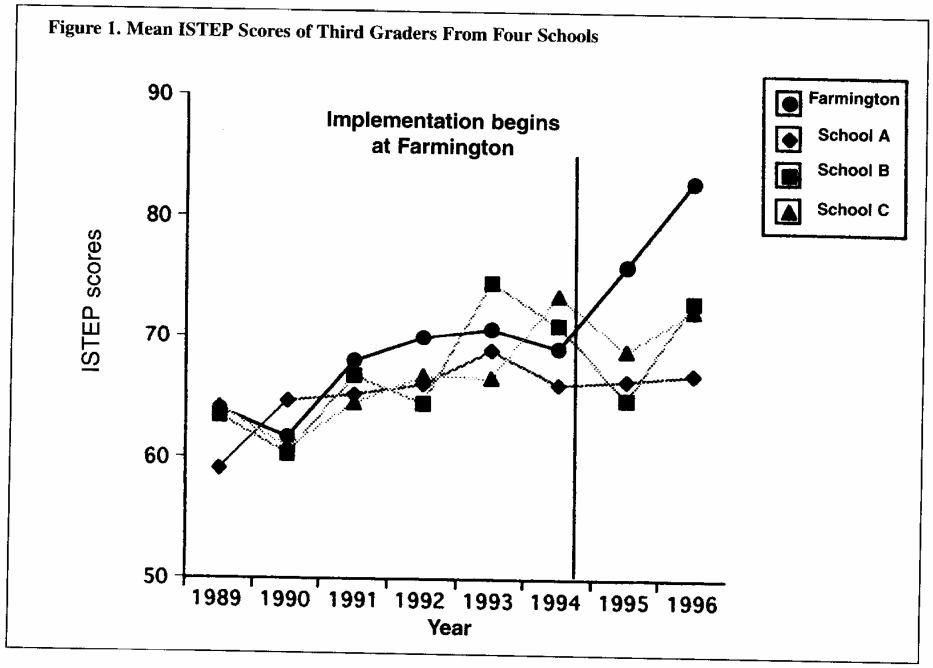


Figure 2.1: Increase in school scores in Farmington Elementary School.
Source: Mettetal, G., Jordan, C., and Harper, S. (1997).

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.

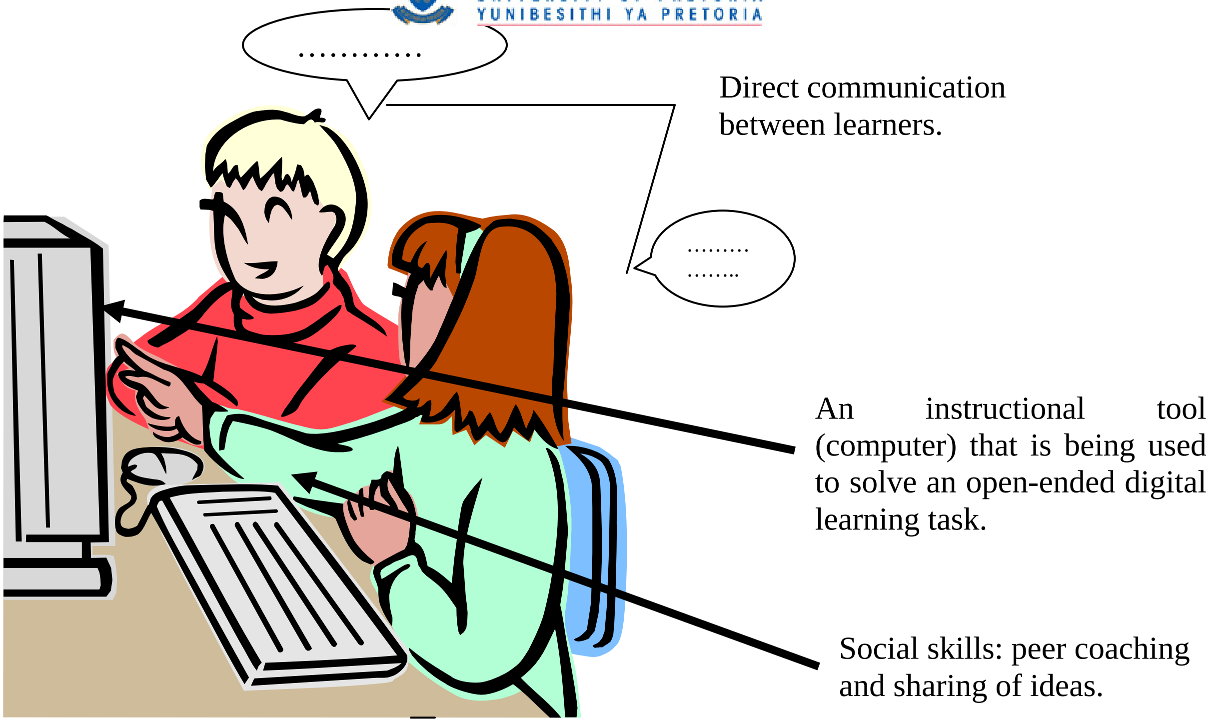


Figure 2.2: Collaborative learning and interpersonal skills

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).

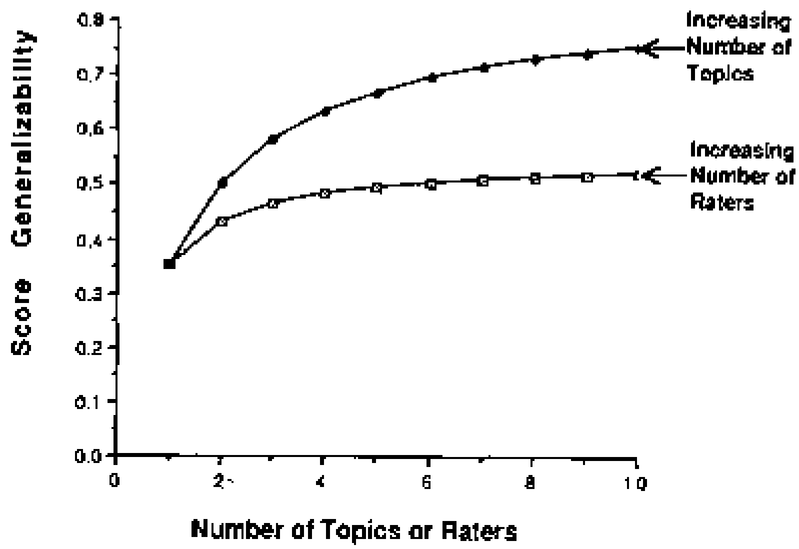


Figure 2.3: Score generalizability of general impression content quality scores of extended history tasks as a function of number of history topics and number of raters (Baker, 1992).

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).

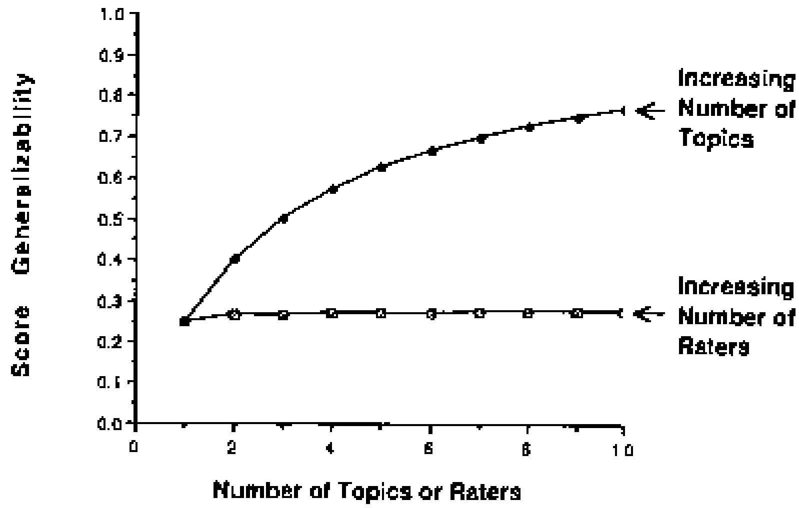


Figure 2.4: Score generalizability of QUASR Form D mathematics score estimated from rater paired 13. Based on S. Lane, C.A. Stone, R.D. Ankenmann, and M. Liu (1992).

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.

✍ Chapter 3 – Research Design and Methodology

This chapter describes the research methodology that was used in the study. A ***qualitative research method*** *was used to understand the interactions between multiple intelligences and the performance of learners as they engaged in the open-ended digital learning tasks that were constructed to accommodate the research design. The chapter reviews and describes in detail the different data collection strategies that were used in the study. These include open-ended-digital learning tasks, observations, scoring rubrics, questionnaire and interviews. This is followed by an explanation of the data analysis procedure, the interpretive method that was used. The chapter concludes with an explanation of the different validity and reliability measures that were implemented during the study as well as a consideration of ethical issues.*

3.1 Introduction

In the literature review in chapter 2, I gathered, assessed and analysed the information that constitute the guidelines that will inform this chapter about the theory of multiple intelligences. In the first place, I described and reviewed Gardner's theory of multiple intelligences that challenges the conventional and widely applied view of intelligence as a unitary capacity that reflects the verbal-linguistic and logic-mathematical aptitudes that are measured in traditional IQ tests.

Gardner (1983) then posited the theory that intelligence is pluralistic and that everybody has at least eight intelligences. Gardner (1983) then defined intelligence as an ability to use at least eight forms of intelligence to solve problems or create products that are valued in a particular culture. These eight intelligences reflect the different ways in which learners interact with the world. If teachers want to give their learners the greatest possible scope for their learning activities and personality development in the school situation, then they have to develop strategies to structure learning activities around problems and projects that will give learners a sufficient number of opportunities to demonstrate these skills and understanding in ways that reflect all eight intelligences. Such strategies should also be designed to evoke the uniqueness of each learner. Such a system implies that learning activities have to be developed should give evidence of a variety of learning preferences and abilities – as opposed to those that are only able to give evidence of logical-mathematical and verbal-linguistic intelligences.

Kornhaber, Krechevsky and Gardner (1990, p. 192) argued that if one hopes to obtain a rounded and comprehensive summation of the multiple intelligences of learners as posited by Gardner's theory of multiple intelligences, then one needs to adopt an 'intelligence fair' assessment process. By this they meant that the assessment processes that are to be used should be 'fair' to the learner who is being assessed. That is the assessors should be certain that the assessment instruments have sufficient capacity and diversity to allow learners to demonstrate all their eight intelligences by using intelligence-appropriate media and contexts rather than by relying exclusively on paper and pencil tests, and short answer questions. This can be done by use of alternative assessment or performance assessment.

Alternative assessment or performance assessment can be used to allow learners to demonstrate their capabilities directly by creating some product or engaging in some activity (Gardner, 1983; Haertel, 1992). Performance assessment process relies heavily on the assessor's observation and professional judgment of learners' products and responses. Mehrens (1992) suggests that the best way to achieve the expected results with accuracy, reliability and the possibility of replicability by other assessors is by using scoring rubrics. It should be noted that when ***alternative assessment*** is mentioned in this study, the phrase refers to the assessment of learners' performances (abilities) while they are working on open-ended digital learning tasks and so revealing the unique combinations of their multiple intelligences.

Therefore, the aim of this research study is to investigate the interaction between multiple intelligences and performance of the learners in open-ended digital learning tasks by using performance assessment process in a classroom situation. The study explores how learners with different intelligences engage in or execute open-ended digital learning tasks provided.

3.2 Theoretical framework – concepts on performance assessment

In this study, I conceptualise ***performance assessment*** as a set of open-ended digital learning tasks, and assessment instruments. These assessment instruments comprise a multiple intelligence survey questionnaire, a school progress report, scoring rubrics, observation checklists and assessment framework that use the concepts of the theory of multiple intelligences. The following figure exhibits the linkages between the open-ended digital learning tasks and the assessment instruments and how they are used together to produce performance assessment.

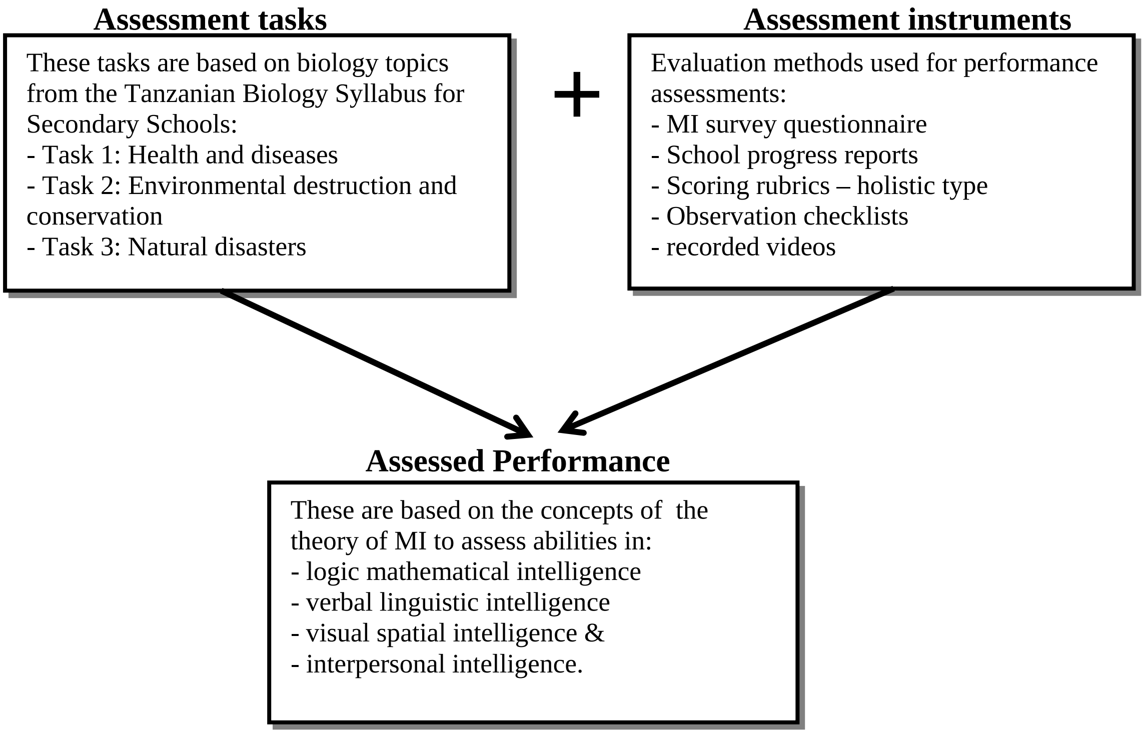


Figure 3.1: A conceptual framework of performance assessments.

The characteristics of tasks and assessment methods determine the performance assessments that were used in the study. The analysis in this section will be conducted in terms of the following subsections:

1. *Assessments tasks.* These include three open-ended digital learning tasks that present the learners with authentic tasks that they have to complete by using their skills and by engaging in social interactions that (all taken and considered together) will give evidence of ***all*** their multiple intelligences.

2. *Assessment instruments*. These include multiple intelligence survey questionnaire, school progress reports, holistic type of scoring rubrics, observation checklists, and recorded videos of learners working on open-ended digital learning tasks.
3. *Assessed performances*. These were constructed in terms of the concepts and performance abilities considered in the theory of multiple intelligences with preference to four intelligences these are: logic-mathematical, verbal-linguistic, visual-spatial and interpersonal intelligences.

3.3 Research design

The research design that I chose for this study is a **qualitative research approach.** Qualitative research was chosen in order to get an understanding of the interactions between multiple intelligences and performance of the learners in open-ended digital learning tasks by using performance assessment process in a classroom situation. Some of the data collection strategies that were used in the study include interviews, observations and questionnaires.

Data was gathered and used inductively to build concepts (Merriam, 2002) in an attempt to understand whether learners have performed according to their intelligence profiles and how learners perform across several intelligences when engaged in the same open-ended digital learning tasks.

I used Gardner's (1983) theory of multiple intelligences as an overarching theoretical framework in order to give the design of the data collection process coherence and plausibility. I collected the data in two main stages. In the first stage, I determined learners' intelligence profiles by using a multiple intelligence survey questionnaire and school progress report. In the second stage, I observed the learners as they worked on their open-ended digital learning tasks and then assessed the ways in which each learner performed and combined the information with the evidence that was contained in their task documents and presentations. I then interpreted the results of each learner's performance abilities in the open-ended digital learning tasks as they emerged as they worked on their tasks during the observation process. The interpretation of these results also included a ***descriptive approach*** that utilised a contingency table to describe the relationship between multiple intelligences and learners' performances in open-ended digital tasks (Patton, 1990; Merriam, 1998; Creswell, 1998). I needed all this information and data so that I could answer the following critical question that is at the heart of my research study: ***How do learners with different intelligences engage in or execute open-ended digital learning tasks?***

3.3.1 Research paradigm

As I have already noted above, I selected an ***interpretive paradigm*** for the knowledge claim that I make in this study. The crucial point in this study is to understand how learners' intelligence preferences and performance abilities display themselves while they work on tasks – in this case, the open-ended digital learning tasks in a classroom situation that constitute this study. I had to search intensively before I found descriptions and explanations that would finally give proper shape to the data that I got from the study (Tashakkori & Teddlie, 2003).

My first problem was to consider the number of intelligences to which I would confine myself for the purposes of this study and what descriptions, performances and explanations I would regard as valid and sufficient for attesting to intelligences that I selected. For the purposes of the study, I focused on only four intelligences, namely, logical-mathematical, verbal-linguistic, visual-spatial and interpersonal. The selection of these four intelligences was based on the performance assessment procedures that I used in the design of the research. I felt that these intelligences could be accurately expressed by the authentic tasks elicited by the three open-ended digital learning tasks that I devised for the sample of learners. It required the learners in the sample to perform and complete these authentic tasks in a classroom situation by using only the resources that were available there (i.e. computers with no Internet connection).

The second problem that I had to consider is the one raised by Wiggins (1993) and relates to the expertise of the researcher and school teachers in such situations. If the researcher (or teachers), for example, do not have or do not possess any formal training in musical or kinaesthetic fields, how can they design instruments or experimental situations that will test such abilities? In the end, because of my own limitations, I based my assessment of the learners' performance abilities on a limited range of four kinds of intelligence that I knew I would be able to assess accurately and fairly. The intelligences that I selected to assess learners' abilities in this study were verbal-linguistic, logic-mathematical, visual-spatial and interpersonal. I designed the research in such as way that learners could use these four intelligences as a prism through which they could assess the reflected intelligence strengths, weaknesses, strategies and skills as they performed on the open-ended digital learning tasks.

3.3.2 Data collection strategies

The data collecting instruments that I used in this study include semi-structured interviews, an observation checklist, semi-structured questionnaires and documents used for analysis (school progress reports, learner's task documents and presentation documents). I therefore used several data collection instruments to construct my understanding of the multiple perspectives that learners brought to the performance of their tasks (Creswell, 1998; Merriam, 2002).

Before embarking on the data collection process, ethical issues involving human participants were taken into account. First, a research clearance letter was attained from the University of Dar es Salaam, to allow me to conduct the study in the selected schools. Second, a letter from the Regional Education Officer in both Regions was used to gain access to the selected schools. Third, consent letters were used to ask permission of participation of the parents and the learners who participated in the study. More importantly, the ethical issues in this study included the confidentiality of all the participants, the informed consent of the parents/guardians of the learners who participated in the study, and a proper relationship among the researcher, the learners, the teachers, the parents, and the school administration. The identity of the schools and individuals who participated in the study have been protected because they were all allocated letters that informed them of the use of pseudonyms in the reporting phase of the study (Gall et al., 1996).

3.3.2.1 Stage 1 of data collection process – Multiple intelligences survey questionnaire and learners school progress reports

The first part of the data collection process required me to use a multiple intelligence survey questionnaire and the school progress reports of the learners in the sample to identify the multiple intelligence profiles of the learners who participated in the study.

(1) Learners' Multiple Intelligence Survey questionnaire

The multiple intelligence survey questionnaire used is a standard instrument that was used to determine a learner's multiple intelligence profile. I adapted my questionnaire from the one that is obtainable from McKenzie (1999) of Surf Aquarium Consulting (http://surfaquarium.com/MIinvent.htm). The inventory questionnaire was used to identify learner's strongest and weakest intelligences. In order to make the instrument applicable to Tanzanian conditions and learners, I had to make changes in some of the items so that they would suit the Tanzanian cultural context and the level of understanding of the learners in the sample. This, for example, I changed the original item "My home has a recycling system in place" to "In my home, we sometimes reuse some things such as bottles". I administered the multiple intelligence survey questionnaires to all 40 learners at the beginning of the study in each school.

(2) The learners' school progress report

I collected copies of the learners' school progress reports from all the schools that participated in the study. The progress reports recorded annual subject scores (marks or grades), and indicated the current level of academic attainment of the learner concerned. I used these school progress reports to validate the results that I obtained from the multiple intelligences survey test instrument. According to Armstrong (1998), Krechevsky (1998) and Teele (2000), a school progress report can provide important information about the learner's performance abilities in different intelligences. If, for example, a learner's grades are high in **mathematics** and the **sciences** (physics, chemistry and biology), and in **literature** (English and other languages), then the school progress report will tend to offer supportive and corroborative evidence of strength in logical-mathematical and verbal-linguistic intelligences (Gardner, 1993; Armstrong, 1998; Campbell, Campbell, & Dickinson, 2004).

3.3.2.2 Stage 2 of data collection process – Open-ended digital learning tasks, reading resources and saved documents

Before learners were given permission to begin working on their open-ended digital learning tasks, I held a collective preliminary session with all of them. In these sessions I carefully explained and taught some of the computer application skills that they would possibly need until each learner was proficient. These computer skills included *Microsoft Excel*, *Power Point* and *MS Word* (in which they were shown how to use clip art, pictures, graphs and colours). I deliberately introduced computer application skills to the learners so that they would have a wider range of choices with which to express themselves as they worked on their open-ended digital learning tasks. At the same time it was an opportunity for the learners to learn new computer application skills that were not taught in these schools.

(1) Open -ended digital learning tasks

In preparing the open-ended digital learning tasks, I considered all aspects of the Biology syllabus for secondary schools in Tanzania (Forms 1-4 of 1996), and selected topics that I thought would be of interest and successfully investigated by the learners who participated in the study. I selected the following topics from the Biology syllabus: (a) health and prevention of diseases, (b) environmental degradation and conservation, (c) natural disasters and effects to the ecosystem. In my selection of the open-ended digital learning tasks, I also considered what importance and relevance the selected tasks would have on 'real-world' concerns outside the school environment and the extent to which they would therefore be ***authentic***. All these tasks engaged the learners with problems that are common in their communities in Tanzania and which are therefore authentic.

In completing these tasks, learners had to use their knowledge of Biology and computer skills to complete the tasks effectively and creatively. A total of three learning tasks were prepared from three different topics. These were: (1) The water in the community is infected with microbes – Don't drink the water!! Is it cholera or typhoid fever? (2) Waste disposal problem in the community – Landfill problems!! Air pollution and health hazards. (3) Ship disaster – The MV Bukoba Tragedy!! What can numbers tell us about her vital voyage?

These three open-ended digital learning tasks are further described in the following sections:

- **Task 1:** Don't drink the water!! Is it cholera or typhoid fever? Learners were asked to read the text resources provided about diseases and then choose one of the diseases for which they were asked to devise an educational strategy that they would use to educate their community on the transmission of microbes and/or other infective agents, symptoms, treatment and the prevention of the disease. They had a choice of using a flyer, a poem, radio or television programme as their educational strategy.

- **Task 2:** Landfill problems!! Air pollution and health hazards. Learners were asked to read the resources on landfills and their effects on the environment. Their educational programme had to suggest the advantages and disadvantages of landfills, and suggest strongest reasons why a community should campaign against the beginning of any new landfill on their community land. They then had to plan a campaign that would galvanise their community to protest against a new landfill in their community by using either posters, letters to their village leaders, a community rally, or a radio programme.

- **Task 3:** The MV Bukoba Tragedy!! What can numbers tell us about her vital voyage? I purposely planned this task so that learners would have to find out the facts about how MV Bukoba disaster that occurred in 1996. They had to say how many people had died (divided into categories of men, women and children), and how many people survived. The learners were then required to write a story and present the data in tables and graphs, and also develop a plan of action that would suggest precautions and offer advice to the government on how they might prevent such tragedies in future. (For all the documents relating to these tasks, see appendix 3. 2).

I expected learners to complete all the three tasks that I prepared by using resources provided and the computers available in the schools. This necessary use of computers did not compel learners only to exercise their logical-mathematical intelligence because the tasks were unrelated to computer programming. For computer programming, learners need a good background in mathematics and they need to be able to reason logically. In this research, learners purposefully used the computers as a means for completing and presenting their tasks.

In the cause of action in checking the validity of the open-ended digital learning tasks developed, I utilised a computer program called **Flesch-Kincaid Grade Level Scores** to check whether the standard of the materials that I had prepared as a researcher were suited to the grade level of the learners and whether the materials could be read and understood with ease. In both instances, the suitability was confirmed by this program.

(2) Reading resources used in the study

The researcher deliberately created these materials as a resource that learners could use if they needed help in the completion of their tasks as they worked on the computers. My first intention during the research design phase was to give all learners an opportunity to search for their own information on the Internet. But because none of the participating schools had functioning Internet connections, I decided, as an alternative, to collect whatever information they might need for preparing the tasks from different websites and to load this information onto CDs for learners. The reading resources they needed were thus available on CDs. But because the computers that the learners used did not have CD drives, I alternatively had to save all the reading resources on the CD onto the hard drives of their computers. The reading resources were intended (1) to stimulate the learners intellectually by giving them a central place to use their reading skills and ***intelligent selection of materials needed for their*** research activities, and (2) to compel learners to give evidence of ***self-management skills*** as they selected content that was relevant to their tasks.

(3) Saved documents - open-ended digital learning task documents and presentation documents

The learners saved all their documents on floppy disks and the data on these floppy disks was later printed and used during the assessment and analysis process. These printouts gave me a total of 112 documents. Fifty six of these contained the solutions to the open-ended digital learning task documents that the learners had typed in *Microsoft Word*. The other set of 56 documents comprised presentation documents that the learners had prepared on *Microsoft Power Point.*

3.3.2.3 Stage 3 of data collection process – observation process

(1) Observation checklist

I used a structured observation checklist with observable characteristics of intelligent behaviours to identify learners' performance abilities for **interpersonal intelligence**. The way in which I used this checklist for observations was firmly based on the concepts of the theory of multiple intelligences and the literature review that was done on open-ended digital learning tasks. The checklist was used by me, the researcher, and by one of the school teachers (the co-observer) to observe learners as they worked at their open-ended digital learning tasks in each school.

Before the start of each observation, I arranged a preliminary session between the researcher (myself) and the teacher (the co-observer). In this session, we discussed how we would use the checklist, what it was that we might be observing, and the nature and general purpose of the observations that would arise out of the checklist. In this preliminary session, I gave the co-observer every opportunity to ask questions, criticise the procedure, and ask any questions that he/she might have about the process and the research design in general. I used a three-scale profile instrument to quantify interpersonal intelligence. This instrument allowed us to decide whether the learner's performance ability was high, medium or low (see appendix 3.3 for the checklist). If the learner scored 3 points in the interpersonal intelligence instrument, he or she was rated **high** in this form of intelligence. If the learner scored 2 points in the interpersonal intelligence instrument, he or she was rated **medium**, and if the learner scored 1 point, then he or she was rated as having a **low** interpersonal intelligence. I calculated an average score for each learner by taking all the three scores that each learner scored in each task (task 1, task 2 and task 3) and divided this by 3.

In total we (me the researcher and the teachers in each school) observed twelve sessions over three tasks each in schools M, N, O and P. All the observed tasks were completed by the learners by using computers that were already present and available in the computer laboratory in each school and that conformed to the research requirements. All the presentations that learners made were from their personal computers (PCs) on which the learners had constructed their presentations. As each learner gave his or her presentation, the other learners gathered around and had to listen to the presentation, ask questions, discuss what they had heard and seen. Once a particular group of learners has completed their presentation, all the learners moved on to the next computer, and so on. None of the schools in the sample had a data projector for presentation purposes and so could not be used in the study.

In order to ensure consistency of the data collected during observation, the researcher (myself) and the teacher (the co-observer) were engaged in a reflection session in which we discussed each of our observations and any matters that arose from these observations. We also wrote up a small report on what we had observed while the events that we had witnessed were still fresh in the minds. I later combined and summarised all the events that pertained to each learner and rated him or her as having a high, medium or low intelligence according to the scales identified by the protocols. I also used the video recordings of activities to complement the observation field notes that were compiled by the teacher and myself (the researcher). During the analysis stage, all the video recordings were transcribed and coded and logically amalgamated with the field notes. All the codes were then sorted in terms of recurrent themes.

3.3.2.4 Stage 4 of data collection process – interviews and questionnaires

There also was another instrument to collect data for this study. This instrument was the semi-structured interview schedule. It consisted of interviews with teachers and parents in a face-to-face sessions and learners in focus group sessions. I used all these instruments sequentially during the data collection process (Tashakkori & Teddlie, 2003). I also followed the suggestion of Denzin (1988) and subjected the data to triangulation after having employed different data collection strategies as a method of ensuring validity. What follows is a discussion of each interview schedule.

(1) Focus group interviews with the learners

I conducted a face-to-face interview sessions with all the learners. All 40 learners took part in the focus group interviews. There were a total of 12 focus groups with three to four learners in each group. In each group, we had a 30-minute discussion that took place immediately after the completion of all three open-ended digital learning tasks that the learners had been asked to complete. The focus group discussions were conducted in the computer laboratory. This gave learners an opportunity to express their views about the use of computers as instructional tools, what computer skills they had learned, their views on the open-ended digital learning tasks that they had just completed, and their participation in and contribution to the learning tasks in terms of performance abilities and teamwork.

I used a semi-structured interview schedule and utilised questions that I had derived from the multiple intelligence theoretical frameworks and the literature review. All the discussions were recorded on video and audiocassettes, which were later transcribed for analysis. All important information identified in the transcripts were highlighted, coded and sorted according to different and recurrent themes. This categorisation process was important for bringing together and giving coherence to the meaning of the data collected (Ryan & Bernard, 2000). The interview schedule that I used can be viewed in appendix 3.4.

(2) Teacher interview

I based the teacher interview schedule around the activities that learners performed in class as they completed the open-ended digital learning tasks, presentations and performance assessment activities. The interview questions in this interview were semi-structured and they gave me an opportunity to probe for more information (see appendix 3.5 for the interview schedule). I used the interview schedule to obtain teachers' views about the learners' performance abilities because they had observed the learners working on the open-ended digital learning tasks and their presentations. I questioned teachers about their views in relation to the particular pedagogy that was used – a pedagogy that made use of authentic tasks and computers, and assessment procedures that made use of rubrics, observation of learner's performances in interpersonal intelligence and computer application skills and collection of the open-ended digital learning task documents.

The interview was arranged into a face-to-face session between the researcher and the teachers. I conducted these interviews with individual teachers in their schools immediately after the learners had all completed their last open-ended digital learning task. The interview sessions were 20 minutes long for each teacher, and with his or her permission I recorded all the interviews on a cassette recorder and later transcribed them for analysis. After all the interviews had been transcribed, I coded all the responses that they had made to different questions. After all the statements from different participants had been coded, I made the final analysis.

(3) Teacher demographic questionnaire

This questionnaire, which I prepared for all the four teachers involved, was a structured questionnaire. I used this questionnaire to obtain the biographical data of the teachers concerned. The instrument was developed by the researcher and contained six items. The information that was collected included the academic qualifications of the teachers, their teaching experience and their teaching subjects. The questionnaire was administered to all four teachers immediately after the observation sessions. Appendix 3.6 contains a sample of the questionnaire. The analysis of the questionnaire was collated with the results of the interviews.

(4) Parent interview

The interview questions in this interview were semi-structured and it gave me an opportunity to probe for more information about the learners' background and performance abilities from the parent's point of view (see appendix 3.7 for the parent's interview schedule). I used the interview schedule to obtain parents' views about the learners' performance abilities because they know their children and they have observed their children since they were small. I questioned the parents about their views in relation to the particular behaviour or performance ability that is obvious in their children, how do they help them support this performance ability and what are their future plans for their children.

The interview was arranged so that it consisted of a face-to-face session between the researcher and the parents. I conducted these interviews with individual parents in their offices and sometimes at their homes. The interview sessions were 20 minutes long for each parent and with their permission I recorded all the interviews on a cassette recorder and later transcribed them for analysis. After all the interviews had been transcribed, I coded all the responses that they had made to different questions. After all the statements from different participants had been coded, I made the final analysis.

(5) Parent demographic questionnaire

This questionnaire, which I prepared, was given to all parents involved in the study. The questionnaire was a structured questionnaire. I used this questionnaire to obtain the biographical data of the parents concerned. The instrument was developed by the researcher and contained six items. The information that was collected included the academic qualifications of the parents, their working experience in years and their residential areas. The questionnaire was administered to ten parents after they have completed the interview session. All the parents where from Dar es Salaam Region. Appendix 3.8 contains a sample of the questionnaire. The analysis of the questionnaire was brought together with the results of the interviews.

3.3.2.5 Stage 5 of data collection process - Assessment of learners' performance abilities using holistic scoring rubrics

I used performance assessment procedures to assess the open-ended digital learning task documents and presentations of the learners. A performance assessment procedure was characterised by a variety of evaluation strategies that maximise learners' opportunities to display what they actually know in ways that are familiar to them (Moll, 1988; Ortiz & Maldonado-Colon, 1986, p. 265). The evaluation strategies that I used in this study included observation checklists, scoring rubrics, video recordings, and field notes. The purpose of the performance assessment process was to trace whatever performance patterns might be exhibited by learners as they worked on the open-ended digital learning tasks. The emphasis in this process was on the ***consistency*** of the learners' performance abilities (intelligences) as they used their Biology knowledge and computer application skills in all three tasks. Observation checklist was used to assess the learners' performance abilities in interpersonal intelligence as they worked on the open-ended digital learning tasks.

(1) Holistic scoring rubrics

A holistic type of scoring rubric (see appendix 3.9) was used to score the task documents and presentations that were saved on floppy disks by the learners themselves. After scoring all the documents in each task, I calculated an overall average score from the three open-ended digital learning task documents and the Power Point presentation documents of each individual learner. The average scores were then grouped into three performance categories, which were: **above average** (AA), **average** (A), and **below average** (BA). If a learner's average score was 2.5–3, he/she was categorised as being above average, whereas 1.5–2.4 meant average, and 1.0–1.4 meant below average. To avoid biases during the analysis of the learner's task documents, the four teachers together with the researcher calculated an inter-rater reliability coefficient for all the tasks that were marked.

3.4 Research methodology

3.4.1 Study profile Geographical context

The study was conducted in four urban secondary schools in Tanzania. Three of these schools were government secondary schools in the Dar es Salaam Region, two of the schools were in the Ilala District, and the third school in the Temeke District. The fourth school was a private school in Iringa Region. Iringa Region is situated in the southern part of Tanzania.

3.4.2 Sampling - schools, learners and teachers

The context and purpose of this study required learners to use their Biology knowledge and computer application skills. It was therefore necessary to find schools that had computer laboratories and learners who were taking computer studies as a course to participate in the study. I used a *purposive sampling strategy* to select the sample of schools and the sample of learners who ultimately participated in the study (Tashakkori & Teddlie, 2003). The criteria that I used were that the schools concerned should have enough computers (that is between 10-20 computers) and that the learners concerned should have enrolled for and be participating in computer courses.

The learners would have to use these computers to complete three open-ended digital learning tasks. Because I found that most of the government secondary schools that I visited during the study did not have more than ten working computers and not more than ten learners who were doing computer studies as part of their courses in forms two and three, I was forced to select four different secondary schools to participate in the study. From these I was able to select a requisite number of learners who would be able to provide the information that I needed to shed light on the research question under study (Patton, 1990). I therefore selected four schools for the study. All of these schools had at least one computer laboratory with more than six working computers in them at the time of the study. The identity of the schools used in the study is shown in Table 3.1.

Table 3.1: Schools that participated in the study

School	**District**	**Ownership**	**New name**
Coeducational	Ilala	Government	**M**
Coeducational	Temeke	Government	**N**
A girls’ school	Ilala	Government	**O**
Coeducational	Iringa urban	Private	**P**

All the government schools that participated in the study had computer laboratories that were privately owned. In each case, a private operator had bought and installed all the computers and printers as a business venture, while the school itself had provided a room to serve as the computer laboratory. Computer studies as a subject was then offered to learners on commercial (private payment) basis. This meant that any learner who wanted to do or take computer studies as a course had to pay a fee to the owner of the computers. The fees for the computer course varied from school to school (they are as shown in Table 3.2). As a result presumably of this added expense, very few learners had enrolled in computer studies in the higher classes.

Between nine and eleven learners from each of the research schools voluntarily agreed to participate in the study, thus making a sample total of 40 learners. Twenty learners were in Form 2 and 20 learners were in Form 3. Of these, 23 were female and 17 were male learners. The age distribution of the learners ranged from between 13 and 19 years.

Four teachers, one teacher from each school, were involved in the research study as co-observers. My initial plan in the design phase was to get two biology teachers from each school who were responsible in teaching these learners biology course to participate in the study. But since, as it has been noted above, the computer laboratories were privately owned, most teachers were not allowed into the computer laboratories in terms of the agreement between the computer owners and the schools themselves. Three of the teachers who participated in the study were teachers who taught mathematics and computer studies. The fourth teacher was the only one who taught biology and chemistry. These teachers participated in this study as co-observers engaged in specific tasks during the presentation sessions and while the learners worked on their open-ended digital learning tasks. These same four teachers also participated in the reflection sessions with the researcher. Table 3.2 provides the summary of information about the schools, the learners and the teachers who participated in the study.

Table 3.2: Summary of information about the schools, the learners and the teachers

Details	School – M Teacher (Tm)	School – N Teacher (Tn)	School – O Teacher (To)	School – P Teacher (Tp)
Learners' education level	Form II	Form II	Form III	Form III
Number of learners	11	09	10	10
Age of the learners (in years)	13 - 16	14 - 18	13 - 17	14 - 19
Gender of the learners	Females 7 Males 4	Males 9	Females 10	Females 6 Males 4
Computer literacy of learners	Basic skills	Basic skills	Basic skills	Basic skills
Completed tasks per school	3 (three)	3 (three)	3 (three)	3 (three)
Hours spent working on learning tasks	04 hrs/day	04hrs/day	04 hrs/day	04hrs/day
Duration (days)	15	15	15	14
Computer studies fees in TShs per annum	40,000.00 or US$36.00	30,000.00 or US$27.00	20,000.00 or US$18.00	15,000.00 or US$13.00
Internet connection	No connection	No connection	No connection	No connection
Teacher's educational qualification	Diploma in Education	Diploma in Education	Certificate in Information Technology	Diploma in Education
Teaching experience (in years)	18	16	02	05
Gender of the teacher	Female	Male	Male	Male

Note: Rate for US $ was calculated on the date when the study was done.

3.4.3 Implementation of the tasks

The time taken to complete the data collection process was four months, and that was between December 2003 and March 2004. I spent five working days per week over three weeks in each school. In each research venue, the learners were all given the materials that they needed for the open-ended digital learning tasks in hard copy in a flat file, and the reading resources were saved for them electronically to their computer hard drives. The reading resources were saved onto the hard drives because most of the computers were old and did not have CD drives. Some of the computers that did have CD drives could not read the CDs that had been prepared for the study. The computer literacy of the learners was considered to be ***basic*** in terms of the syllabus that was being followed in the schools. Each group of learners that participated in the study came from the same class, that is, from Form 2 or Form 3. It was therefore assumed that they all possessed the same level of biology content knowledge and were roughly equally proficient in computer literacy skills.

Before the study was conducted, all the correct official procedures were adhered to. Heads of schools were informed about the study, and in each case they have their official permission to the researcher to proceed. As the study needed the participation of the learners for more than 3 hours per day after school hours, it was necessary also to obtain the consent of the parents or legal guardians of the learners who participated in the study. Written permission was also obtained from the owners of the computer facilities because the learners were using the computers after school hours. In both cases, such permission was granted.

In general, the administration at the various schools was supportive. Although some of the teachers were interested in the study, they explained that they would be unable to apply computer technology in their classrooms because they did not have access to the computer laboratory. They also said that they were computer illiterate and that there were no government plans to train them in computer skills in the future. Since the government has failed to provide the schools with computers, computer courses had been commercialised and were therefore only available to those who could afford to pay for them. Many teachers themselves could not also afford to pay for the computer courses on offer and this was a source of great frustration to most of them.

3.5 Data analysis procedures

Together with all those collaborating in the study, I collected data over a four-month period by using all the instruments that have already been mentioned. The data analysis process in this study followed an **interpretational analysis approach.** This means that the data was analysed by interpreting the identified significant repetitive emergent patterns, constructs, and themes (Tesch, 1990; as cited in Gall et al., 1996). The data itself was obtained from the multiple intelligence survey questionnaires, school progress reports, open-ended digital learning task documents and presentations, interviews, and observation checklists that identified how learners revealed their multiple intelligences and performance abilities in the open-ended digital learning tasks and in their personal interactions with one another.

3.5.1 Readability statistics of the open-ended digital learning tasks

A computer program called **Flesch-Kincaid Grade Level Scores** was used to check the standard of the materials prepared by the researcher in terms of readability and ease of understanding. A readability statistics was calculated to show if the materials were of the same grade level with the learners. This readability statistics is a computer programme found in the *Microsoft Word programme*.

Readability statistics are mathematical formulae that are designed to assess the suitability of text documents for learners of particular grade levels or learners in defined age groups. The readability formula cannot measure features such as the interest or enjoyment of the reader, how comprehensible a text may be to readers, and whether the text is suitable for the particular needs of specific readers. Readability formulae are usually based on one semantic factor (the difficulty of words) and one syntactic factor (the difficulty of sentences). Words are then either measured against a frequency list or are measured according to their length in characters or syllables, and sentences are measured for their average length in characters or words (http://www.gopdg.com/plainlanguage/readability.html). In this way, the Flesch-Kincaid Reading Grade Level was used to determine the readability level of the tasks. 'Are the learners able to read and understand the tasks with ease?' is a question that the instrument purports to answer. A readability statistic was calculated from all the open-ended digital learning tasks that I had prepared for the study.

The Flesch-Kincaid Reading Grade Level scale measures reading from 100 (easy to read) to 0 (very difficult to read). For most standard documents, the approximate score should be about 60 to 70 for learners in Grades 8 to 10 if one expects that they will be able to read with ease (American standard). The American Grades 8 to 10 are equivalent to Tanzanian grading forms 1 to 3.

After I had applied the Flesch-Kincaid Grade Level Score to the open-ended digital learning tasks that I had prepared, I determined that learners from the grades that would participate could read the text of the tasks with ease. In fact, the learners managed to read and understand the learning tasks with very little help from the researcher (see appendix 3.2 for the open-ended tasks used in the study). Table 3.3

shows the results of the readability statistics for the tasks that were prepared for the study.

Table 3.3: Readability statistics for tasks 1, 2, and 3

Criteria	Task 1	Task 2	Task 3
Passive voice sentences	36%	18%	26%
Flesch Reading ease	54.2	52.2	64.7
Flesch-Kincaid grade level Tanzanian standard -	10.1 (Form 3)	10.1 (Form 3)	8.5 Form 2)

3.5.2 Cohen's kappa statistical measure for inter-rater scores in open-ended digital learning tasks and presentation documents

A holistic type of scoring rubric was used to score all the learners' tasks and presentations that were saved on floppy disks. The researcher and the teachers who participated in the study together did the scoring of the tasks. For fair assessment of the tasks and presentation documents, I used Cohen's kappa statistical measure to calculate the inter-rater reliability coefficient for all the tasks that were marked.

Cohen's kappa reliability coefficient (K) is a measure of percentage agreement corrected by chance agreement. It uses the following equation (Tinsley & Weiss, 2000):

$$K = \frac{P_o - P_c}{1 - P_c}$$

Where:

- P_o = the proportion of the ratings in which the two judges agree.
- P_c = the proportion of ratings for which agreement is expected by chance.
- K = Cohen's kappa reliability coefficient.

The proportion of ratings for which agreement is expected by chance (P_c) was calculated by taking the highest value that a learner could score in the tasks (which was 3), and the perfect agreement among the judges which is 1. P_c is then 1/3 = 0.33, i.e. the proportion of ratings for which agreement is expected by chance in this study.

The maximum possible kappa coefficient is 1. A kappa coefficient of 0.61 represents a reasonably good overall agreement or a significant degree of agreement between the raters. Landis and Koch (1977, p. 165) suggested the following benchmarks, which I also used in this study for interpreting kappa reliability coefficients.

Kappa coefficient	**Strength of Agreement**
= 0.00	Poor
0.00- 0.20	Slightly poor
0.21- 0.40	Fair
0.41- 0.60	Moderate
0.61- 0.80	Substantial
0.81- 1.00	Almost Perfect

The results of the inter-rater reliability coefficient for all three tasks, and for all the learners, was 'substantially' good to 'almost perfect', with an overall agreement of between 0.74 and 0.82, as is shown in Table 3.4. This means that the learners' performance abilities that were identified in their task documents and presentations, were highly significant and permitted high agreement scores between the researcher and the teachers.

Table 3.4: Cohen kappa reliability coefficient for all three tasks

Open-ended digital learning tasks	**Task 1**	**Task 2**	**Task 3**	**Average of all 3 tasks**
Kappa coefficient	0.82 (Almost Perfect)	0.74 (Substantial)	0.78 (Substantial)	0.78 (Substantial)

3.5.3 Analysis of the multiple intelligences survey questionnaire

The multiple intelligence survey test instrument provides a measure of all the nine intelligences identified by Gardner (1983; 1996). Each intelligence is represented by ten statements that describe the behavioural patterns of each intelligence. All the learners who participated in the study were given the multiple intelligence survey test instrument and asked to indicate whether or not each statement was characteristic of their behaviour by checking 'yes' (see appendix 3.1). Scores were computed by counting the number of 'yes' responses in each intelligence group. The scores were then categorised into the following three categories: a score of between 8 and 10 items is ***high***, a score of between 5 and 7 is ***medium***, and a score of between 1 and 4 is ***low*** in the categories of logical-mathematical, verbal-linguistic, visual-spatial and interpersonal intelligences. I used this multiple intelligence survey test instrument to identify the primary intelligence profile of all the learners in the sample. The validity of the results depended upon the respondent's willingness, frankness and honesty in answering the questionnaire. I then validated the results obtained by using other instruments such as the learners' school progress reports.

3.5.4 Analysis of learners school progress report

The school progress reports from the different schools reflected between 10 and 14 subjects. I grouped three different subjects with similar performance abilities together and classified them under the heads of the three main intelligences (logical-mathematical, verbal-linguistic and visual-spatial intelligences). I did not include interpersonal intelligence because its assessment would have required more observed performance abilities than I was able to include in the research design and because I was using written sources for validation. I grouped mathematics, physics and chemistry – subjects that need an ability to use and manipulate numbers to solve mathematical problems and identify numerical relationships – under logical-mathematical intelligence.

For evidence of verbal-linguistic intelligence, I considered learner performance in English, Kiswahili and French language subjects. Verbal-linguistic intelligence is indicated by an ability to use language skills (such as the possession and application of a good vocabulary and sentence structure, an ability to communicate verbally, and, for school-going learners, an ability to express oneself in different but related tasks in science problems, languages and the social sciences. For the visual-spatial intelligence of the learners in the sample, I considered their performances in geography, biology, and computer studies because, in these subjects, learners need performance skills in drawing images and pictures by using charts, maps, diagrams and the ability to use colours.

In order to assess the learner's possible performance ability from the school progress report, I calculated an average score from the three subjects in each intelligence for each individual learner. I then grouped the average scores into the three categories of high, medium and low. Where a learner had an average score of between 70 and 99% I assumed that his or her intelligence was high. For cases where it was between 40 and 69%, I assumed that it was medium, and cases where it was between 10 and 39%, I assumed that it was low. I calculated these scores and values for logical-mathematical intelligence, verbal-linguistic intelligence, and visual-spatial intelligences. The researcher thus knew beforehand the learner's intelligence profile that had been identified in this way. The teachers who participated as co-observers in the observation sessions were not informed of the learners' profiles. In this way, the teachers who were participating acted as a control to prevent the researcher from influencing the results.

The scoring procedure that I used to assess the learners' tasks and the presentation documents followed the examination scoring criteria that are used in Tanzania by the National Examination Council of Tanzania. The scoring criteria are as indicated below.

81% - 99% - A: (Distinction).
61% - 80% - B: (Above Average)
41% - 60% - C: (Average)
21% - 40% - D: (Below Average)
0% - 20% - F: (Fail)

I selected a participant observer method for us (me and the school teacher) to observe the learners as they worked on their open-ended digital learning tasks and presentation sessions in all four schools. I also personally participated in the study as an observer and helped learners in classroom activities to work through computer troubleshooting and difficulties they encountered in the computer application skills that they had been taught earlier. All the tasks were open-ended and required the learners to make their own personal selections of what they wanted to achieve at the end of the tasks.

3.5.5 The relationship between multiple intelligences and learners' performance using a contingency table

The relationship between multiple intelligences and learners' performance was analyzed descriptively using a contingency table. The descriptive analysis was important to find the relationship between the learners' intelligence profile (strengths and weaknesses) and their performance abilities particularly in computer application skills. I drew up the contingency table by combining the results from the intelligence profile of the learners and the assessment results of the learners' performance abilities in computer application skills in different intelligences. I adjudged a descriptive data analysis procedure to be appropriate because of the small sample size and the purposive sampling of the study unit. These limitations disallow the use of a chi-square statistical test. A chi-square test moreover requires at least 80% of the cells of a contingency table to contain at least five cases if a satisfactory confidence level is to be obtained from the results (Cohen, Manion, & Morrison, 2000).

In order to describe what the researcher and the teachers had observed and assessed in each activity as vividly as possible, all the results from each open-ended digital learning task and presentation were later reconstructed into ***stories***. Four selected stories were then used to describe four individual learners whose performance strengths were shown to be outstanding in each of the four intelligences selected for this study. These stories indicate performance patterns of learners according to their intelligence profiles and also how they performed across several intelligences as they were engaged in the same open-ended digital learning tasks.

All the activities that had been recorded on videotape and all the interviews that had been recorded on audiocassettes were transcribed. The coding of the data and the identification of themes then followed. The research findings and interpretations are reported in chapter 4.

3.6 Validity and reliability of the study

In the following section, I discuss issues that relate to validity and reliability in the research design. Validity and reliability in a study such as this are important if one wants to produce research that other researchers and observers can describe as credible and trustworthy (Johnson & Christensen, 2000). The other question that needs to be asked is: Is the contribution that this research makes to knowledge in this field both believable and trustworthy? For the purpose of this study, I have used the following terms: ***credibility*** for validity, and ***dependability*** or ***consistency*** for reliability.

3.6.1 Credibility

The study followed several basic strategies to ensure the credibility of the data that was collected. They were triangulation of the collected data, the use of multiple investigators, the checking of research biases, and the use of thick and rich descriptions in the observation process. I used all of these different strategies to obtain the data that I needed for the study (Merriam, 1988; Johnson & Christensen, 2000; Johnson & Turner, 2003).

3.6.1.1 Triangulation of data

Multiple methods of data collection were used to validate the emerging findings. The instruments of data collection were:

1. Structured observation checklists. These were used to check the observed behaviours of the learners as they worked on their open-ended digital learning tasks.
2. Learners' school progress reports and the multiple intelligence survey test instrument were used to identify the learner's intelligence profiles in four intelligences.
3. Semi structured interview schedules for the teachers, parents, and learners were used to solicit more information about the performance assessment process that is the authentic, and open-ended digital learning tasks used, computer application skills and assessment process.
4. Open-ended digital learning tasks and presentation documents were used for document analysis and analyzed with the other data from the rest of the instruments.

Triangulation added credibility to the findings by incorporating multiple sources of data, methods, and investigators (Erlandson, Harris, Skipper, & Allen, 1993).

3.6.1.2 Multiple investigators

A co-observer (a teacher from each school) participated in the study during the observation sessions of the learners while they worked on their open-ended digital learning tasks and while they were making their presentations. All the teachers used the same observation checklist that the researcher did. They used these observation checklists to identify the different performance abilities and patterns of preferences that learners exhibited. Later, after the observation sessions had been concluded, I conducted a reflection session with each researcher. I recorded all the findings that emerged in a journal for future use during the analysis stage.

3.6.1.3 Avoiding research bias

All the four teachers (one from each school) who participated in the observation sessions used the structured observation checklist. The structured observation checklist was handed to the teachers after they had attended a short meeting that I arranged with each researcher to brief them on and discuss the kinds of observations that we might be expected to make.

A multiple intelligence survey questionnaire was distributed once to the learners immediately when the study started. Only the researcher (not the teachers) knew the results that this questionnaire delivered. Although the researcher was aware of the multiple intelligences results, the teachers acted as a control that prevented the researcher from unduly influencing the observations. After every observation session, each teacher engaged in a brief discussion with the researcher in order to summarise the observations that had been made and in order to assign a common score to the learners. These discussions provided the researcher with a general picture of the trend of performance abilities of the learners and reduced any bias that might have been brought about by the researcher.

Finally, all the open-ended digital learning tasks and presentation documents were scored by the teacher and by the researcher using the same scoring rubric. Then the researcher calculated an inter-rater reliability measure by using Cohen’s kappa reliability coefficient (Tinsley & Weiss, 2000) for all the three tasks. The reliability coefficient provided evidence on the agreed score from the researcher and the teacher.

3.6.1.4 Thick and rich description

In this study, I sought to achieve thick and rich descriptions of data by interpreting all the data that I collected from observations, analysis of learners’ task documents and presentations, interviews, and school progress reports. The aim of the study was to identify the patterns of performance abilities that the learners exhibited during the study. By using a performance assessment process that utilised observations, interviews, and authentic and open-ended digital learning tasks, thick and rich descriptions of all the data were accomplished.

Thus, for example, some of the important performance activities that were recorded included the interactional processes of the learners as they worked collaboratively. Such activities, for example, included talking to one another, exchanging ideas, having discussions, and working alone or in small groups on the computer. Other activities included scaffolding processes: the way in which learners related to each other, the ways in which they helped their peers to use the computers, the ways in which they worked, the ways in which they asked for assistance from the researcher and the ways in which they worked on their open-ended learning tasks and their presentations. I used a journal to record all the activities while using an observation checklist as a guide. I obtained rich descriptions moreover from the responses that emanated from the teachers and parents whom I interviewed and from the focus group interviews that I conducted with learners.

3.6.2 Dependability / Consistency

The research investigated the interactions between multiple intelligences and the performances of learners in open-ended digital learning tasks, and it involved young people who were learners from secondary schools in Dar es Salaam and Iringa Regions of Tanzania. These learners worked on prepared open-ended digital learning tasks for a minimum of four hours per day for five days of the week over a maximum period of three weeks for each group.

It was important during the study to interpret as many of the performance abilities and actions of the learners as I could while they worked on the three open-ended task presentations. The teachers and the researcher participated as observant participants during the observation sessions. The degree of consistency with which the performance abilities and actions were assigned to each learner by the researcher and the teachers all using the same category had also to be taken into consideration (Hammersley, 1992). This will now be explained in the following sections.

3.6.2.1 Consistency in observations

1. The researcher and the teachers used a structured observation checklist for recording all the activities performed by the learners as they worked on their open-ended digital learning tasks and presentation sessions.
2. The researcher and the teachers recorded separate notes on the observation checklists if they had other information of interest that they needed to record, were used during the reflection sessions.
3. A camcorder was used to record all the activities on video. This was later transcribed and the transcriptions were later compared to the notes that the

researcher and the teachers had made during the observation sessions (Kirk & Miller, 1986).

4. Reflection sessions were used to discuss all the observed performance activities that were recorded by the researcher and the teachers for a final scoring of the learners. All these discussions were recorded in a journal (Spradley, 1979).

3.6.2.2 Consistency in open-ended digital learning task text documents and presentation documents

1. Structured assessment scoring rubrics were used to assess the open-ended digital learning task documents and the presentation documents that the learners had saved on floppy disks.
2. A teacher from each school and the researcher used the same scoring rubrics to assess the learners' open-ended digital learning tasks and presentation documents. This was done so that an inter-rater reliability could be obtained (Silverman, 2001) and so that the level of consistency of learners' performance abilities in all three tasks could be determined because reliability depended on replication and on the aggregation of multiple observations (Reizen & Kaser, 1989).

3.6.2.3 Consistency in interviews

1. Semi-structured interview schedules were used to collect information from the parents, teachers and learners in focus groups. The interviews permitted the researcher to probe for in-depth information from parents, teachers and learners, and also allowed for the asking of questions of clarification in cases where the interview question had not been understood.
2. The tape recording of all interviews was made on an audiocassette recorder.
3. All these audiocassettes were then transcribed in terms of the answers given.

This process was necessary to obtain reliable information. Working on human behaviour and investigating the performance abilities of learners is not easy because behaviour is never static and if one does not obtain the right information at once, the opportunity passes (Merriam, 1998).

3.6.3 Validity and reliability of scoring rubrics

In the development of scoring rubrics, reliability was important and had to be taken into consideration. This means that a good scoring rubric is likely to improve both inter-rater and intra-rater reliability. A scoring rubric with well-defined scoring categories can assist in maintaining consistent scores regardless of who the rater is or when the rating is completed.

Inter-rater and intra-rater reliability are two forms of reliability that are typically considered in classroom assessment. Rater (scorer) reliability generally refers to the consistency of scores that two independent raters assign and the consistency of scores that the same rater assigns at different points in time (Moskal & Leydens, 2000). The former is referred to as 'inter-rater reliability' while the latter is referred to as 'intra-rater reliability'.

Inter-rater reliability refers to the concern that learners' scores may vary from rater to rater. Learners are often critical of examination results that seem to show that their scores appear to be based on the subjective judgment of an instructor. Thus, for example, an examiner may reach a conclusion about a learner's written products after merely reading it and then making a judgment about its quality. If there are no predetermined and established criteria that can be used to guide a rating process, two independent raters may end up assigning different scores to the same response. Each rater has his or her own evaluation criteria and these are bound to differ from those of others. Scoring rubrics take this concern into account by formalising criteria at each score level (Moskal & Leydens, 2000). Such descriptions of score levels are used to guide the evaluation process. Although scoring rubrics do not completely eliminate variations among raters, a well-designed scoring rubric can reduce the incidence of such unacceptable discrepancies.

Factors that are external to the purpose of the assessment can also impact the manner in which a given rater scores student responses. Thus, for example, a rater may become fatigued with the scoring process and begin to devote less and less attention to a particular analysis over a period of time. Thus certain responses may be given different scores from those that they might receive if they had been scored earlier in the evaluation period (Moskal & Leydens, 2000). If a rater's mood on the given day is less than optimal or if a rater knows who a respondent is, he or she may allocate scores that are different from what they might have been if conditions had been better or fairer. All these factors affect the scoring process. A correct response from a failing student may be more critically analysed than an identical response from a student who has been performing well (Moskal & Leydens, 2000).

According to Moskal and Leydens (2000), intra-rater reliability refers to each of these situations in which the scoring process of a given rater changes over time. The inconsistencies in the scoring process result from influences that are specific to the rater rather than from true differences in student performances. Well-designed scoring rubrics respond to the concern of intra-rater reliability by establishing a description of the scoring criteria in advance. Throughout the scoring process, the rater should revisit the established criteria in order to ensure that consistency is maintained.

The most recent opinions of proponents of performance or alternative assessment and of the theory of multiple intelligences give great importance to social context in which learning tasks take place and the relation between ability and responses to various forms of cooperative and guided learning. Teachers and learners usually work collaboratively because a school and classroom do not exist in a social vacuum.

3.6.4 Transferability / Generalizability

The research study was limited to a small sample of four schools: 40 learners, four teachers and ten parents. I selected this sample purposively because I wanted to achieve an in-depth understanding of the interactions between multiple intelligences and the performance abilities of learners who performed on open-ended digital learning tasks. The inability to generalise is compensated for by the opportunity I had to study a small sample of the learners in a performance assessment process based on the theory of multiple intelligences. The results may however be compared to studies performed on learners with the same computer skills, educational backgrounds and similar cultures in the same kind of context. Borman, LeCompte, and Goetz (1986) also affirm that such findings can only be generalizable to the extent that they can be compared to similar research sites, events or populations.

3.7 Ethical Issues

Ethical issues have to be taken into account in any data collection process. Important ethical issues in this study included the confidentiality of all the participants, the informed consent of the parents/guardians of the learners who participated in the study, and a proper relationship among the researcher, the learners, the teachers, the parents, and the school administration. Participation of learners in the study was voluntary and nobody was forced to participate. The identity of the schools and individuals who participated in the study have been protected because they were all allocated letters that indicated that their schools and learners will function as pseudonyms in the reporting phase of the study (Gall et al., 1996). Ethical issues pertinent to data collection, data analysis and interpretation, the writing up and the dissemination of research results are all dealt with in the following sections.

3.7.1 Ethical issues in data collection

3.7.1.1 Gaining access

I used a research clearance letter from the University of Dar es Salaam in order to obtain permission to conduct my research in the sample schools from the Regional Education Offices for Ilala, the Temeke districts in Dar es Salaam Region, and the Iringa Region. I then applied by letter to the head of each school asking for permission to conduct this research in their schools. This research clearance letter attested to my identity and bona fides as a researcher and employee of the University of Dar es Salaam and a student from University of Pretoria. It also explained the objectives of the research, the time frame of the study, how the confidentiality of the data and the personal identities of participants would be maintained, and a description of how the data would later be used for research purposes only. For a copy of the letter is contained in appendix 3.10

3.7.1.2 Participants' participation

I observed that the right to participate in this study has to be highly appreciated by participants and I took this into consideration. Because the learners who were involved in the study were all legal minors (aged between 16 and 19 years), a letter of consent was given to the learners to ask them permission if they could participate in the study. A sample of the letter can be seen in appendix 3.11. Moreover, a letter was sent to the parents of the learners to ask them permission if they could allow their child to participate in the study voluntarily, and the letters had to be signed by the respective parent or guardian. This letter also included information about the purpose of the study, procedures that I would employ, and acknowledgement of participant's participation in the study. In the letter, I moreover assured the parents about the security of the learners and explained that identities would be protected during the data collection and analysis process. For a sample of the consent letter that I sent to the school administration and parents, see appendix 3.12.

3.7.1.3 Interview process

I used a semi-structured interview protocol in the study. I recorded all the interviews with learners, teachers and parents on a Dictaphone. I asked for and obtained permission from all the respondents who would be recorded before any recording session commenced.

3.7.1.4 Questionnaires

I used a structured questionnaire schedule in this study. The multiple intelligence survey questionnaire was administered to all learners at the beginning of the study. I used the multiple intelligence survey questionnaire to identify the intelligence profile of each learner. I also administered a questionnaire to all the learners, teachers, and parents who participated in the study in order to obtain their demographic data. All the questions in this demographic data questionnaire were structured so that I would obtain the information that I needed to complete demographic profiles of participants in the study. I used plain English so that I would be sure that no one would be embarrassed by not understanding what was contained in this questionnaire.

3.7.2 Ethical issues in data analysis and interpretation

3.7.2.1 Analysis of data

Since the researcher is the primary instrument for collecting and controlling data in this study, it is conceivable that some of the data might have filtered through her particular theoretical position and biases – positions and biases that might not have been readily apparent to the researcher herself (Merriam, 2002). During the analysis phase, I checked my interpretation of data and accuracy by using different data sources wherever possible. Another factor that militated against bias was my use of anonymity for the individuals who participated in the study. Because I used pseudonyms for all individual learners, teachers and schools during the writing process, any bias that I might have entertained about individual places and individual identities are likely to have been minimised or even avoided altogether.

I implemented the ethical guidelines and principle that have long been established by the Government of Tanzania, The University of Dar es Salaam, the Ministry of Education and Culture of Tanzania, and University of Pretoria throughout the study. Thus, for example, the research clearance that I received from the University of Dar es Salaam established the researcher ownership of the research data and furthermore specified that the data would be used only for study and research purposes. The data itself remains legally the property and possession of the University of Dar es Salaam. The University retains the right as the legal institutional owner to withdraw the data if it is abused in any way or shared in an improper way with individuals who are not involved in a bona fide way in relevant study or research.

3.7.3 Ethical issues in writing and disseminating research findings

3.7.3.1 Dissemination of findings

I have used plain and straightforward English language throughout in reporting of the findings from the study, without, I believe, compromising the complexity of certain issues and procedures. I have been especially careful in the writing process not to use language or words that might be construed as biased against the learners, teachers and parents who were involved in the study. The research report includes the real and actual findings from my study. Creswell (2003) notes that fraudulent practices and data are totally unacceptable in professional research communities. Finally, I will make my written interpretations and reports available to the heads of the school on behalf of the learners, parents and teachers as a token of thanks for their participation and contributions to the study. Also each learner who participated in the study up to the end of the data collection process received a certificate of attendance (see appendix 3.13).

The findings of the study will be reported in chapter 4, the next chapter.

✍ Chapter 4 – Research Findings & Analysis

In this chapter I describe how learners manifested their multiple intelligences in the performance of open-ended digital learning task. This chapter examines the effect of performance assessment on learning as well as the effect of open-ended digital learning tasks on learning. The chapter concludes with a detailed discussion of the interaction between multiple intelligences and the performance of the learners in open-ended digital learning tasks.

4.1 Introduction

The data presented here was assembled by means of four different methods described previously in chapter 3. Those methods were (1) observation, (2) interviews, (3) multiple intelligences survey questionnaire, and (4) retrieval of information from learners' open-ended digital learning task documents and presentations, and school progress reports. In this chapter, I will discuss the findings of the study, the investigation of multiple intelligences in relation to learners' performance in selected open-ended digital learning tasks. The findings of the study show that when the learners in this research study were given the opportunity to work on open-ended digital learning tasks, they managed to make their own preferred choices about modes of performance in the completion of the tasks. They did indeed vary in their preferred choices and performance abilities according to their intelligence profiles.

Other value-added advantages identified during the performance assessment of the learners as they worked on the open-ended digital learning tasks included computer application skills as well as the freedom that learners had to express their preference for diversity as they gave evidence of collaborative and social learning. Another important value-added advantage in their performances after working on the open-ended digital learning tasks was increased motivation, sustained attention and an ownership of the tasks among learners.

4.2 Value of performance assessment on learning

Performance assessment strategy that was used in the study, showed to have a positive impact in the learning process of the learners who participated in the study. The performance activities that were provided to the learners had meaningful, real-life tasks that enabled learners to demonstrate what they know and what they can do in such situations.

The use of assessment strategies to assess performance abilities changed the course of assessment where facts and figures were considered to be the main indicator of success to an ***assessment*** of what learners can do or perform. This then may be used as a basis for extrapolating learners' ***potential*** when faced with the same or similar tasks and situations. The data gave varied indications of learners' performance abilities as they worked on the open-ended digital learning tasks. Learners' performance abilities improved in the use of different computer application skills, collaborative and social learning, and self-management. The sections that follow present the discussion of how these learners performed in various open-ended digital learning tasks and presentation sessions.

4.2.1 Computer application skills

Computer application skill is one of the performance abilities that had a positive effect on the learners who participated in the study. At the beginning of the study, learners were equipped only with very basic computer application skills such as the booting and closing down of a computer and the ability to use some of the features of Microsoft Word. During the course of the study, the learners were taught how to use other application skills that they would need to complete their tasks successfully. All the learners were taught how to use various features of Microsoft Excel, Microsoft PowerPoint and Microsoft Word. They thus learned how to use and manipulate graphs and tables, how to design and use pictures, clip art, animations, how to import tables and graphs to slides, and how to create and manipulate tables, pictures, clip art, font sizes, colours and word art. After this prior training, the learners were allowed to work on the open-ended digital learning tasks and were encouraged to use all the computer application skills they could apply in their task documents and power point slides in order to make their presentations more presentable. My expectation as a researcher was that learning was much more likely to transfer if learners were given the opportunity to practise with a variety of applications and if they were encouraged to use these applications as part of their solution strategies.

The data that emerged at the end of the study showed that a good number of learners positively incorporated several computer application skills in their task documents and presentation slides as the result of being allowed to use whatever computer skill they wanted to. Thus, for example, several of the learners managed to use pictures in their text documents as well as in their slide presentations. Some of the learners however, showed eagerness to learn how to use spreadsheets and tables in their tasks. This is inferred from the fact that some learners kept raising their hands to ask for assistance from the researcher. During the interviews with the teachers, teacher Tp commented that:

> "… It seems that leaving the learners to work on their own and select what they want to do has helped them learn much more quickly than when they were to be taught the same skills in class demonstration. They have learnt more than what I expected, I am impressed..."

During the focus group interviews several learners stated that the tasks they had to accomplish, made it possible for them to make choices about whether or not they can use a certain computer application skill (some of which were already familiar to them and some of which they had learned during the research event). Those who did use these applications creatively felt that they had improved the quality of their documents and presentations, and also improved their computer skills. One learner, for example, pointed out that the continuous use of computers in the study that is three to four hours per day, has given him the confidence to use different computer features in Microsoft Word, Excel and PowerPoint. He is now confident that he can use these skills in future in other subjects. He stated *inter alia*:

> This project has helped me a lot […] because the skills I have learnt […] I was able to apply them in my tasks. For example, I used a table and also managed to draw a graph from Excel. I am happy and I will be able to teach my friends too, after the study.

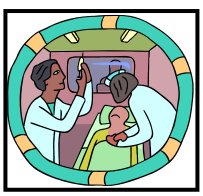
From these observations, I can say that making technology (computers) available to the schools and learners does not produce an appropriate use of technology. But, the extent to which this technology is integrated into instruction, using open-ended tasks can enable learners learn more on the use and application of computer application skills.

Other findings from this research study, suggests that authentic and open-ended digital learning tasks provided learners with a learning environment that was different from which they were accustomed to (i.e. the conventional and authoritarian, memorise-and-repeat after demonstration classroom format). My expectation as a researcher was that learners would be able to demonstrate their higher order thinking skills by generalising what they had learned, by providing examples apart from those that they had been given, and by applying and manifesting their different abilities (intelligences) while working on each of the tasks provided. Thus, for example, the learners were set to work on the tasks without any strict instructions about how they would answer the questions posed by the tasks and without any imposition of the kind of formal classroom behaviour that is automatically observed by all learners who have been conditioned in conventional authoritarian classroom situations.

The learners had to make their own choices and decisions about what they wanted to do and how they would complete the tasks. This gave learners opportunities to use all of their multiple intelligences and to deploy all the resources of their imagination, knowledge and other gifts to demonstrate their performance abilities and their preferences. For example, learners were given the freedom to make their own decisions about when and how to use spreadsheets and tables to organise their numerical information, when and how to use pictures to convey other information in visual format, and when and how to use other information such as text (such as poems) to convey information, emotion or other data in various formats. The fact that the learners in the sample responded so creatively by and large to this freedom means that this new learning environment (characterised by authenticity and open-ended digital learning tasks) allowed learners to process information in different and diverse ways using different combinations of intelligences.

4.2.2 Preference diversity between learners

One may assume that the open-ended digital learning tasks and encouragement to use the computer application skills that they had recently learned both to some degree stimulated learners to make their own preferences about how they would like to complete their tasks. Firstly, the learners were asked to summarise their information so that they would be in a position to present their data and thoughts to their peers. Some learners managed to add pictures in their texts because they felt a strong desire to represent their knowledge in visual form. One of the learners, for example, used several pictures in his text and PowerPoint slides. He stated that he had used pictures so that he could share in a very strong way with his peers what conditions are really like when a community is affected by cholera.



One of the pictures used by the learners in task 1: The picture shows a sick person being attended to. The message is that if people do not have clean and safe water, they may contract cholera, get ill and end up in hospital, or even die.

Figure 4.1: A sick person being treated.

Because the tasks were open-ended, learners made their own choice of various ways in which to complete and embellish the tasks in which they were engaged. The learners selected those modes of expression that they felt would enable them to be most successful. Thus, for example, learners who possessed a strong visual and spatial intelligence tended to select whatever pictures and clip art they could find to explain their texts. For them the use of pictorial forms of representing situations seemed to be more powerful than the use of words alone.

The presentation of activities by means of PowerPoint slides also permitted learners to set up questions that would solicit answers from their peers and commentaries from their observers (the researcher and teacher). This question and answer strategy worked well for most learners because it gave them scope for improving their communication skills. I noticed that discussions in the first presentation were not very lively. Some of the learners were shy and others asked no questions at all. But as they became accustomed to the format during subsequent task presentations and were given time to realise that there would be no adverse reactions to individual initiative and creativity, more and more learners started to ask questions and participate in discussions.

During the interviews one of the learners said that she had learned new words during the process and so had improved her vocabulary. According to her:

> My vocabulary has increased especially when learning about landfills. I did not know that landfills meant “dampo” in Kiswahili. While presenting, I knew exactly what I wanted to say.

Being expert was not only in the way they presented their tasks, but also in the ability to improve on what they have learnt. The analysis of the presentation slides showed that in the first task, the number of presentation slides prepared by learners ranged between 4 -7 slides. But with the subsequent presentation, the number of slides increased from 9 to 13. These learners were more motivated and wanted to share with their peers how well they have managed to get new information, with extra presentation slides to complete the task and contribute in the discussions.

As the learners continued to work on their tasks, some managed to use several computer application skills that ranged from the use of a picture or clip art to emphasize a point to tables and graphs that they imported into their texts and presentation slides. Most of the learners learned various animation skills that made them more expert than their teachers in this area. During the reflection session, Teacher Tn noted that he did not know how to work with PowerPoint at all. He was fascinated by how his students had managed to learn all the required skills in such a very short time. Teacher Tn insisted that he would learn how to use PowerPoint from his own students after the study had been completed. In his words:

> I liked how the learners have managed to use different computer application skills, and especially the PowerPoint program. Look! They are confidently working on their own. I will have to learn from them after the project (Teacher Tn).

I also noticed that learners put more effort into tasks that incorporate a technology that they can manipulate and use creatively. This seems to suggest that if the uses of technology have been properly taught; such a technology may well have the capacity to positively influence the performance abilities of learners. In such circumstances, learners are able to prepare products that one could not imagine them making. This was in fact demonstrated by this particular sample of learners. One group of learners, for example, prepared a flyer with the use of a computer. This flyer was part of an educational strategy they had to select and use to educate their community about cholera and how it might affect people. These learners used columns – in Microsoft Word programme to arrange the text in such a way that the A-4 paper could be folded like a flyer for distribution purposes. This strategy was an alternative to the kind of essay question that might have been asked in a normal (conventional) classroom setting. Figure 4.2 shows the flyer that these learners prepared. Another group of learners prepared a poem. This poem was prepared as an educational strategy for their community. Clearly new skills were learned in this exercise that will be able to be used in future activities.

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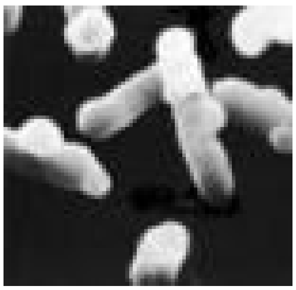
Beware of Typhoid Fever!!

Cause:
Typhoid fever is contracted when we eat food or drink water that has been infected with bacterium - Salmonella typhi.



Bacterium: Salmonella typhi.

Symptoms:
It is recognized by the sudden onset of fever, severe headache, nausea and severe loss of appetite. It is sometimes accompanied by hoarse cough and constipation or diarrhoea.

Occurrence:
Typhoid fever affects 17million people worldwide every year, with approximately 600,000 deaths reported from Asia, Middle East and Latin America.

Typhoid fever is transmitted by food and water contaminated by the faeces and urine of patients and carriers, Polluted water is most common source of typhoid.

In addition, shellfish taken from sewage-contaminated beds, vegetables fertilized by night soil and eaten raw, contaminated milk and milk product have been shown as a source of infection.

Communicability:
People can transmit the disease as long as the bacteria remain in their system.

Disaster Implications:
With disruption of the usual water supply and sewage disposal, and of the elimination or reduction of control on food and water, transmission of typhoid fever may occur if there is an active case or carriers. Efforts are to restore safe drinking water suppliers and sanitary disposal facilities are essential.

Selective immunization of groups such as school children, prisoners and utility, municipal or hospitals personnel can be helpful.

Prevention:

- Protect and chlorinate public water supplies and avoid possible back flow connection between sewers and water suppliers.
- Sanitary manner and maintain good disposal of human faeces in a fly-proof latrines.
- Use scrupulous cleanliness in food preparation and handling.
- To educate the public regarding the importance of hand washing; this is important for food handlers and attendants in the care of patients and/or children.
- Thorough and frequent hand washing is essential, especially after bowel removal.

Figure 4.2: A flyer prepared by learners in task 1.

Transmission:

POEM

This disease caused, by typhoid bacillus,
And the name of microbe, is called Salmonella typhi,
This disease is bad, because it kills many people,
What is that disease, the disease is typhoid fever.

Symptoms of the disease, there are so many
Variety of symptoms, it occur to the person
That has contracted with Salmonella typhi,
What is that disease, the disease is typhoid fever

The spread of micro organisms, they are spread by humans,
You can get the disease, if you drink or eat food or beverages,
Those have been handled, by the people carrying the bacteria,
What is that disease, the disease is typhoid fever.

The rest of the verses of the poem prepared by these learners can be viewed in appendix 4.1

Other performance abilities that were demonstrated by learners included the use of computer application skills such as the creation of graphs and tables and the use of clip art and pictures to make high-quality products for use in classroom presentation by using basic resources that were present in the schools. Although all the learners could use whatever computer application they preferred at any time, the use of different application skills was evident among the learners in the sample. My own observations of the learners showed that this was so. I observed some learners using graphs, tables and number organization skills in order to logically present their information in all three open-ended digital learning tasks. Other learners used clip art, and other learners used pictures and drawings to represent their information in a visual way. Yet others used Microsoft Word to type their texts so that they could present them in that format. Writing skills were also augmented as learners were able to check their spelling mistakes by using the Word's Spell Check function. I also noticed that learners also managed to include more information in their later tasks than they had did in the first tasks that they handed in. Certain writing skills that were in advance of those expected of their age group were also apparent in some of the learners' texts.

Convincingly, learners were not only exposed to the used of computer application skills only, but they also practiced using these applications in the open-ended digital learning tasks and created presentations with which they themselves used to present to their classroom peers.

4.2.3 Collaboration and interpersonal intelligence

During the course of study, the learners worked in collaborative couples on one computer per pair. The learners were very positive about working collaboratively. They expected that this kind of collaborative work would make problem solving easier and they also anticipated that a product produced by a pair would probably be of better quality than it would have been if it had been produced by individuals. When they were asked for their opinions about working in teams, most learners said they had gained a lot from working collaboratively. One of the learners said:

> See, I like working in groups because we learn from each other. Nobody knows everything, so we benefit from each other… For example, I managed to help Pat and Sally how to search for a picture in clip art. It was nice helping them.

This comment summarizes the view that each learner will bring his/her own experiences and learning to a situation and that each learner is capable of contributing to the completion of a task in his or her own unique way. In so doing, all the groups engaged in cooperation.

One requirement of working collaboratively to complete a task is that all meanings have to be negotiated. The learners were not initially unaware of how important negotiation is for the process of getting a task completed collaboratively even though negotiation is indispensable in all collaborative learning groups. One of the learners said she was not happy working with her colleague:

> I don’t want to work with Martha anymore. She is very bossy and does not want to include my ideas in the document. What she says goes … She even

> does not want me to type the document. She is saying I am slow in typing… but I also want to contribute in the task.

Another learner pointed out some of the more difficult aspects of negotiation and working collaboratively on a common task thus:

> I quarrelled with my friend. First, she comes late most of the time; she does not want to contribute to the work, and she keeps talking to others… I was not happy with this behaviour.

The issues and potential problems that arose out of the learners' responses show that conflicts and a level of discomfort and irritation (challenge) are all possible processes and outcomes of collaborative learning arrangement. The teacher can always intervene to rectify or help negotiate a possible solution if a collaborative pair reaches an absolute deadlock. As the participant observer in the study, I had to discuss the ground rules with the learners who had problems and get them to understand and accept that everyone needs to contribute to the task at hand. In this case, each person in a collaborative pair had to contribute about half of the work. The other collaborative pairs in the groups managed to work comfortably and without any major friction or deadlocks.

The use of open-ended digital learning tasks did provide an environment in which learners could use their individual performance abilities to complete the tasks. This meant that the use of authentic tasks opened the way for each learner to apply his or her unique performance abilities to realise specific solutions to each problem that arose. In this way the open-ended digital learning tasks permitted learners to make connections between the skills and abilities that they had learned in school subjects and real-world (authentic) activities.

4.2.4 Social learning

As the researcher and participant observer, I also made myself available to learners to help them – where needed and specifically requested – work through their tasks, especially when it came to matters such as computer trouble shooting and assistance with computer application skills. My main aim in being thus available was to clarify issues and problems that were unclear to them so that they could get back into the right track and bring their tasks to completion.

The arrangement of the learners into pairs provided a good support system because each learner supported his or her partner and even on occasions offered support to friends and fellow learners in other groups (peer support). In some cases, they offered suggestions to one another but could not decide how to proceed without the assistance of the teacher or the researcher. If the problem of indecision related to some technical point, the researcher or teacher provided help. If it was a tactical issue involving the completion of the tasks, they were left to decide by themselves.

In dealing with the content of the open-ended digital learning tasks and the presentation process, they gave significant assistance to one another. The learners were quick to perceive that working with and helping one another also helped them to imprint and perfect their own learning. For example, when Rachel and Anna were asked in the interview about working in collaborative pairs, they both indicated that they were happy to work in a team because it had helped them to learn new computer skills from one another, and that it had also extended their repertoire of biology terms as they were able to complement one another in this regard. According to Anna:

> In my team, we helped each other in completing the tasks and presentations. Sally was very helpful because she taught me how to search [for] and use clip art pictures on PowerPoint slides as well as the use of tables. I am now proud of myself.

The support that the learners provided to one another was fundamental to the learning process and it helped them to complete the tasks in a shorter time than would have been possible if they had been working alone. And because of the collaborative approach, the teacher and researcher were able to play a smaller role in supporting the learners which they did only when they were requested to help.

In general, the findings indicate that open-ended digital learning tasks provide an opportunity for learners to improve their performance abilities. Thus, for example, learners learned new computer skills from their peers and from the researcher as they worked on the tasks. This evidence may encourage teachers to use such strategies in their teaching and learning processes in situations where computers are implicated.

4.3 Value of open-ended digital tasks on learning

There are several ways in which open-ended digital learning tasks may have impacted on learners' learning. One major possibility is that the impact of open-ended digital learning tasks on learners' learning might have been caused by the relevant content of the tasks, all of which were 'real-world problems' or 'examples of actual problems' that had or could arise in the communities from which the learners came. These tasks motivated learners to exert themselves to find real (i.e. effective and workable) solutions to the problems concerned. The fact that a great deal depended *in reality* on the effectiveness and accuracy of their solutions motivated these learners to give their sustained attention and effort to finding solutions and accepting ownership of the tasks. It was later in the observation and interview sessions with the teachers and learners that learners and teachers spoke about the influence of such *authentic* open-ended digital learning tasks on learner motivation to succeed and how this identification with the problems that they were required to solve had also encouraged them to improve their reading, writing, decision-making and computer application skills.

4.3.1 Learners' motivation to learn

All the teachers who participated in the study reported that they had personally observed the degree of enormous enthusiasm that the learners had brought to the solution of their open-ended digital learning tasks. Teachers Tm, Tn and To said that they were amazed at how very hard these learners had worked on their computers and at their tasks, at how they did not be need to be reminded or prompted about what to do, how they had worked much harder than they were expected to work, and how they had worked for much longer periods on these tasks than what they were officially expected to do. They noted:

> **Teacher Tm:** Some of these learners are very slow and inactive in class. But these same learners are now active and working very hard to complete their tasks. I am impressed. It seems most of the learners are competing from each other in making their work look the best.
>
> **Teacher Tn:** These learners are now good in doing things on their own. For example, in one week, they learnt to work on their own without being pushed by the teacher to do so. They summarized the information and presented it in class on time. They have also managed to work with some computer programmes with confidence compared with the time before they started this project. For sure now, they can stand up with confidence and talk to their peers with their heads up.
>
> **Teacher To:** They have gained a lot, and they have enjoyed the lessons so much – especially when they are presenting their slides. All the learners were involved in the discussion. Look, they keep working and working until they have to be told to stop working because time is out. When I teach them they do not stay that long. When the bell goes, they are happy to leave.

4.3.2 Sustained attention

The learners did indeed work very hard to complete their tasks. They gave the tasks their sustained attention and effort and concentrated single-mindedly on their tasks. Learners, for example, were specifically requested to utilise several of the reading resources provided and a number of the different computer applications available to them to complete their tasks. They were also specifically requested to discuss problems with one another and to help each other wherever possible. Both teachers and learners mentioned that the resources and time they were allocated to invest in the tasks encouraged them to work hard and even put in extra time to get their tasks completed by the deadline. The following are some of the comments that learners made:

> I cannot be tired working on a computer especially with a task like this. I managed to read and summarize my notes, type them onto the computer and later present them to my friends. I really liked using my knowledge to help my community. My biology has improved now.
>
> I liked the learning tasks. They where well arranged with the resources to read. I could find the answers to questions given in the handouts, and the facts were very educative.

> I was able to summarize my work, write in point form, add pictures and do a presentation that was important to me. […] I had to get things done as other learners would ask more questions if I am not sure of what I have written.

> Teacher To said: I am impressed about how the learners have taken a self-directed way of learning. They have become independent and confident in using different computer application skills apart from what they already know. They have learnt a lot of computer application skills, for example, the use of Microsoft Word (tables, clip art and pictures, word art), Microsoft Excel (data organization and drawing of graphs), Microsoft PowerPoint (developing slides and presentation to others). The presentation sessions were so motivating I could see it in their eyes and the way they talked. They did not want to finish the discussion.

When the time arrived to make presentation, learners showed their skills in the presentation of their tasks and in how they justified and debated their solutions as they looked for the best fit. They realized that open-ended digital learning tasks can present real-life (authentic) problems to solve. One learner, for example, said:

> I am happy that I convinced others that my educational strategy can be used in teaching people how to prevent the spread of cholera. That has made me proud.

The presentation process gave learners opportunities to go beyond formal written reports and communicate instead by using vivid written, oral and visual means such as slide shows, graphics and photographs. These skills were new to these learners and to their schools. During the reflection session with the researcher, Teacher To stated:

> I wish we could have this system of allowing learners to present their work in class as it provided a lot of challenge to the learners especially in gaining confidence in presenting what they have done to others.

This kind of learning process in which presentations are made to others means that, at the end the work is accepted and owned by the whole group and that is what it matters. Learners were also observed to be flexible in their use of media. In this way, by varying content, media and teaching materials, they found that they could retain a high level of audience interest and participation.

Through collaboration with their classmates and by respecting one another's ideas and inputs, these learners managed to work socially and collaboratively in a classroom setting. Most of the learners remarked that they had not realised that that time was passing by so rapidly and they therefore had to come back to complete their tasks on the following day. They were happy working together because they shared the workload and ideas and because they also helped one another to master new computer skills. In one of the interviews, one of the learners said:

> Because each person is different, people have different talents. So we helped each other in the process of putting down ideas. Finally the end product was good compared to [what it would have been] if the work was done individually.

Teachers To and Tn also noted that their learners had improved their learning through collaboration.

> **Teacher To:** I think it was a good idea that these learners worked in groups. They managed to share with each other. Especially for those who know things, they were able to help others.
>
> **Teacher Tn:** The team activity was good for the learners. For example, the learners were able to learn from their peers and they helped each other. They were also happy the way you helped them, especially when they got stuck in the preparation of the PowerPoint slides.

4.3.3 Learners' ownership of the tasks

Open-ended digital learning tasks *also* provided learners with opportunities to demonstrate their decision-making skills and to take risks. They made their own decisions about what they would read, about how to access their background knowledge in biology and their communities, about how they should summarize their tasks, and about how they would present their work. They had to create professional-looking visuals to assist them to lead class discussions about their problems and their proposed educational strategies selected as solutions. This was important as they had to have sound reasons as to why they had selected their educational strategies and why they had thought a particular strategy would work in their communities and what informed decisions they had made to arrive at their solutions. All these decisions compelled them to take ownership of the task documents that they had prepared. In one of the interviews, one of the learners said:

> I managed to prove to myself in class that I can make it. In our group we proved to our friends that our strategy was the best. The way we managed to summarize our ideas, and justify the use of the strategy… That was cool!

In short, I think that the open-ended digital learning task format and the performance assessments helped the learners in areas that meant a great deal to them. The tasks equipped the learners with how to handle the complexities and uncertainties of a world that they knew existed but which they had not hitherto found any point of inspired access. Learners were inspired by the real-world activity format because it enabled them not only to collect and share factual information with their classmates; it also compelled them to synthesize what they had learned, to integrate it, and to make decisions and then justify those decisions in front of others.

In real-life situations, efficacy means finding out what the best is that one can do when confronted by tasks and possible solutions to apparently insoluble problems, and how one can take ownership of tasks so that one has a personal stake in the solution.

4.4 Interaction between Multiple intelligences and performance of the learners in open-ended digital learning tasks

The investigation into the interaction between multiple intelligences and the performance of learners in open-ended digital learning tasks took place in two stages. These stages required me to

(1) ascertain the intelligences profile (relative strengths and weaknesses) of the learners, and the relationship between the intelligences profile and performance of the learners,

(2) assess learners' tasks and presentation documents and identify their performance abilities in computer application skills in terms of four intelligences (logical-mathematical, verbal-linguistic, visual-spatial and interpersonal intelligences).

4.4.1 Intelligence profile of the learners

The intelligence profiles of the learners described in this section are those of learners from three urban schools in Dar es Salaam and one rural school in the Iringa Region of Tanzania. I chose as respondents a total of 40 learners. Of this number, 30 were learners from the three schools in Dar es Salaam while 10 were learners from the one rural school. There were 23 females and 17 males in the sample. Whereas Gardner (1983; 1996) documented nine intelligences, for the purpose of this study I focused only on four intelligences, namely the logical-mathematical, verbal-linguistic, visual-spatial and interpersonal intelligences.

I ascertained the strengths and weaknesses of the learners' intelligence profiles for each of the four intelligences from two assessment sources. These sources were (1) the multiple intelligence survey test instrument, and (2) school progress reports of the learners. This data has been summarised in Table 4.1 below. The outcome of the assessment gave an indication of the strengths and weaknesses of the four selected intelligences of these learners. I later also used the findings from these two sources to compare the performances of the learners as they worked through the three open-ended digital learning tasks and presentations to their scores for these four intelligences. My aim in comparing these two sets of data was to identify the relationship between the performance abilities of the learners and their four intelligences profile.

Table 4.1: Intelligence profiles of all the learners for four intelligences

Schools		Logic		Verbal		Visual		Interpersonal
	Learner	IS	SR	IS	SR	IS	SR	IS
Dar Es Salaam region.	ca	H	H	H	H	H	H	M
M	ir	M	M	H	H	M	M	H
	sc	M	M	M	H	M	M	M
	rh	H	H	H	H	L	M	H
	rm	M	M	H	H	H	M	H
	mb	L	M	M	M	L	H	M
	tp	M	M	M	H	L	M	M
	dm	M	M	H	M	L	M	M
	ik	M	H	M	H	L	H	M
	jm	L	M	M	M	L	H	M
	sm	H	H	M	H	M	H	L
N	be	H	H	M	M	L	H	L
	et	M	M	H	H	M	H	M
	am	H	M	H	M	H	M	H
	sm	M	M	L	L	M	M	H
	mm	M	M	M	M	M	M	M
	ah	M	M	M	M	L	H	L
	ka	H	H	M	H	L	H	M
	nn	M	H	H	M	L	M	M
	mb	H	NR	H	NR	M	NR	H
O	ak	M	L	H	M	H	L	H
	as	M	M	H	M	H	M	H
	ark	H	H	H	M	M	M	H
	aa	H	M	H	M	M	M	H
	cs	H	H	H	M	H	M	H
	dk	M	M	H	M	L	M	H
	eka	H	H	M	L	M	M	H
	ks	M	M	H	M	M	M	H
	mj	H	M	H	M	H	M	H
	rs	L	L	H	M	M	M	H
Iringa region.	mc	L	L	H	H	L	M	M
P	fm	L	L	H	M	H	M	H
	hs	M	L	H	H	H	M	H
	na	M	M	H	M	M	M	H
	rn	L	L	M	M	M	M	H
	us	M	M	M	M	M	M	H
	tr	M	M	H	H	M	M	H
	en	M	L	H	H	M	M	M
	ek	H	H	M	M	L	M	H
	fb	L	NR	M	NR	M	NR	H

Key to codes and symbols used in Table 4.1:

(i) Assessment sources: **IS**-intelligence survey test questionnaire, **SR**–school report

(ii) Intelligence profile: **H**-high, **M**-Medium and **L**-Low

(iii) **NR -** School reports where not available.

4.4.2 Results of the study

The results that are presented in Table 4.1 indicate a range of strengths and weaknesses in the four intelligences of each learner. Discussion of these results in the following sections will be in terms of (2) the intelligence profile of the learners in general and (2) comparisons between the schools.

4.4.2.1 Logic mathematical intelligence

(1) Intelligence profile of the learners

The results of the multiple intelligence survey questionnaire shows that 12 learners are high in logical-mathematical intelligence, 24 learners are medium, and 6 learners are low in this kind of intelligence. This is how they perceived themselves in this intelligence. The learners' performance ability in logical-mathematical as calculated from their school progress report shows that 11 learners are high, 20 are medium and 7 are low. The intelligence profile of the learners shows that most learners who scored high, medium or low in their multiple intelligence survey questionnaire, also scored high, medium and low in their school progress report respectively. The data relating to this intelligence profile is as summarised in figure 4.3 below.

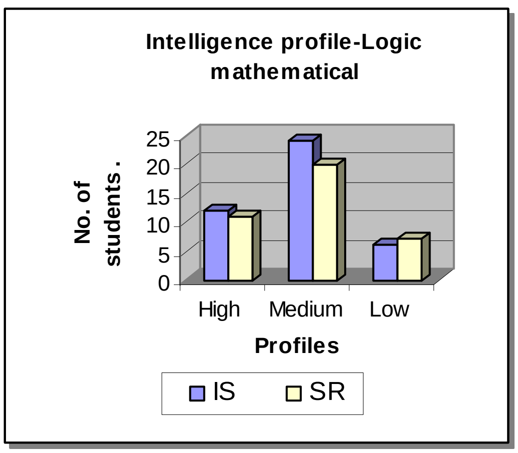


Figure 4.3: Intelligence profiles of the learners in logic mathematical intelligence.

(2) Intelligence profile of the learners between the schools

A comparison of the intelligence profile between the schools revealed that the performance ability of the learners in schools M, N and O was mostly high and medium compared to School P, where most of the learners' ability in the area of logical-mathematical was low. In three subjects, namely, mathematics, physics and chemistry, the learners in School P had an average score of between 10% and 39% (i.e. below 50%). The findings show that the performance ability of the learners in logical-mathematical intelligence is low.

4.4.2.2 Verbal linguistic intelligence

(1) Intelligence profile of the learners

The learners' intelligence profile distribution as revealed by the multiple intelligence survey questionnaire showed that 24 learners were high in verbal-linguistic ability, 15 were medium, and 1 was low. The school progress report, however, showed that 14 learners were high, 24 were medium, and 2 were low in this form of intelligence. The learners' profile in verbal-linguistic therefore showed that the multiple intelligence survey questionnaire graded more learners as high in verbal-linguistic intelligence even though an analysis in their school progress reports showed that the majority of learners' performances with regard to this form of intelligence is medium. This discrepancy could be explained by the fact that the school progress reports measured a narrow range of intelligences (namely the verbal-linguistic and logical-mathematical). But when one analyses learner ability and performance in terms of in multiple intelligences (even the four here selected), one takes into account a wider spectrum of learners' abilities in the assessment. A consequence of this might be that learner weaknesses in the verbal-linguistic and logical-mathematical could have been compensated for by their relative strength in other measures such as visual-spatial and interpersonal intelligences (which were not factored into the assessment presented in the school progress report). Figure 4.4 shows the summary of the learners' profile in verbal-linguistic intelligence.

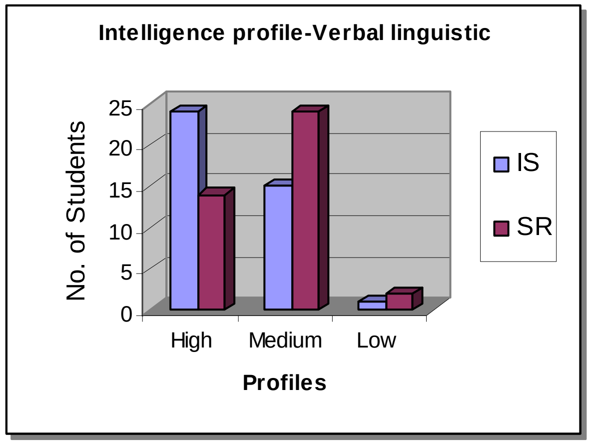


Figure 4.4: Intelligence profiles of the learners in verbal linguistic intelligence.

(2) Intelligence profile of the learners between the schools

The results of a comparison of the intelligence profile (verbal-linguistic intelligence) between the regions shows that the performance of the learners was almost equally distributed as high, medium and low in all the four schools. None of the learners in school P had a low profile in verbal-linguistic intelligence and none of the learners had a low profile in both instruments.

4.4.2.3 Visual spatial intelligence

(1) Intelligence profile of the learners

The multiple intelligence survey test instrument indicates that the intelligence profile of the learners in visual-spatial intelligence are as follows: 9 learners rate as high, 18 rate as medium, and 13 rate as low. The results of the school progress report showed that 9 learners were high in the three relevant subjects (geography, biology and computer studies), 28 were medium and 1 was low. The learner whose average score is medium in their school progress report is also medium in their performance ability according to the multiple intelligence survey questionnaire. Figure 4.5 shows the summary of the learners profile in visual-spatial intelligence.

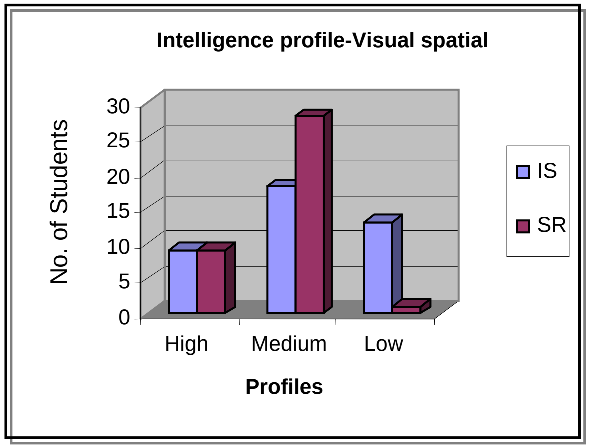


Figure 4.5: Intelligence profiles of the learners in visual spatial intelligence.

(2) Intelligence profile of the learners between the schools

The results of the intelligence profile (visual-spatial intelligence) between the regions show that Dar es Salaam Region has more learners with high and medium intelligence profiles compared to Iringa Region. Four learners from school P, have low scores from the observation checklist, but have medium scores in their school progress report.

4.4.2.4 Interpersonal intelligence

(i) Intelligence profile of the learners

Intelligence profile of the learners in interpersonal intelligence shows that 24 learners were high, 13 were medium and 3 learners were low, according to self-perception of the learners in the multiple intelligence survey test instrument. Learners' interpersonal intelligence profiles according to the observation checklist showed that only 6 learners were high, 23 were medium and 11 were low. Figure 4.6 summarised the learners' profile in interpersonal intelligence.

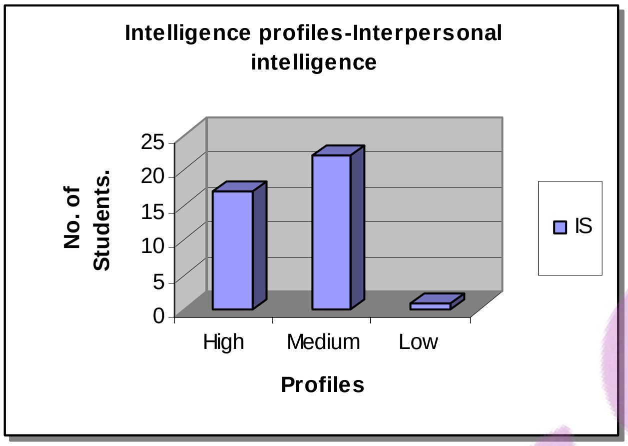


Figure 4.6: Intelligence profiles of the learners in interpersonal intelligence.

(2) Intelligence profile of the learners between the schools

A comparison of the results of the intelligence profile (interpersonal intelligence) between the regions shows that more learners from Dar es Salaam Region are high in this intelligence. An analysis of the low intelligence profile according to the observation checklist results shows that these 5 learners were from school P. These learners did not like to share ideas with others and would not talk to other learners if they could avoid doing so.

4.4.3 Conclusion

The intelligence profile distribution of the learners in the four intelligences shows that majority of the learners are medium performers except in verbal-linguistic intelligence where majority of the learners are high and medium performers. The results of the school progress report seem to tally with the results of the multiple intelligences survey questionnaire in most cases. Interestingly, some of the learners reported themselves as being high in logical-mathematical intelligence while their performance as rated by the school progress reports and observation checklists rated them as having low scores. Some learners however displayed a consistent fit between their intelligence profiles across all three assessment instruments.

The three instruments that scored the intelligence profile of some learners do in some cases reveal blatant inconsistencies as when, for example, some learners were scored as being high, low, low ***or*** low, medium, low in different intelligences. For the purpose of this study, I calculated a combined overall intelligence profile for each learner from the three instruments in order to obtain a final judgement score. This meant that if a learner had high, medium and low scores, I combined these to make medium, and so on. But in cases where a learner had consistent scores such as high, high, high, the overall result would obviously be high, and so on. The final judgement of the intelligence profile results of the learners is as shown in Table 4.2. I will now use these results in a discussion of the learners' intelligence profiles as they relate to their performance abilities in the different tasks.

Table 4.2: Consolidated results of the intelligence profile of the learners from the multiple intelligence survey test instrument, school progress report and observation checklist

		Final intelligence profiles of the learners			
Schools	**Learners**	**Logic mathematical**	**Verbal linguistic**	**Visual spatial**	**Interpersonal**
M	ca	H	H	H	L
	ir	M	H	M	H
	sc	M	M	M	M
	rh	M	H	M	H
	rm	M	M	M	M
	mb	M	M	M	M
	tp	M	H	M	M
	dm	M	M	M	M
	ik	M	H	M	M
	jm	M	M	M	H
	sm	M	H	M	L
N	be	M	M	M	M
	et	H	H	M	M
	am	M	M	H	H
	sm	M	M	M	M
	mm	M	M	M	M
	ah	M	M	M	M
	ka	H	H	M	M
	nn	M	M	M	M
	mb	H	M	M	H
O	ak	M	H	M	H
	as	M	H	H	H
	ark	M	M	M	H
	aa	M	M	M	H
	cs	M	H	M	M
	dk	M	M	M	H

	eka	M	M	M	H
	ks	M	M	M	H
	mj	M	M	M	H
	rs	L	M	M	H
P	mc	L	H	M	M
	fm	M	M	H	M
	hs	M	H	M	H
	na	L	M	M	M
	rn	M	M	M	M
	us	L	M	M	M
	tr	M	H	M	H
	en	L	H	M	M
	ek	M	M	L	M
	fb	M	H	M	H

KEY: H – high, M – Medium, L - Low

4.5 The relationship between learners' intelligence profiles and performance in computer application skills

The data collected by the study demonstrated that the learners in the sample had diverse intelligence profiles with varied combined strengths and weaknesses. Two basic assumptions in this study were that most learners will perform in the three open-ended digital learning tasks and in their presentations in a way that corresponds to their intelligence profiles, and that some of the learners will give demonstratable evidence of several intelligences in these tasks and presentations. The discussion below about how these learners gave evidence of their varied performance abilities is based on the researcher's assessment of the three open-ended digital learning tasks and presentations, with reference to computer application skills. The research design also required me to establish whether or not there was any relationship between learners' performances in computer application skills and their intelligence profiles.

I used a contingency table to find out whether there was any significant relationship between the learners' intelligence profiles in logical-mathematical, verbal-linguistic and visual-spatial intelligences and their performance in computer application skills.

4.5.1 Assessment of learners' performance abilities in computer application skills in relation to the three intelligences

I assessed the learners' performance ability to use different computer application skills in relation to their intelligences by using a holistic type of scoring rubric. The assessment criteria that I used to relate computer application skills to logical-mathematical intelligence were:

- A score of 1 (below average) was assigned to any learner who did not use tables or graphs to show ability to record and organise number information.
- A score of 2 (average) was assigned to any learner who used either a table or graph to show ability to record and organise number information.
- A score of 3 (above average) was assigned to any learner who used both tables and graphs to show ability in recording and organising number information.

The other assessment criteria used in the assessment of verbal-linguistic and visual-spatial intelligences can be viewed in appendix 3.9. I then proceeded to assess all the learner's products from the three open-ended digital learning task documents and their PowerPoint presentation documents by using a three-category scoring rubric, namely 1 for below average, 2 for average, and 3 for above average. The numerals assigned match the ascending order of the quality of the performance. The scoring rubric that I used to assess the computer application skills was different from the other scoring rubrics that I used to assess learners' performance abilities in other intelligences. After I had scored all the documents in each task document and PowerPoint presentations, I then calculated an average score for each individual learner. I then grouped the average scores into three competence categories, namely: above average (AA) – 3,3,3 or 3,3,2 or 3,2,2; average (A) 2, 2, 2, or 3,2,1, or 1,2,3; and below average (BA) – 1,1,1 or 1,1,2 or 1,2,2. The results of how each learner performed in each intelligence are summarised in Table 4.3 below.

Table 4.3: Learners' performance abilities in computer application skills in terms of the four intelligences

		Computer application skills according to intelligences											
		Logic mathematical				Visual spatial				Verbal linguistic			
Schools	**Learners**	**Task 1**	**Task 2**	**Task 3**	**Grade**	**Task 1**	**Task 2**	**Task 3**	**Grade**	**Task 1**	**Task 2**	**Task 3**	**Grade**
M	ca	2	3	3	AA	3	3	3	AA	2	3	3	AA
	ir	2	2	2	A	2	2	1	BA	3	2	3	AA
	sc	1	2	2	BA	2	3	1	A	2	3	3	AA
	rh	1	2	2	BA	2	3	1	A	2	3	3	AA
	rm	1	1	1	BA	2	1	1	BA	3	2	2	AA
	mb	1	1	2	BA	1	3	2	A	2	3	2	AA
	tp	2	2	3	AA	3	3	2	AA	2	3	3	AA
	dm	2	3	2	AA	1	2	2	BA	3	3	2	AA
	ik	2	3	2	AA	1	2	2	BA	3	3	2	AA
	jm	1	1	2	BA	1	3	2	A	2	3	2	AA
	sm	2	2	3	AA	3	3	2	AA	2	3	3	AA
N	be	3	2	2	AA	1	1	1	BA	1	2	2	BA
	et	3	2	3	AA	1	3	2	A	3	2	3	AA
	am	1	1	1	BA	2	3	3	AA	1	2	2	BA
	sm	1	2	2	BA	1	3	2	A	1	2	2	BA
	mm	1	1	2	BA	1	1	1	BA	1	1	1	BA
	ah	1	1	2	BA	1	2	2	BA	1	1	1	BA
	ka	1	2	2	BA	1	2	3	A	3	2	3	AA
	nn	1	1	2	BA	1	2	2	BA	1	1	1	BA
	mb	2	3	3	AA	1	2	3	A	1	2	2	BA
O	ak	2	2	2	A	2	3	3	AA	3	3	2	AA
	as	2	2	2	A	2	3	3	AA	3	3	2	AA
	ark	1	1	2	BA	2	1	1	BA	3	2	3	AA
	aa	3	2	3	AA	2	3	2	AA	2	2	2	A
	cs	2	1	2	BA	2	1	2	BA	3	2	3	AA
	dk	1	1	2	BA	1	1	1	BA	2	2	2	A
	eka	2	1	2	BA	2	2	1	BA	2	2	2	A
	ks	1	1	2	BA	2	2	1	BA	2	2	2	A
	mj	3	2	3	AA	2	2	2	A	2	3	3	AA
	rs	2	1	2	BA	2	1	2	BA	2	1	3	A
P	mc	1	1	2	BA	1	1	1	BA	2	2	2	A
	fm	1	2	2	BA	1	2	2	BA	1	3	2	A
	ha	1	1	2	BA	1	1	2	BA	3	2	2	AA
	na	1	1	2	BA	1	1	1	BA	1	1	2	BA
	rn	1	1	1	BA	1	1	1	BA	1	2	1	BA
	us	1	2	1	BA	1	1	1	BA	1	2	2	BA
	tr	1	1	1	BA	1	2	2	BA	1	2	2	BA
	en	1	1	2	BA	1	2	1	BA	2	2	2	A
	ek	1	1	2	BA	1	2	1	BA	1	2	2	BA
	fb	2	2	2	A	2	3	3	AA	2	3	3	AA

KEY: BA – Below Average, A – Average, and AA – Above Average.

Performance ability in computer application skills was found to be on ***average*** for most learners. The learners in the sample, as I noted earlier in the text, participated in this study partly because they were already taking a computer course in their schools. These results were not therefore surprising. However, when the learners' performance ability in computer application skills was assessed in terms of the criteria selected for the four intelligences, a large number of variations became apparent.

4.5.1.1 Recording, organizing and using number information (logic mathematical intelligence)

The performance ability of the learners in computer applications (i.e. their ability to record and organize number information and make a logical arrangement of their text document) was generally below average. Thus, for example, only ten learners performed above average in this field because they were able to use two computer programs (Microsoft Excel and Word) to draw graphs and tables in order to record and organize their number information. These same learners also demonstrated that they could use the features of Microsoft Word in an effective way to arrange and format their text document in a logical way. Thus they tended to **bold** subtitles and cross heads and set them in a different font size, and to arrange their text into logical paragraph units that expressed logical deduction and a superior understanding of the logical transitions from one element of text to another. These same learners also frequently used number information creatively in their text to emphasize a point, and in many cases also added some of this information to their presentation slides.

The performance ability of four learners was average because they managed only to use one computer program to create and organise their documents and slides. Thus they used either a table ***or*** a graph (but not both) to record and organize their number information in their tasks. They also used number information sparingly in both their texts and their presentation slides.

At the bottom of the rating schedule were 26 learners who were rated as performing in below average way. This meant that they did not use any other computer applications to help them to record and organize their number information in the form of tables and graphs in either their Microsoft Word documents or in their presentation slides. They used Microsoft Word to type their text in (usually) one or two paragraphs but they did not indicate subtitles or in any other way reflect logical thinking or understanding in the arrangement of their texts or presentations. Generally speaking, these learners used no other computer application skill apart from Microsoft Word to type their texts.

4.5.1.2 Visual application skills – pictures, clip art, colours, tables and graphs, font size and style (visual spatial intelligence)

The learners in the sample represented visual information by using different computer application skills in Microsoft Word and PowerPoint. Eight learners were rated above average in this category because they managed to use pictures from clip art, photographs from the reading resources (to emphasize a point), word art and different font colours (for decoration), bolded fonts and lines to underline their titles and subtitles (for emphasis), and tables and graphs (for organizing number information) in their Microsoft Word text documents. They also used animations in their PowerPoint presentations.

Nine learners were rated as average in computer application skills because they managed to use only one computer application skill for the visual representation of information in their texts and PowerPoint slides. They only used pictures from clip art and pictures from their reading resources to the exclusion of other possibilities. Twenty-three learners were rated as below average because they did not use any visual application skills in their Microsoft Word texts or in their PowerPoint presentation slides in all of the three tasks.

4.5.1.3 Organization of ideas – paragraphs, bullets, and columns (verbal linguistic)

An analysis of the performance abilities that indicated verbal-linguistic intelligence showed that most learners performed either in an above average or in an average way in the completion of the tasks. A total of 20 learners were rated as above average out of a total group of 40 learners. These learners used paragraphs and bullets to organize their ideas in their text documents in a way that conferred a greater degree of coherence and logical organisation on their texts and presentations. One group of learners used columns to format their document and made a flyer by using the resources of Microsoft Word (see Figure 4.1). And another group prepared a poem as an educational strategy for their community (see text on appendix 4.1).

Most learners seemed to be comfortable with using Microsoft Word programme compared to other programmes in the study. This might indicate that these features are routinely taught in the kind of computer courses that are presented in Tanzanian schools. For example, these learners tended on the whole to use Microsoft Word to type their documents and divide them into logical paragraphs, as well as features of Microsoft Word such as Spell Check. (Their use of Spell Check reduced the incidence of spelling mistakes). None of them needed any supplementary help from the researcher to manipulate this programme.

On the other hand 12 learners scored below average in computer application skills in this category. The text documents they typed were less organized, some of the learners had one big typed paragraph and all the information was collectively in this text. Some of the learners even needed help on how to open the programme, and use of other application skills like bold, underline and saving the document on a floppy disk. This was a big challenge for them especially when everyone was supposed to complete the given open-ended digital learning tasks. However, 8 learners were average performers who managed to use the Microsoft Word programme with very little help from the researcher.

Most learners obviously felt comfortable and sufficiently skilled to use Microsoft Word to type their text. This is because the computer course syllabus for Tanzanian secondary schools emphasises training in basic skills, and that means being able to use the features of Microsoft Word with a degree of facility. It is evident that most of the learners in the sample have mastered at least the most basic computer application skills recommended by the Tanzanian syllabus. That much is evident from their facility in using these basic functions and features. One might also make the deduction that if they had further opportunities to learn, explore, practise and experiment, they could extend their repertoire of skills and knowledge and integrate and apply those skills and that knowledge in new situations. They have a sound basic knowledge of how to use Microsoft Word programme. But they urgently need at least some skill and facility in the use of other Microsoft Word features such as Microsoft Excel and PowerPoint.

In the following section, I will establish whether there is a *significant* relationship between the learners' four intelligences profile (strengths and weaknesses) and their performance abilities in computer application skills.

4.5.2 The possibility of a relationship between learners' intelligence profile and computer application skills in terms of four intelligences

I utilised a contingency table to determine whether there was a relationship between the learners' intelligences profiles (their strengths and weaknesses) and their performance abilities in computer application skills. I prepared this contingency table by using data from: (1) the results of the final judgement results of the intelligence profile of the learners recorded in Table 4.2, and (2) the assessment results of the learners' performance abilities in computer application skills in different intelligences (as recorded in Table 4.3).

I then proceeded to use a descriptive data analysis procedure. I judged this procedure to be appropriate because of the small sample size and purposive sampling process used for the learners who participated in the study. These limitations *disallow the use* of *a chi-square statistical test*. A chi-square test moreover requires at least 80% of the cells of a contingency table to contain at least five cases if a confidence level is to be obtained from the results (Cohen, Manion, & Morrison, 2000). In this case, some of the cells in the contingency table contain fewer than five cases or none at all. The distribution of learners in the contingency table is as seen Table 4.4.

Table 4.4: Distribution of learners in each intelligence profile (logical-mathematical, visual-spatial and verbal-linguistic) and their performance abilities in computer application skills

Computer skills ↓	Intelligence profiles of the learners											
	Logic mathematical				Visual spatial				Verbal linguistic			
	H	M	L	Total	H	M	L	Total	H	M	L	Total
Above average	4	6	--	10	3	5	--	8	13	7	--	20
Average	--	4	--	4	--	9	--	9	2	6	--	8
Below average	--	21	5	26	1	21	1	23	1	11	--	12
Total	4	31	5	40	4	35	1	40	16	24	--	40

KEY: H – high, **M** – Medium, **L** - Low

The distribution of learners in the contingency Table 4.4 reveals a distinct pattern that suggests a relationship between learners' intelligence profile in the different intelligences and their performance abilities in computer application skills. A number of learners showed that their performance abilities in computer application skills related to their intelligence profile (their strengths and weaknesses) in logical-mathematical, visual-spatial and verbal-linguistic intelligences. I shall discuss at length the overall performance abilities of the learners and their intelligence profiles in the following sections.

4.5.2.1 High/low profiles in logic mathematical intelligence and computer application skills

Four learners who rated high in their logical-mathematical profile managed to perform in an *above average* way in their computer application skills in the three tasks. These learners organised and planned their data skilfully and logically, and they recorded and organized their number information in tables by using the table feature of Microsoft Word and the graphs feature of Microsoft Excel. This subset of learners used numbers creatively and imaginatively to supplement their explanations and presentations because they referred to numerical information from graphs and tables in their text documents. On the other hand, the five learners whose intelligence profile was low in logical-mathematical intelligence, also performed in a *below average* way in their computer application skills in the three tasks. These learners did not use tables from the table feature of Microsoft Word or graphs from Microsoft Excel to organize and record their numerical information as they processed the data that they had to present to their peers. Moreover they did not sequence the content part of their texts well by using paragraphs or other indicators of logical division and presentation although the paragraph is a fundamental feature of Microsoft Word text presentation. They organised the logical division of their texts by sequentially presenting examples that they obtained from the reading resources – but without reflecting logical transitions in the layout of their text and presentations.

The middle group of four learners, who had been assessed as having a medium intelligence profile, also scored an *average* rating in computer application skills. These learners used a minimum of computer applications in their tasks. They included *either* a table or a graph (but not both) in the organization of the numerical information of their texts and presentation. Some of them sequenced their information into paragraphs in Word, and some used numbers to organise their texts logically and clearly.

The group of 27 learners who were rated as having medium intelligence constituted the majority of the sample, with six learners who scored above *average* in their computer application skills while the remaining 21 learners scored *below average* in their computer application skills.

4.5.2.2 High/low profile in visual spatial intelligence and computer application skills

Out of the four learners with high intelligence profile in visual-spatial intelligence, three managed to obtain an *above average* rating in their computer applications skills in the three tasks. These learners demonstrated their visual-spatial intelligence skills by using pictures from clip art, Word art and photographs from their reading resources. In some of the tasks, these learners used tables and graphs from Microsoft Word and Excel to decorate their texts and presentations. These learners also used colours to lend point to their fonts, and substituted attractive and appropriate fonts for the standard Times New

Roman from the selection in Word to add interest to their tasks. Other computer features that they used in their texts included bolding and underlining their headings and subheadings. They also successfully managed to use animations in their PowerPoint presentations.

The nine learners who had medium intelligence profiles scored an *average* rating in their computer application skills. These learners used either a table or a graph, and used only one kind of picture feature in their presentations. That is to say, they used either clip art or photographs from their reading resources in their presentations (but not both). They also used other computer features such as underline while some changed the font styles in their texts. Some of them also managed to include animations in their PowerPoint presentations.

One learner with a low intelligence profile in visual-spatial intelligence performed in a below *average* way in computer application skills. This learner did not give any evidence of visual skills in the completion of his tasks. He did not use pictures from any of the programmes like clip art, Word art or any pictures from the reading resources that were provided. He also did not use tables or graphs, or any colours or variation in font size or style to embellish any point in the tasks. Nor did he use animation in his PowerPoint presentation of slides. All that this learner basically managed to do was to type a text by using Microsoft Word, Times New Roman (12) and nothing else. He did not supplement his presentation by using any of the most basic Word features such as underline, bold and or varying font size.

Five learners out of this group scored *above average* in their computer application skills in the three tasks although they were rated as having a medium intelligence profile. In addition, 21 learners who were rated as having a medium intelligence profile in visual-spatial intelligence scored *below average* in their computer application skills.

4.5.2.3 High/low profile in verbal linguistic intelligence and computer application skills

Thirteen learners who were rated as giving a high intelligence profile in verbal-linguistic intelligence scored *above average* in their performance ability in computer application skills in all the three tasks. In general, these learners used Microsoft Word to type their ideas. They organised their narratives in themes that they divided coherently into sub-themes. A pair of learners from school M, for example, used their verbal skills to invent rhymes to make a point about diseases in task 1. They wrote a poem as part of their strategy to educate people in their campaign against to make people in the community aware of the dangers of typhoid fever. They also divided their texts into logical and coherent paragraphs.

Six learners who were rated as having medium intelligence profiles in verbal-linguistic intelligence produced medium performances in their computer application skills. Most of these learners managed to use Microsoft Word to type their texts, and some were also able to set their presentation into a narrative form and to use bullets effectively to emphasise some of the points that they had obtained from the reading resources. Finally, since there was no learner in this group who had been rated as having a low verbal-linguistic profile, and no one performed in a below average way to express this intelligence, no possible link could be made in this regard.

However, within the group of 16 learners who had been rated as having a medium intelligence profile, seven performed in an *above average* way in the in computer application skills, and 11 performed in a *below average* way in all three of the tasks.

4.5.3 Conclusion

The results of the study show that there was a distinct pattern of performance abilities that emerged from the data. Every learner exhibited both strengths and weaknesses in each intelligence category rather than a uniform level of ability in all or any of the intelligence categories. The contingency Table 4.4 indicates that a positive relationship exists between learners’ intelligence profiles and their performance abilities in computer application skills (as the shading in the contingency Table 4.4 emphasises). A good number of learners who had high intelligence profiles also produced *above average* performances, while learners whose intelligence profiles were low also produced *below average* performances in their computer application skills in all three of the tasks.

Some of the learners who had been rated as having medium intelligence profiles also produced *average* performances in their computer application skills in all three tasks given. The findings of this study show that learners' intelligence profiles do have an influence on their preferences and performance abilities in different tasks. The assessment results of the three tasks showed that the performance abilities that learners exhibited in the computer application skills were also unique to individual learners. For example, in visual-spatial intelligence, learners who had been rated with *high* intelligence profiles used various pictures, images and clip art pictures to express themselves even though all the learners were required to complete the same tasks under the same conditions and with the same limitations. Some of them also used manila sheets to complete some of the drawings that they needed to complete the tasks. But learners who had been rated as having low visual-spatial intelligences used sometimes only one or two pictures from the clip art – or did not use any at all. They also did not use the manila sheets to complete their tasks.

If one looks at the tasks that the learners had to complete and does not focus only on the skills that are useful in the school context, one can see that the open-ended digital learning tasks gave learners an opportunity to use different learning preferences to attain significant and rewarding outcomes in their tasks. Thus, for example, learners used different computer preferences to complete their task documents and their slide presentations, and they integrated computer application skills (Microsoft Excel and PowerPoint) that were new to them to complete their tasks. They also made use of – and benefited from – the collaborative learning format of the research. These enriching activities could not have been experienced if the learners had been given standardized tests and had been required merely to provide answers to the questions asked.

However easy or difficult it might have been for individual learners to complete these authentic tasks, some learners gave evidence of appreciating how difficult it is to address complex issues that occur in real life (authentic) situations. But these learners nearly all appeared to enjoy their tasks. Some came up with provocative and original ideas during the presentations session and these prompted interesting class discussions. Many of the learned skills that the learners acquired may also be transferred to other courses and work situations. In this study, for example, the real world activities that the researcher selected ensured that learners would be likely to use the computer skills that they had become proficient in their tasks and that they might even aspire to learn new and valuable skills during the process.

The use of computers to complete open-ended digital learning tasks not only captured the learners' attention; it also highlighted differences in learners' performance abilities on the basis of different intelligences. Thus, for example, one of the learners out of the whole group performed exceptionally well. His name was Coleman (a pseudonym). Coleman's intelligence profile was high in logical-mathematical, verbal-linguistic and visual-spatial intelligences, and he also performed in an *above average* way in all the three tasks across all the three intelligences. But in interpersonal intelligence, Coleman had a medium profile and his performance was also medium in all the three tasks.

In order to describe what I, the researcher, and the co-observant teachers observed and assessed in each activity as vividly as possible, I reconstructed the results from each of the open-ended digital learning tasks and presentations into ***stories***. These stories are about four learners who were consistently rated highly in performance abilities in visual-spatial, logical-mathematical, verbal-linguistic and interpersonal intelligences. The first story, for example, is about Coleman. Coleman gave evidence of an unusual competence by consistently being rated highly in logical-mathematical, verbal-linguistic and visual-spatial intelligences although he was rated low in interpersonal intelligence. The following story is about Rachael who was rated highly in verbal-linguistic intelligence but low in other intelligences. Next is about Abigail who was rated highly in interpersonal intelligence, and, finally, there is Kim, who was rated highly in visual-spatial intelligence but low in the other three intelligences. I present these narratives or stories in the sections that follow.

4.6 Learners' intelligence profiles, preferences and performance abilities in four intelligences across the tasks

The intelligences profiles that I described in the earlier part of this research helped to explain the overall strengths and weaknesses that learners displayed in the four intelligences selected as the basis for this research, namely logical-mathematical, verbal-linguistic, visual-spatial and interpersonal intelligences. These profiles showed that while some learners demonstrated high intelligence in some categories of intelligence, they demonstrated lower intelligence scores in others categories of intelligence. For the purposes of this research, I used the information that I obtained from observing how learners completed the open-ended digital learning task documents and their presentations to complement and confirm the picture presented by the intelligence profiles that I obtained from the other named sources.

I thus found that learners who were strong in logical-mathematical and visual-spatial intelligences also completed the required tasks in a way that demonstrated that they possessed above-average logical-mathematical and visual-spatial intelligences. The results from the intelligence profiles tables and contingency tables however did not give me any detailed (layered) information about how each individual learner managed to use the four intelligences, in different combinations to complete their tasks in the form of task documents, presentation slides, discussions and manila sheets.

The following sections give a detailed description of how the following selected learners have shown to possess high logical-mathematical, visual-spatial, verbal-linguistic and interpersonal intelligences from the two separate sources described above have performed in each task.

I made use of four stories to show how this subset of learners made certain important choices to complete their tasks. I only selected the four stories after the tasks had been scored by myself and by the teacher, and after I had evaluated the intelligence profiles of all the learners so that I could define the subset of learners in whom I was interested in. I was anxious to establish whether any patterns might consistently emerge in the performance abilities and choices demonstrated by these learners in the three different tasks, and in the way that they solved the open-ended digital learning tasks and fashioned their products (The names of the learners used in this section are pseudonyms).

As one may expect from a group of this kind, the dominant intelligence(s) of the learners was shown in their actions, choices, techniques and instinctive preference for one particular mode of operation. Thus, for example one group of learners showed a consistent preference for using numbers, graphs and tables (an indication of logical-mathematical intelligence); another group of learners showed or decided on a preference for using pictures, clip art, colours and different font sizes (an indication of visual-spatial intelligence); another group of learners showed a marked preference for detailed verbal explanations in text documents generated by Microsoft Word (an indication of verbal-linguistic intelligence); another group of learners showed a noticeable preference for helping their peers to use computer applications and for leading and stimulating discussions in their teams (an indication of interpersonal intelligence). The intelligences and performance abilities that were used in the assessment of the documents are summarized in Table 4.5 below.

Table 4.5: Intelligences and performance responses

Intelligence	Responses to tasks
Verbal linguistic –	Uses own words to express themselves in the texts, contributes to discussions, like reading, talks a lot, describes a procedure.
Logic mathematical –	Uses numbers, summarizes number information in graphs and tables, put things into categories, uses spread sheets, and databases, logic sequencing of information.
Visual spatial –	Can draw images and pictures. Use charts, diagrams, clip art and word art. Like to use colours.
Interpersonal –	Like to organize, relate, manipulate, and mediate with people. Like to provide help, have friends and like to and can assign roles to others.

In his theory of multiple intelligences, Gardner (1983; 1993) argues that while all average people are capable of drawing on all the intelligences, individuals are distinguished by their particular profile of intelligences, that is, **by their consistent preference for utilising one or more of their stronger intelligences.** This profile of consistently chosen preferences identifies the learner's own unique combination of relatively strong intelligences to which they instinctively resort to solve problems or fashion their products (Walters & Gardner, 1985). I shall use this concept of the relative strength or weakness of specific intelligences to account for the individual differences that the learners displayed in the context of the following stories (Gardner, Kornhaber, & Wake, 1996).

The stories of these learners were compiled from data collected during the observation and assessment of their performance abilities as it was presented in their open-ended digital learning task documents and presentations. My observations were guided by the use of rubrics. I gathered other data and information from the interviews that I conducted with the learners, teachers and their parents.

4.6.1 Story 1: Strong in logic mathematical, visual spatial and verbal linguistic intelligences

This is a story about Coleman who was 16 years old and in Form 2. He exhibited an unusually high competence in more than one of the intelligences. His quite noticeable preferences as he worked on the open-ended digital learning tasks and presentation session were for using his logical-mathematical, verbal-linguistic and visual-spatial intelligences. He was nevertheless quite weak in interpersonal intelligence. The following sections present a detailed discussion of how Coleman performed in all of the three open-ended digital learning tasks.

4.6.1.1 Logical-mathematical

According to Gardner (1983; 1996) and Chapman (1993), strong performance abilities in logical-mathematical intelligence are evident in learners who enjoy using calculations, problem solving, critical thinking, data interpretation and categorizing facts. While such learner enjoy using technology (computers), they also like to use spreadsheets to give shape to their results, and they show a marked preference for summarizing number information in the form of tables and graphs. They also prefer to identify and collate logical and numerical patterns in data and information in order to explore patterns and relationships.

Coleman's performance ability in logical-mathematical intelligence, compared to the performance ability of other learners, was impressive indeed. In all of the three tasks, Coleman scored three points. This means that his performance ability is above average in logical-mathematical intelligence. Let us look at how Coleman performed in task 1. Task 1, this is the activity that required learners to prepare an educational strategy that would educate their community about two extremely dangerous water-borne diseases, *Cholera* and *Typhoid fever*. They were asked to prepare a flyer, a radio or television programme, or a poem.

Coleman selected a television programme and typhoid fever disease. First, he summarized all the information he felt would be relevant and typed it in a Word document. He then logically arranged this information in short paragraphs that showed what is typhoid fever, the name of the microbe that transmits the disease, how the disease is transmitted, the symptoms, treatments, prevention, and finally the implications to the community and the government if the disease is not treated on time. Apart from summarizing his work logically, Coleman selectively used numbers in a consistent way in his text, so that more emphasis would be placed on the effects of the disease to human life. He then provided official statistics about the number of people who were infected and died from typhoid fever disease annually in the whole world during a certain time frame. These are the words he used to convey this. This extract also shows how he used numbers in the text to make his point:

> The annual occurrence of typhoid fever is estimated at 17 million cases, with approximately 600,000 deaths annually world wide. Typhoid fever is a global health problem affecting an estimated 12.5 million people annually and is endemic in many countries, particularly those in Asia, **Africa,** and South America.

During the interview session, when I asked Coleman why he had used the information quoted above for his television programme, he said, “I had to put more emphasis on the disease by telling people how this disease can be dangerous. [I did this] by indicating the number of people who have been affected and died. And hence people in the community should not take it lightly. They have to be aware that it has affected many people world wide. They have to know that.”

In task 2 – landfills and its effects to the environment, Coleman also inserted the following relevant numerical information (data) into his text:

> Dar es Salaam city has a population of 3.5 million people and produces 2,000 tonnes of garbage per day. 20% of this is collected compared to some of the cities in New Zealand where about 90% of the garbage is collected per day.

Coleman showed a marked preference for using numbers to emphasize points. He said in the interview that it was important for him to use numbers in his educational strategy to educate his community. People, he said, understand more easily when one uses information with numbers to explain the severity or the impact of a disease.

The results from the tasks also showed that Coleman performed well in categorizing numbers. Thus, for example, he used tables to display his information in a summarized form by using Microsoft Word (see Table 4.5) and graphs using Microsoft Excel (see Figure 4.7 below). This graph by Coleman (below) summarizes information to show various ferry disasters that occurred in different countries (as indicated in reading resources for task 3), and the number of people who died over three years in such disasters. During the presentation session, Coleman used this table and the graph to discuss with his peers how ferry disasters had also affected other countries and how these disasters could be compared with those that had occurred in Tanzania.

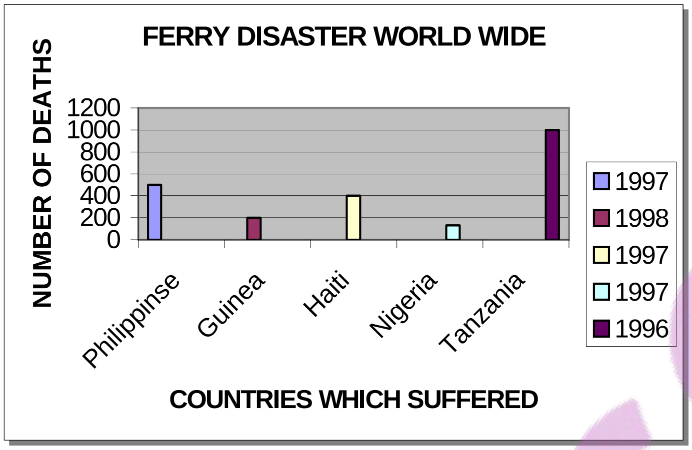


Figure 4.7: The graph used by Coleman to show the incidence of ferry disasters worldwide over a period of three years.

Coleman also thought of a way of conveying information from other parts of the world and relating it to the local context by logically arranging the information that he wanted to convey. After he had done this, Coleman said he felt that he had managed to summarize the information to the level that could be understood by the members of his community. From his graph, the people of his community would see that Tanzania had suffered most by losing more that 1000 people in the MV Bukoba tragedy that occurred in 1996, compared to those in the Philippines and Haiti.

Table 4.6: The table used by Coleman to illustrate the details of the MV Bukoba tragedy

MV Bukoba Tragedy					
Survivors	**Trapped**	**Rescued**	**Lost completely**	**Tanzanians**	**Ugandans**
125	522	158	500+	1,000+	10

Coleman's strong performance ability in logical-mathematical intelligence was also supported by his academic results in the school progress report. Coleman scored 72% as his average score in mathematics, physics, and chemistry subject. This shows that he has an exceptional ability to work with numbers and an ability to work logically in mathematics and science subjects. In self-rating multiple intelligence survey questionnaire, Coleman rated himself as being strong in logical-mathematical and gave himself a score of 9/10. This suggests that he is well above average in logic-mathematical intelligence.

4.6.1.2 Visual spatial intelligence

According to Gardner (1983; 1996) and Chapman (1993), visual-spatial intelligence is the learner's capacity to perceive and create visual experiences. It may be seen in the imaginative and creative use of photographs, pictures, visual strategies and images. It also indicates an ability to use different media to produce and exploit the potential of graphics, designs and colours.

Coleman's performance in the area of visual creativity was also impressive in this context. In my first encounter with Coleman during the pre-session discussion about the study, Coleman introduced himself, and talked about what he would like to do in the future. He said he would like to be a pilot one day and that he would like to be able to observe the world from the sky. What was most striking about Coleman as he worked on the open-ended digital learning tasks was the way in which he combined different media – in this case, computers (electronic media) and manila sheets (paper-based media) – to construct his pictorial representations. Although all the learners were required to use the computers in one way or another, Coleman used different computer applications including the pictures from reading resources, photographs from clip art, and tables and graphs that he constructed by using features from Microsoft Word and Microsoft Excel respectively.

Coleman showed good judgement in his selection of pictures and photographs to represent his visual ideas as he completed his tasks on the computer. In task 1 (diseases), for example, he selected a certain picture to show that certain types of microbes caused typhoid fever (Figure 8), in another picture it showed one possible way in which a microbe can be transferred or transmitted to another person (Figure 9), and another one to show the effects of this disease on the daily lives of the people (severe and often terminal illness) (Figure 10). What Coleman wanted to convey by using these visual effects was the logical narration of how a disease can spread and how it can affect people *sequentially*. This was the information that Coleman felt was vitally important, and he wanted to use it in his educational strategy. During my interview session with Coleman, he said that he had used pictures because he had to consider the limitations in the educational level of the people living in his community. He said:

> I know some of the people in my community will not understand the whole text I have used [...] Adding pictures is one way of simplifying the information. People understand easily when they visualize the information by using pictures. […] Pictures show real situations. […] Like the picture I used showing people standing in the water: it represents the real situation out there.

(i). Pictures Coleman used in Task 1: Health and Diseases.

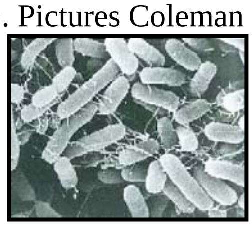


Figure 8-microbes


Figure 9- transmission

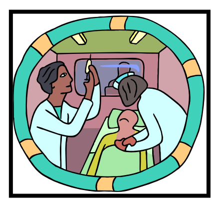


Figure 10 – a sick person.

For task 2, Coleman selected several pictures that showed the stages through which garbage passes from collection to disposal in landfills. The first one showed garbage being collected from a household (Figure 11). The second shows a garbage collection truck emptying garbage into an officially designated landfill area (Figure 12). The final one shows a household that is surrounded by garbage and dirty water (Figure 13).

(ii) Pictures Coleman selected for Task 2: Landfills and its effects on the environment.


Figure 11 – Collection


Figure 12 – emptying in landfills


Figure 13 –filthy place.

Apart from making an intelligent selection from and an effective use of the pictures that were part of the clip art and photographs in the reading resources provided, Coleman also used pencils and marker pens to create a poster on one of the manila sheets provided. He told me that the poster formed part of the educational strategy that he had devised for his community. His poster summarized information about how landfills can affect a community in different ways. (Landfills that are not properly planned or maintained can pose serious health hazards to people who live near them. But local authorities can take advantage of landfills by recycling certain waste products for a profit).

Coleman described how members of the community could be seriously affected by these often fatal diseases. His picture 1, for example, shows one of the ways in which a landfill can be dangerous. It depicts sharp rusted instruments such as nails that can injure the children who play in these landfills. A child hurt by an infective agent such as a nail could develop tetanus poisoning (an often fatal condition). In his second picture, Coleman shows the fumes, smoke and foul odours that landfills emit. The fumes and often toxic smoke from landfill sources can precipitate chest conditions such as bronchitis and other related diseases in children – or worse. Landfills are often sources of heavy metal compounds that are released into the atmosphere as fumes or smoke. Some of these heavy metal compounds deposit themselves in the human body and cause severe and often irreversible long-term heath problems (such as foetal deformities) and even premature human fatalities. In his third picture, Coleman suggests ways in which the government can recycle, for example, empty cold drink cans to obtain aluminium which, in turn, can be used to produce useful household items such as cutlery.

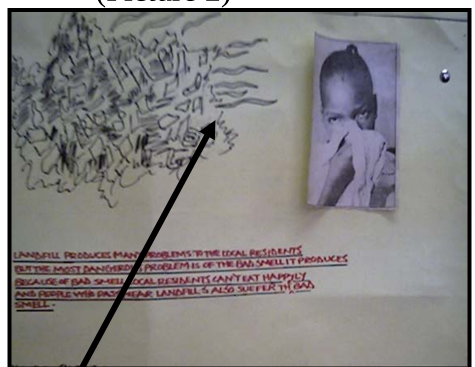
All Coleman's drawings show a creative use of colour (see, for example, Figure 4.14). Coleman's skilfully detailed drawings showed an intelligent awareness of the possible effects of landfills on the environment and the hazards that these can be posed to human beings who lived in their proximity.

Health hazards that can be caused by landfills

(Picture 1)

Two young boys are playing near a landfill. In the landfill are some dangerous objects such as rusted nails. These nails can puncture the skin and cause a fatal disease such as tetanus.

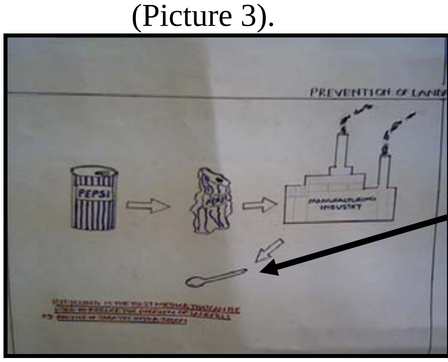
(Picture 2)



Landfills often produce poisonous smoke and noxious odours that can precipitate asthma, bronchitis and other severe respiratory diseases in humans. The picture shows a woman suffering from the effects of the foul-smelling chemical fumes and smoke that are being emitted by slow-burning toxins in a nearby landfill.

Recycling process to reduce landfills effects

(Picture 3).



In this picture Coleman shows how aluminium cans can be recycled to decrease waste-disposal volumes and provide a source of recycled aluminium.

Pepsi tins, for example, may be collected and returned to a factory where they can be reprocessed to produce aluminium that can be used to produce spoons, for example.

Figure 4.14: Drawings done by Coleman to depict the potential health hazards posed by landfills

For task 3, the learners were asked to write a story about the MV Bukoba Tragedy, which claimed more than 1,000 lives. Coleman, however, used his initiative and visual imagination to write a story which he then illustrated by a picture of a sinking ship (Figure 15). During the interviews Coleman said:

> I did not know that the people who lost their lives in the MV Bukoba tragedy. [They must have] died in a painful manner. [They] could not be rescued in time before they died. Moreover, most of the bodies could not be retrieved for burial […] It was sad for their families.

He included a slide in his presentation that showed a person crying in agony. He illustrated it by saying, "Maybe it is the will of God […] that these people died in the tragedy." (See Figure 4.16).

(iii) Pictures used in task 3 by Coleman to illustrate the MV. Bukoba tragedy.

Figure 15 – sinking ship.

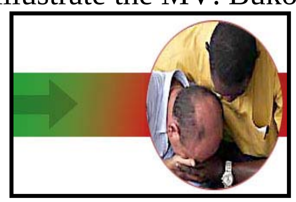


Figure 16 – person crying with agony.

Judging from the three task documents completed by Coleman showed that he had a high visual-spatial intelligence. This finding was supported by the results of the multiple intelligences survey questionnaire in which Coleman received a score of 8/10. Coleman's school progress reports also showed that his average score was 81% (distinction level) for biology, geography and computer studies. Learners who have imaginative skills, visualization ability and who are able to use pictorial images creatively will find that their performance in these subjects can be significantly enhanced by these abilities. Coleman's scores and results in such subjects suggest that he likes to think in images and pictures, draw, and use graphs, maps and diagrams. In an interview that I conducted with Coleman's mother, she supported the suggestion that he might have a strong visual-spatial intelligence. She said:

> Coleman is a person who likes to imagine and visualize things […] He has always dreamt of being a pilot [from when] he was young at the age of five until today [...] He always said he would like to visualize the world from the sky.

By actively employing his visual-spatial skills in all of his tasks and showing a distinct preference for using pictures and images in all three tasks, Coleman showed that he scores highly in this kind of intelligence

4.6.1.3 Verbal linguistic intelligence

Verbal-linguistic intelligence is expressed through the medium of language. People who are strong in this kind of intelligence have the capacity to communicate well and make sense of the world through language (Krechevsky & Seidel, 1998). Coleman's writing skills were good. In task 1, for example, he used simple but cogent sentences to describe his ideas, and he arranged his work in coherent themes. He led into his task with an introduction and he used subtitles (such as Transmission, Symptoms, Disaster implications, and Prevention) to good effect. The information he supplied was straightforward and to the point, as may be seen in Figure 17 below.

TYPHOID FEVER

Typhoid fever is one of the dangerous diseases affecting our society. Typhoid fever is contracted when people eat food or drink water that has been infected with Salmonella typhi.

TRANSMISSION.

Typhoid fever is transmitted by food and water contaminated by the faeces and urine. Polluted water is the most common source of typhoid fever. In addition , shellfish taken from sewage contaminated beds, vegetables fertilized by night soil and eaten raw, contaminated milk and milk products e.g. butter, yoghurt, and ice cream have been shown as source of infection.

SYMPTOMS.

It is recognized by the sudden onset of sustained fever, sever headache, nausea and sever loss of appetite. It is sometimes accompanied by hoarse cough and constipation or diarrhoea. Paratyphoid fever shows similar symptoms but tends to be milder and the case fatality rate is much lower. The annual occurrence of typhoid fever is estimated at 17 million cases, with approximately 600,000 deaths annually world wide. Typhoid fever is a global health problem affecting an estimated 12.5 million people annually and is endemic in many countries, particularly those in Asia, **Africa,** and South America.

DISASTER IMPLICATIONS.

With disruption of the usual water supply and sewage disposal and if there is no control of food and water transmission, typhoid fever may occur if there are active cases or carriers. Efforts to restore safe drinking water supplies and sanitary disposal facilities are essential. Selective immunization of special groups such as school children, prisoners and municipal or hospital personnel is important.

PREVENTION

- To protect and chlorinate public water supplies. Provide safe water supplies and avoid possible back flow connections between sewers and water supplies.
- Disposal of human faeces in a sanitary manner and maintain fly proof latrines.
- Use scrupulous cleanliness in food preparation and handling.
- Educate people regarding washing their hands before eating.

Figure 4.17: Coleman's written transcript on Typhoid fever.

Coleman purposefully used simple language and subheadings to convey his information because he wanted to use the task as the basis for a television programme for his educational strategy to educate his community about typhoid fever. (Some people in his community would not have understood more complex language because they had very little formal education.) During the presentation session, Coleman said:

> My reasons for choosing a TV programme for this disease are: I want to reach more people all over the country […] I used simple language as people have to listen and understand what they are required to do to stop the disease. They need to understand the importance of keeping the environment clean. Simple language is important […] Hence, they will be able to get a lot of information about this dangerous disease. (Presentation made by Coleman on 8 January 2004).

During the discussion and feedback session, other learners said they did not think that a television programme would be effective because, firstly, many people do not have television sets in their houses, and, secondly, most rural areas (i.e. the areas in which people are most likely to be affected) did not have electricity and so people there would not have been able to use television sets even if they could afford them. During this discussion, Coleman continued to defend his choice of using television as an educative medium by saying:

> A TV programme is still effective because, apart from the presenter narrating the important information about typhoid fever (as it could have been if a radio is used), pictures can also be used to show how typhoid fever is transmitted, how people are hospitalized in hospitals and preventive measures can be taken, and everything will be seen on TV. On TV they can also show the text which people can also read. Then, the few who will be able to see this programme will tell others who do not have TV at home (Presentation made by Coleman on 8 January 2004).

Although Coleman knew that the television programme format he preferred would not reach all the people in his community, he nevertheless adduced some good reasons why it might still work to a limited extent.

For task 2 (the assignment about landfills and their effects on the environment), Coleman prepared his information component in an MS Word document. He organized and sequenced his information well. He presented it in the following order: (1) What a landfill is, (2) How a landfill is formed, and (3) How a landfill can become a serious health hazard in the environment. The following excerpt is taken from that part of the text in which he explains how landfills can become health hazards:

> Because of the location of the landfill near places where people live, it causes lot of loose garbage in and around houses. Local residents experience dust in the dry season, mud in the wet season and a lot of smell, smoke and chemical fumes from the landfill. Sometimes there are fires at the landfill, which could be started by local residents who are unhappy at the way the landfill operates or they are trying to reduce garbage by burning it. These fires cause a lot of smoke problems for locals, and also disrupt the operations of the landfill. Moreover, landfills can cause diseases for example Cholera and can be transmitted to people through the vector called housefly (Excerpt from text saved by Coleman on 10 January 2004).

For task 3, Coleman wrote a story about the MV Bukoba tragedy in Tanzania. He started his story by narrating how different countries have been affected by tragedies, and how these countries have lost people and material wealth. Coleman wanted to explain how important it was for people to ***understand*** that tragedies do occur, and that they affect many people – and not only the Tanzanians who were tragically and personally affected by the sinking of the MV Bukoba. Here is an excerpt from the text of Coleman's presentation:

> Many countries all over the world have been suffering because of the tragedies of sinking of ships. Because of that, many countries have lost their people and many families have lost their loved ones. Few examples of countries who have suffered from this type of tragedy are the Philippines when they had to experience the sinking of the 13,935-ton MV Princess of the Orient near Manila. Guinea Bissau also suffered in 1998. About 200 people were drowned as they fled fighting in the West African state (Excerpt from text saved by Coleman on 16 January 2004).

Coleman used international examples too, to give the general information, and then in the local context, he specifically narrated his story about MV Bukoba tragedy that occurred in Tanzania in 1996, killing approximately 1,000 people. He organized the information from general to specific. A section of the text explaining MV Bukoba tragedy is as follows:

> Now we are going to look at the biggest shipping tragedy in Tanzania, which took place on May 21st 1996, when the steamer MV Bukoba sank on Lake Victoria 30Kms from Mwanza port. The steamer had a capacity to carry 430 passengers but MV Bukoba carried more than 1,000 people, because it was feared that as many as 1,000 have died. Among the dead there were some 400 children returning home from school after their final examinations (Excerpt from text saved by Coleman on 16 January 2004).

Coleman also revealed his own spirituality and sensitivity to spiritual values in the following words:

> The pain of this tragedy will continue to be in the people's hearts and they will never forget the date of May 21st 1996. The people of Tanzania continue mourning for the loss of their loved ones, especially the families that lost more than five people. Other people have also described the tragedy, which is mainly blamed on the inefficiency on the part of Tanzania Railways Corporation (TRC), but it can be that it is the <u>will of GOD</u> (Excerpt from text saved by Coleman on 16 January 2004).

In general, Coleman's text documents showed that he could use language to produce different effects – to motivate, to encourage, to convey information, and to show emotion. The vocabulary that he used was simple and appropriate for his purposes and the possible limitations of his audience (theoretically, the community). In his PowerPoint slides, he included pictures and text that were well sequenced. These achievements confirm his verbal-linguistic intelligence score. The multiple intelligences survey questionnaire indicated that he has a verbal-linguistic score of 9/10. This means (partly) that he enjoys explaining his ideas to others. His school progress report showed an average score of 80% in English, Kiswahili and French. He performed consistently well in all his language subjects.

4.6.1.4 Interpersonal intelligence

Coleman's performance ability in interpersonal intelligence was relatively low compared to his other intelligence performance abilities. His score of 6/10 was taken from the multiple intelligences survey questionnaire. Interpersonal intelligence is expressed when learners undertake actions that involve organizing, relating to, manipulating, and mediating for other people. People who score highly in this intelligence are people who like to help others, who have many friends, and who enjoy assigning roles to others (Nitko, 2001). These factors were accounted for in this study because most learners were required to work in pairs.

During this study, Coleman was allowed to work alone because his friend, who he was supposed to work with, had to attend a funeral of a relative, so he left before the research began. Because he was working alone, some of Coleman's behavioural performances (in instances in which he might have spoken to others, helped them verbally or discussed ideas with them) were absent because of his working alone and so could not be accurately be detected or assessed during the observations. Even so, no other learners asked him for any assistance. He also did not consult any of his colleagues (the other learners) on any issue before the discussion. During the discussion and presentation sessions, he asked questions where possible. The questions that he asked were well structured and they brought a liveliness to the class discussions because he wanted to present correct information (and that only), and was ready to justify his suggestions when need be. When Coleman was not presenting, he would sit in an alert posture and listen attentively to others. He is rated as low person when it comes to interpersonal skills.

To return for a moment to Coleman's dream of becoming a pilot one day, the overall assessment shows that Coleman performed well across several intelligences in each task. His last comment in one of the interviews was this:

> To make sure that I can become a pilot in future, I am working hard on all my science subjects, for example physics, chemistry, biology and mathematics. These are my favourite subjects. […] Also I am now doing computer studies in order to familiarize myself with the knowledge of computers and what is taking place in the rest of the world.

Coleman's strong performance abilities on the basis of three different intelligences lend credence to the hypothesis that learning can be better accounted for across a wide range of skills and understandings. In all the three tasks, for example, Coleman's performance abilities ranged from high logical-mathematical ability, verbal-linguistic and visual-spatial to a low interpersonal intelligence. Krechevsky (1998) tends to confirm this hypothesis when she says that information-processing capacities and problem solving features of each intelligence are to a large extent independent of one another. She notes however that the intelligences do not work in isolation (Krechevsky 1998, p. 4).

4.6.2 Story 2: A learner strong in verbal linguistic intelligence

4.6.2.1 Verbal linguistic

Rachael was a learner who demonstrated a strong ability in verbal-linguistic intelligence. At the time of the study, she was 13 years old and the youngest in her class. During the pre-session discussion before the study, Rachael said she liked reading, writing and discussing issues. This information was supported by the results of her multiple intelligence survey questionnaire which showed that Rachael scored 8/10 in verbal-linguistic intelligence.

Rachael's performance abilities in the open-ended digital learning tasks also confirmed that she has an ability to express herself through the use of language. In addition, she communicated well and was able to translate what she was thinking into sensible speech (Krechevsky & Seidel, 1998). The results of the three tasks she performed showed that she scored three points (the maximum). This means that her performance abilities were above average. For task 1, the cholera assignment, Rachael started out by summarizing her work in Word document. In this document, she presented the necessary information in short sentences that were clear, vivid, and to the point. She then used this information to construct a radio programme, which was the format that she selected as the main vehicle of her educational strategy to educate her community.

Rachael also arranged her information in coherent themes. She began each subsection with a title and then further divided the text by means of subtitles. In this way, she produced an introduction, and then dealt with the symptoms of the disease, its means of transmission, the effects of the disease, methods of cure, and finally, preventive measures. In order to clarify some of the points in her informational presentation, she gave examples of regions that were more affected by cholera, and explained why, in some regions, there was a higher incidence rate of cholera than there was in others places such as the Dar es Salaam Region. The following is part of the text that Rachael used to explain how cholera affects these areas. It illustrates the vivid but forceful way in which she used language:

> Places with a large population of people are mostly affected with Cholera. For example, [in] Manzese, Kigogo, Vingunguti they never follow health rules. They throw garbage wherever they want. Dirty water from bathroom and toilet sewage are not properly disposed, and is allowed to flow out in the open, bringing a lot of flies. These flies later sit on the food. Children are the ones mostly affected. They never choose a safe place to play. They sometimes play in places where there is dirty water flowing from toilets carrying cholera microbes. Moreover, they rarely wash their hands after leaving the lavatory. At the same time they usually eat with their dirty hands. Then, the most effected places are the places with problem of water supply because they buy water from young boys who use to sell water in gallons, but they do not care about where exactly the water has been collected and what the source of this water is. Also they do not boil drinking water. These people are mostly affected because they drink unboiled water (Text saved by Rachael on 7 January 2004).

During the presentation session, Rachael was required to attempt to persuade others that her chosen format of a radio programme would be the best educational strategy for educating her community about the disease. The main reason she adduced in defence of her choice of her primary strategic vehicle was that the radio was the most effective and widespread means of getting information to the kind of people who lived in her community. She also noted that most people in her community (although poor) *could* afford to buy a radio, even if it is a hand radio. She explained that radios were prized possessions even though her community was not served by electricity. The people in the community bought and used batteries as a source of power for their radios. She further explained that although few people could afford to buy a television set, ownership of radios, especially portable radios, was fairly widespread in her community.

She told her audience that a further advantage of radios for rural people was that they could be taken anywhere, especially the portable ones. Thus, even when workers went to work on farms, they could take their radios with them and thus stay in touch with what was happening in the country, the nation and the world. Radios were thus a primary source of political and other vital information such as disease prevention measures for the community. Rachael also noted that it was necessary for her to choose a radio programme rather than a flyer for her community because while not everyone in her rural community knew how to read and write, everybody could listen to a radio and think about what they were hearing. By presenting all these points in a cogent and reasoned manner, Rachael used her strong language (verbal-linguistic) ability to present and gain support for her decision to use a radio programme as her primary strategic means.

In task 2 (Landfills and its effects on the environment), Rachael chose to write a letter to the chairman (the leader of her community) in MS Word format. The information that she conveyed to the leader was presented under the following heads: (1) What is a landfill? (2) How a landfill is formed (3) How a landfill can become a health hazard to the people living in the community. Rachael also included information about how the environment could be affected if landfills were not considered to be an environmental hazard. The following extract is a section from Rachael's text (her letter) in which she explains how landfills can affect the environment:

Environmental problems caused by landfill

Landfills destroy the good appearance of the environment. It makes the environment look filthy because most of damps do not have gates or fences. During windy and rainy season the garbage is spread in other areas and start giving very bad smell. If not well-managed, it can cause serious air pollution. Then some of the garbage can create toxic liquid called leachate, which pollutes the environment.

This can be prevented by:

- Buying materials kept in less packaging to reduce by half the rubbish in landfills.
- Grow our own fruits and vegetables than buying canned or packed food.
- Compost manure can be made from food scraps
- Refuse taking plastic carrier bags from shops. Take your own fabric bag instead.

Major problems when a landfill is established are:

- It takes a long time for waste to break down (decompose)
- It destroys the aesthetic of the environment
- It pollutes air, soil and water.
- It brings a lot of health hazards to children and adults.

(Text saved on 10th January, 2004).

Figure 4.18: A text prepared by Rachael to explain how landfills can be an environmental hazard to a community.

Rachael managed to assemble the correct information that she needed to convey to the village leader and to the other members of the community. Her letter included selected information that it was important for the village leader to understand. The essential information that the letter conveyed included the following: what is a landfill is; the amount of garbage produced per day in the city; possible health hazards arising out of improperly managed landfills; specific suggestions to the village leader about what could be done to reduce the amount of garbage being produced by the people, and how a landfill could be prevented from destroying the community. Rachael summarized these ideas well and presented them in a way that would enable the village leader to understand how landfills could be an environmental issue and a health hazard for his community.

Here is a short excerpt from Rachael's letter, in which she explains the amount of garbage produced is as follows:

> A landfill is a place where wastes from different places are put. Dar es Salaam has a population of 3.5 million people and these people produce around 2000 tonnes of waste per day. About 20% gets collected. Up to 80% consists of organic food scraps that cause a bad smell very quickly in warm temperature and finally can cause diseases.

The following part of Rachael's text explains possible health hazards that can be caused by improperly managed landfills:

> Major health hazards caused by a landfill: Communicable diseases can be caused during rainy season, for example, Cholera and Typhoid fever. Problems in respiration result from smoke which is in the air when burning the wastes. Cancer of the lungs can also be caused by smoke while other potential diseases include cough and influenza.

During the presentation session, Rachael said that the information she had included in the letter to the village chairman was important because village leaders in Tanzania are the decision makers on all issues that pertain to cleaning, conservation of the environment and water sources in their areas. She therefore felt that it was important for her to explain to the village leader what an adverse impact on the environment a landfill might have.

For task 3, Rachael wrote a story about MV Bukoba tragedy in Tanzania. She started her story with this striking sentence that led straight into the story: "On this specific day, 21st May 1996, the steamer MV BUKOBA sank on Lake Victoria 30 kilometres from Mwanza Port..." This was an excellent and dramatic way of introducing such a story, and it suggests that Rachael might one day become a distinguished journalist (a career option for which her strong verbal-linguistic ability would make her well suited). Rachael then wrote the remainder of her story in a coherent and cogent manner and included information about how many people from a neighbouring country, Uganda, had died on

MV Bukoba. The part of the text that gives the information about the people from Uganda who died is as follows:

> More than 10 Ugandans are believed to have died in the accident when the Tanzanian vessel MV Bukoba capsized. The MV Bukoba left the port of Bukoba with three hundred passengers. But on its way to Kemondo Bay to pick more cargo, more passengers forced their way in. The ship did not have a passenger [section] for third class passengers and so it was overloaded. An announcement was made through radio in Uganda and identified the clergy (who died in MV Bukoba) as Brothers Mpuga and Alexandria from Barakaloli brothers of Kiteredde in Masaka Dioceses in Western Uganda (Text saved by Rachael on 16 January 2004).

In general the text documents prepared by Rachael were well arranged into paragraphs that made a clear and logical presentation of information. She also included examples, where possible, to enrich and amplify the information. The vocabulary that Rachael used was simple but forceful, and was well understood by her peers during the presentation session. Her strong verbal-linguistic intelligence was supported by her school progress report in which she had scored an average of 71% in all three language subjects: English, Kiswahili and French. A learner requires definite linguistic skills to perform well in these subjects.

Rachael's good writing and communication skills during the presentation sessions were also confirmed by her mother in information gathered in the interview with the parents. Rachael's mother told me that she had also noticed Rachael's strong verbal intelligence and abilities. Rachael's mother described her daughter as a person who was good in languages and who enjoyed reading books. She also added that Rachael was fluent in the speaking and writing four different languages. She said:

> My daughter is mostly quiet, and her best hobby is reading books. She likes staying indoors and especially in her bedroom, and in there she will be reading. She likes reading storybooks, academic books and novels. She is a very good reader like me. Whenever I go to a bookshop I will always buy a book for her and myself. Moreover, when you tell Rachael to tell you what she read in the book, she can do it by narrating the story to you or [she can]

> summarize the story on a piece of paper. (From an interview conducted with Rachael's mother on 18 January 2004)

Rachael's mother added the interesting information that her daughter was good in an important language other than English, Kiswahili and French. She said:

> My daughter is good in languages and she can speak and write four different languages fluently. These are Kiswahili, English, French and Arabic. She uses Arabic in her religion classes because Arabic is not used in schools. Being a Moslem she needs to know how to read and write in Arabic. (From an interview conducted with Rachael's mother on 18 January 2004).

When I compared Rachael's performance abilities across the four intelligences in all the three tasks, I saw that although Rachael was strong in verbal-linguistic intelligence, she was comparatively weak in visual-spatial, logical-mathematical and interpersonal intelligences. I shall now describe this more fully in the following sections.

4.6.2.2 Visual spatial

The main sign or evidence of visual-spatial ability is a preference for using pictorial representation in the form of drawings, pictures, clip arts, or for using colours in text documents. Rachael, however, did not (with one near exception noted below) use any pictorial or graphic representations in the three task documents or in the presentation of her slides. She also did not draw anything on the manila sheets that were provided for their use during task completion and presentation.

However, she did use a ***table*** in her handling of task 3 to indicate the number of people who had died, the number of survivors, and the number of people who had been trapped alive in the hull of the MV Bukoba (see Table 4.7 in the section 4.6.2.3 Logical-mathematical below).

In the assessment of her visual spatial intelligence, Rachael scored 2 points. This meant that her performance ability was average. These findings were supported by the results of the multiple intelligences survey questionnaire, in which she scored 2/10. During the interview sessions, Rachael said that her performance ability was below average in visual-spatial intelligence because she was not good at drawing. Her school progress report showed that Rachael received an average score of 66% in biology, geography and computer studies. Although Rachael might not have been good in drawing, she might conceivably have improved her performance abilities if she had been given the opportunity.

4.6.2.3 Logic mathematical

In logical-mathematical intelligence, Rachael was an average performer. Rachael clearly preferred not to use numbers or any kinds of graph in any of her tasks. She did not use any numbers in task 1 even though her text logically sequenced chains or series of events. She introduced her work by mentioning what caused cholera, how the microbe was spread, and symptoms of the disease, methods of treatment and prevention, and the names of places in which the incidence of cholera is high. She identified all these elements in her Microsoft Word document and in her slide presentation. For task 2 (Landfills and their effects on the environment), Rachael used numbers in her first paragraph when she referred to the number of people living in Dar es Salaam, the amount of garbage that was produced by these inhabitants every day, and the percentage of this garbage that was collected every day. This part of her text is contained in the section that deals with the amount of garbage produced in task 2. Her text was logically sequenced throughout.

In task 3, Rachael used subheadings to ensure the narrative sequence of her text and to make of it a coherent story about the MV Bukoba tragedy. Rachael explained when and where the tragedy occurred, the number of people who were in the ship at the time, the capacity of the ship, and how the capsizing of the vessel occurred. She followed this by noting the number of people who had died, the number who were rescued, and the number of dead bodies that were ultimately removed from the ship. She also included interesting information about the countries which had also lost people in the tragedy. Although Rachael's use of paragraphs was excellent, she supplemented this by inserting a table that summarized the number information pertinent to those who had died in and who had survived the MV Bukoba tragedy. Rachael's table is shown in Table 4.7 below.

Table 4.7: A table prepared by Rachael to show by means of numbers the categories of people who had died in or survived the MV Bukoba tragedy

SURVIVED	DIED			
SURVIVORS	Trapped alive, died later	Bodies recovered from water	Tanzanians	Ugandans
125	522	158	1000+	10

It is interesting to note that Rachael's performance is high when it comes to logical-mathematical intelligence in classroom activities. The results of the school progress report showed that Rachael scored an average score of 70% in the three subjects, physics, chemistry and mathematics. This means that although her performance abilities were above average in classroom activities, her performance preference in the open-ended digital learning tasks was rated as weak. These findings are supported by the results of the multiple intelligences survey questionnaire which indicated a score of 6/10. This means that Rachael was an average performer in this area.

4.6.2.4 Interpersonal intelligence

As far as interpersonal intelligence goes, Rachael was a relatively quiet and unassertive person although she worked well with her team mate and took the lead by assigning activities to her team mate to complete. On occasions, Rachael became frustrated with her team mate who, she felt, was not pulling her weight in the completion of the tasks. During the focus group interviews, Rachael said: "I worked well to complete the tasks, but sometimes my partner did not come and I had to work alone, or sometime she would come in late, and I have do most of the work alone."

This kind of behaviour on the part of Rachael's team mate indicates that, in collaborative work, some learners are not committed to do what they are supposed to do. This can become a major source of frustration to others who are committed and diligent.

Rachael's mother's evidence supported a better rating of Rachael's interpersonal ability. In one of the interviews with Rachael's mother, she said that though Rachael seemed to be quiet, she had many friends. This indication of interpersonal ability doubtless helped Rachael to work harmoniously with her team mate in spite of the latter's less than satisfactory behaviour. Rachael willingly worked her way through all the three tasks and even managed to inspire her team mate's support and participation towards the end when they were required to make their presentations. Before the presentations, Rachael explained to her team mate what she had done and what would be expected from them. So both of them would present their texts and participate in the discussions.

4.6.3 Story 3: Strong in interpersonal intelligence

4.6.3.1 Interpersonal intelligence

The third story is about Abigail. Abigail was a form three learner and 13 years old at the time of the research. Abigail performance abilities in interpersonal intelligence were uniquely strong. Her other intelligences were weak when compared to her interpersonal abilities. During the debriefing session before the study started, she said: "I like working with friends and I also like team work. I have many friends too. I like to socialize with my friends here at school or at home." According to the data shown in Table 4.1, Abigail had a high intelligence profile in interpersonal intelligence. In the multiple intelligences survey test instrument (a self-reporting questionnaire), Abigail scored 10/10 in all the items indicated in the questionnaire.

In one of the interviews she said, "I have organized a study group at home in which I am the leader, and many of my friends like to work with me." Abigail possessed an unusual ability to organize people and work with friends.

In an interview session that supported these findings, Abigail's mother said:

> My daughter is very talkative and talks to everybody. She has made a lot of friends because of that. She is very active and works well with others. But she is not good in physical games (Excerpt from an interview conducted on 28 January 2004).

Abigail's impressive ability in interpersonal intelligence is supported by the results of the observation checklist in which she scored 3 points (indicating a high profile) in interpersonal ability. Abigail worked well with her team mate (although she naturally assumed the leadership role). She was always talking and giving instructions about what should be done as it can be observed in the following pictures, taken from the video recording.

Figure 4.19: Abigail in discussion with her team-mate**.**

Figure 4.20: Abigail elaborating a point.

Apart from this, Abigail was constantly engaged in helping other learners from other teams. A good example of this occurred when Abigail and the others were completing task 1. Abigail was consulted by a member of another team who solicited her help on behalf of their team. They needed Abigail's help to understand PowerPoint because it was not altogether clear to them.

Figure 4.21: Abigail helping one of her friends.

Abigail immediately offered her help. She went over and showed them how to use the PowerPoint program. Abigail's friends trusted her and always asked for her help. She had built up this trust over time because she was always ready to offer a helping hand where it was needed. Although I as the researcher in this study was present at all times in the classes and available to give assistance in computer skills or in any other legitimate matter to the learners, they obviously felt more comfortable in asking Abigail for help. In one of the discussions (focus group interviews), I asked one of the learners why they had asked Abigail more for help than they asked the other learners. She replied:

> Abigail is always ready to offer a helping hand and I am comfortable asking her for help. Abigail is always of help all along even in our daily classroom activities. I don't like asking help from other girls because if they know something, they will tell you to wait first, and sometimes they will not help you that much. But Abigail will not keep you waiting.

The discussion in this section involved Anna, Abigail's team mate, with whom she worked together in all the three open-ended digital learning tasks and presentations. It was important to include Anna (for reasons mentioned below) because the interpersonal abilities of Abigail were more obvious as she worked with her and the other members of her class. Observations of Abigail working on her open-ended digital learning tasks showed that she was always talking and discussing matters with her peers. This was in contrast to Anna who was a bit shy and ill at ease and who now and then offered a few comments. It was always Abigail who initiated discussion in their team and who kept the work going. Working in groups in this way provided Abigail with opportunities to demonstrate in natural learning conditions how strong her interpersonal abilities were. The setting allowed Abigail to talk to her team mate and to share her skills with members of her own and other groups.

Here is an excerpt from a discussion between Abigail and Anna as they worked on their open-ended digital learning tasks:

> Anna: W*hat are we going to do now?*
> Abigail: *Mmm. I think we need to read the resources first and summarize the work on a piece of paper.*
> Anna: *Then?*
> Abigail: *I will type as you read from the paper… Is that okay?*
> Anna: Yes.

Abigail also controlled most of the activities in which she was involved by opting for natural leadership role in any situation. Thus, for example, Abigail rather than Anna typed the tasks. Abigail made it Anna's responsibility to read the information while she typed it. When a division of work was decided in any team, Abigail always assumed the leadership role. *Working cooperatively together* seemed always to be Abigail's preferred way of doing things. It was remarkable to note that Abigail's interpersonal skills were evident not only in her work on the open-ended digital tasks, but also in her cooperation with other members of her community as they accomplished various tasks together.

Abigail's interpersonal ability, as I have noted above, extended beyond classroom creativity and organisation. She thinks that many things can be done collaboratively and by sharing. Abigail says that she learns more from working with other people and from sharing skills, information and ideas:

> I like working with other people because by working in a team we share ideas, we are able to correct each other when someone makes a mistake.

Abigail's ability to work in teams and her actions as a facilitator and a leader are demonstrative of strong interpersonal performance abilities. Her interpersonal intelligence can be seen to be unusually strong when one compares it to that of the other learners who participated in the same study.

4.6.3.2 Verbal linguistic

In verbal-linguistic ability, Abigail was a medium-range performer. Her task documents showed that Abigail's linguistic ability was medium. Although her ideas were well connected and issued in a coherent text, the results of her school progress report showed that she attained the average score of 56% (which rates as medium) in all her three-language subjects: English, French and Kiswahili.

During the presentation session, Abigail was very active. Abigail's verbal abilities were more pronounced then written linguistic skills. This was in contrast to Anna who was a bit shy and ill at ease and who now and then offered a few comments. They both liked to ask questions and they contributed actively to the discussions. But, Abigail was always the first to initiate the discussions during the presentation sessions. She asked questions in order to obtain clarification from others, especially when she felt that the arguments they were offering were not clear or persuasive enough to support the educational strategies that they had selected as their primary means of community education.

Figure 4.22: Abigail asking for clarification.

When it was Abigail and Anna's turn to present, their fellow learners also asked *them* a lot of questions. They insisted on getting clarification about why they had chosen a radio programme for their educational strategy for their communities in tasks 1 and 2. Their colleagues wanted them to justify why they thought that a radio programme would be effective as their primary educational strategy when they knew that not everybody had a radio at home. Abigail and Anna gave the following reasons to support their selection of the radio programme format:

> First, a good number of people have radios compared to TV, because radios are cheap, for example those small portable radios. Even in the villages where there is no electricity, people have radios, because they use batteries. Second, many people listen to radios for news and other information so the information will reach them where they are. Third, some of the people are illiterate (cannot read and write) but they can listen to radios and understand the information about cholera and landfills compared to if they are given flyers to read. (Presentation by Abigail and Anna to the group on 23 January 2004)

As the discussion progressed, other learners wanted to know what would happen to people who did not have radios because it is true that not everyone in the village has a radio. Abigail was the first to answer and the following discussion ensued:

> Abigail: *It is the best means of reaching these people as many of them do not have TV.*
> Karen: *Do you know that, in most communities, not everyone has a radio?*
> Abigail: *I know most have radios even if it is a small one.* […] *Moreover, people in the village also share their things. On an important thing like this* [cholera], *they would even go to their friends place and listen.*
> Karen: *But all of them cannot fit in the house?*
> Abigail: *Yah… They will sit outside; people do that most of the time.* […] *They will listen from this radio as they are seated outside. Hence, radio is still an important strategy to use in educating people.*
> (Abigail in conversation in a presentation by Abigail and Anna to the group on 23 January 2004).

The picture below shows Abigail and Anna in conversation with their peers. They both possessed a capacity to express themselves and to get others to understand why they had done something (in this case, why they had prepared their tasks in the way in which they had done).

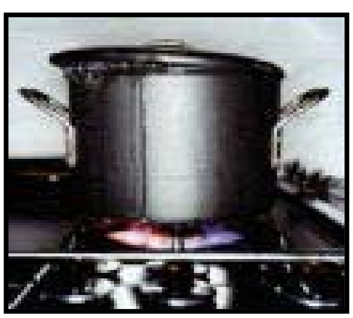
Figure 4.23: A question addressed to Abigail from a a colleague, during the discussion session.

Figure 4.24: Abigail elaborating a point.

4.6.3.3 Visual spatial intelligence

Abigail's preference for the use of visual representation in the three tasks was average. Abigail scored 2 points (which means that she used pictorial representation minimally), and she showed a minimal use of colour. She showed some use of artistic sense and colours in her writing of the headings that she used in tasks 1 and 2. Below is an example of the word art that Abigail used in task 2.

Figure 4.25: The use of Word art by Abigail in task 2.



When discussing about cholera as she presented slides relating to task, Abigail showed a picture of a pot with boiling water. Abigail then noted the importance of safe and clean water as one among many other measures to reduce the spread of cholera. "People have to be educated on how to have safe water. They need to boil their drinking water before they use is as drinking water."

Figure 4.26: Boiling water to prevent cholera.

These findings are supported by the results of her school progress report in which Abigail attained an average grade of 59% (medium) in three subjects, and the score from her multiple intelligences survey questionnaire (she scored 5/10 for visual-spatial intelligence).

4.6.3.4 Logic mathematical

Abigail's performance in logical-mathematical ability is medium. Her school progress report showed that she had an average score of 55% (medium) in the three subjects that is physics, chemistry and mathematics. This means that her ability to perform calculations and use numbers is average. These results were supported by the multiple intelligences survey questionnaire in which Abigail scored 6/10 (medium). Abigail's overall performance in her open-ended digital learning tasks was also average. She did not, for example, use any number-related format in task 1 even though the learners were all required to mention the number of people who had been infected with and had died from cholera. The learners in this research were also required to mention the economic implications (in monetary terms) of the disease to the country. Abigail did not incorporate any of this numerical data into her answers. In task 2 (the assignment about the landfills and their effect on the environment) she was likewise expected to mention the amount of garbage produced every day in Dar es Salaam and she was also expected to say how the landfills can affect the health of people living near to them. This she did not do. In task three (the MV Bukoba tragedy), Abigail similarly did not offer any numerical information either in her task or in the presentation of her slides. Nowhere in Abigail's work were there any graphs or tables – either in her text or in her presentation documents.

But Abigail logically sequenced her text documents by using subtopic headings. A section of text from her task 2 document demonstrates this. It is shown below:

PROBLEMS.
Urban waste is a fast growing problem driven by rapid urban population growth, which is general at least twice the respective national population growth rates.

EVIDENCES.
Due to this problem there are evidences to prove for example:
-Increasing illegal dumpsites
-Irregular collection of garbage.
-Rising garbage piles and dumps in city alleys, streets and residential areas. Some of the waste overflows and makes rivulets in different direction, destroying the environment even beyond the area.

Figure 4.27: A section of the text as sequenced by Abigail.

4.6.4 Story 4: Strong in visual spatial intelligence

4.6.4.1 Visual spatial

This is the story about Kim who was 16 years and in form three. Although he exhibited competence in visual-spatial intelligence, his performance abilities were low in logical-mathematical, verbal-linguistic and interpersonal intelligences. In the following sections I will discuss how Kim performed in all the three open-ended digital learning tasks.

Visual-spatial intelligence is the capacity to imagine, construct, manipulate and make sense of images and pictures. Learners can exteriorize their visual imagination and concepts by using charts, diagrams and clip art pictures, and also by making use of colours. In this study, Kim showed a remarkable use of visual abilities in his tasks. He received a score of 9/10 from his multiple intelligences survey test instrument. He also self-reported that he could use images and pictures creatively and that he could recall things in mental (visual) images from charts and diagrams. His school progress report also indicated that Kim was high in visual-spatial ability because he scored an average of 75% in the three subjects that is biology, geography and computer studies.

Kim's performance abilities in all the three tasks were quite exceptional. He first made selective use of pictures and images throughout his task documents and presentation slides, and drew a poster on a manila sheet as part of his educational strategy.

For task 1 (Health and diseases), Kim selected typhoid fever as his topic. In his text document Kim included pictures of the microbes that cause typhoid fever. He used this picture to illustrate his speech when explaining the causes and means of transmission of typhoid fever. In order more clearly to explain how to prevent this disease, Kim used a picture of open hands to bring home to his audience just how important it is to wash our hands before we eat or handle any food at all.

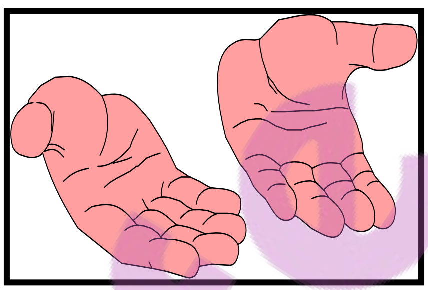


Figure 4.28: Hands that need to be washed (used by Kim to illustrate a point in task 1).

During his presentations, Kim used various pictures in his PowerPoint slides. One of these more remarkable pictures (Figure 4.29) depicted a cemetery. In his presentation session, Kim made the following remarks to accompany this picture.

It is surprising how more and more people are dying each year. The government has to help in educating people about the disease. We are going to use a TV broadcast as our strategy to educate our community.

Figure 4.29: Kim's picture showing a cemetery.

When Kim was asked why he had chosen this picture, he said: *People will be scared and maybe it might help them to act immediately. People do not want to die.*

Kim's use of visual images did not end there. He also warned the class during his presentation that the population group most affected by this disease in the community is the children. They also therefore need to be educated about typhoid fever and other water-borne diseases. They are the most vulnerable sector of the population because when some of them go out to play, they forget to take clean and safe water with them. And so they end up drinking dirty and contaminated water (as shown in Figure 4.30).

Figure 4.30: Kim's picture showing children drinking dirty and contaminated water

Kim chose Marine Pollution as his topic for task 2 (learners could choose between marine pollution and landfills and their effects on the environment for this task). Kim then proceeded to use Word document to summarize the information that he collected about marine pollution. Kim's work was especially interesting in the visual representation part of his assignment. He first used computer clip art and pictures to show the audience different marine organisms and the way in which they could cause pollution on beaches. He inserted all these pictures into his PowerPoint presentation slides.

Figure 31 - Endangered marine organisms.

Figure 32– Waste products that destroy the fragile marine ecosystem.

While making his PowerPoint presentation, Kim brought home to his audience the importance of conserving the marine environment and the fact that a failure to do this would result in the death or destruction of all the marine organisms that live in the ecosystem. During his presentation, Kim said:

> Marine organisms are being endangered because of human activities, like the use of dynamite, fishing and [the] throwing [away] of waste products. For example, the beach around Posta is destroyed. We need to educate people about this.

Kim's preference for using pictures and images was also confirmed to his PowerPoint presentation. He also demonstrated that he had a capacity to draw convincingly by using a manila sheet to complete this task. On the manila sheet, he drew a poster for a hypothetical school competition exhibition for which he had to produce a drawing. On this poster Kim drew images to represent some of the major problems that are caused by human activities. They included buildings, industries and bodies of water. He emphasised that some human activities can destroy bodies of bodies of water (such as lakes, rivers and steams) – and even the ocean itself. He demonstrated how effluents from industries and waste disposal all ultimately end up in the ocean because all rivers flow into the sea (see Figure 4.33).

A truck emptying waste into a body of water.

Effluents from industry being released into water.

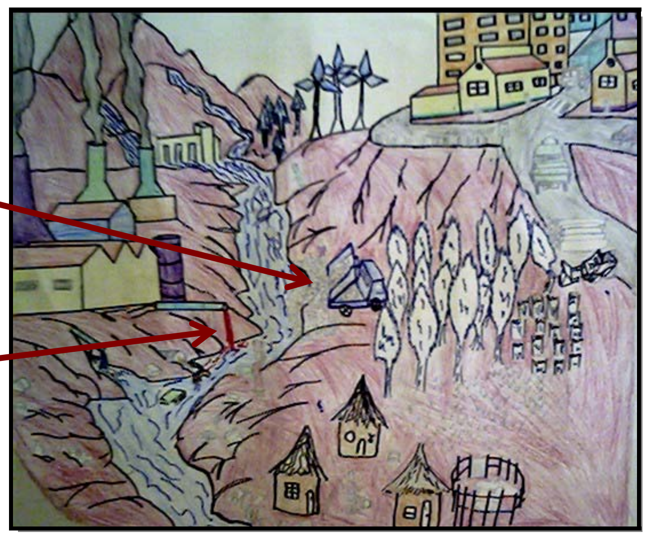
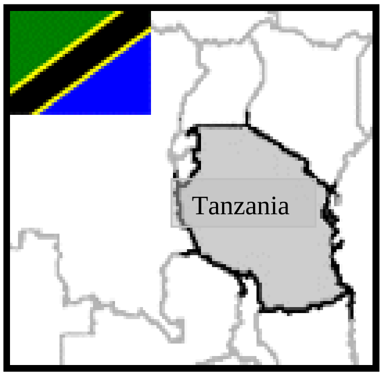


Figure 4.33: A poster drawn by Kim on a manila sheet.

In his drawing, Kim demonstrated an imaginative handling of colour. While, for example, he used blue for water, he used red for the effluent produced by industry, yellow and purple for the colour of the buildings, and brown for the soil. His use of red, yellow and purple was both bold and effective. He also spaced the items on the poster thoughtfully and effectively. Thus the buildings that he portrayed, as well as the river and the other items, were all proportionately distributed on the manila sheet.



In task 3 (the MV Bukoba tragedy), Kim did not use a picture or table in his MS word document. Instead he inserted pictures into his PowerPoint presentation of slides. One of these pictures showed a sinking ship (he took this from his reading resources). Another was of a man who was crying because he had lost his loved ones (these were the same pictures that Coleman had used). Another picture (Figure 4.34) contained a map of Tanzania along with the country's flag. Kim used this to express his love and concern for his country and its suffering people.

Figure 4.34: The map and flag that Kim used to express his love for his country and its suffering people.

4.6.4.2 Verbal linguistic

His school progress report showed that Kim attained an average score of 68% (medium) for the three subjects English, French and Kiswahili. He also scored 6/10 in the multiple intelligences survey questionnaire – an indication that he had a medium profile in verbal-linguistic intelligence. Kim's performance ability in task 1 was therefore medium; he scored 2 points. He managed to use sentences coherent enough to make a connected and logical text. He mentioned examples of countries that had already been affected with typhoid fever and how the disease had affected the lives of people worldwide. Kim organised his ideas well in his tasks. He mentioned how the disease was caused, its symptoms, methods of prevention, and its worldwide epidemiology. He also spoke about what advice he would give to people who were planning to travel to countries in which typhoid fever was prevalent. Here is an excerpt from Kim's Microsoft Word document in which he deals with some of these points (Figure 4.35).

Typhoid fever

As I mentioned in the first time, typhoid fever has killed many people. Now let us know how it has affected and killed people:

- -World wide and annually around 17,000,000 cases of typhoid fever have been reported with approximately 600,000 deaths.
- -Typhoid fever affects about 400 people in the United States each year and 70% of them get Salmonella typhi when travelling internationally.
- -In developing countries e.g. Asia, Africa and Latin America it is said that 12.5 millions people are affected by the disease each year.

Figure 4.35: An excerpt from Kim’s MS document dealing with typhoid fever

In task 2, Kim explained in his own words how the ocean can be economic important to people living near it. He noted that they could catch and trade in ocean products as a living. They can also gather and sell salt that can then be used in cooking. They could make and sell ornaments and jewellery from coral and also use the ocean as a means of transport. Kim continued to say that the ocean had been destroyed and that more and more marine organisms were being killed as the years passed as a result of human activities such as over-fishing, fishing by using dynamite, the emptying of industrial and sewage waste into inland water bodies of water that eventually all flowed into the sea (see Figure 4.32). Figure 4.36 shows an excerpt from Kim’s text in which he explains some of the impacts that human activities make on the ocean.

The Ocean Pollution

The ocean occupy about70% on the continent. There are several organisms that live in the ocean such as dolphins, sea cows, seals and so many others. But instead of preserving it human beings destroy the ocean through the following:

(1) OVER FISHING

The people fish out in large quantity and use dynamites to kill fish.

(2) ATMOSPHERIC DEPOSITION

Out of 57 major industries surveyed in the Dar-es- Salaam, 37% of them have been identified as source of air pollution. For example, Tanzania Portland Cement LTD at WAZO HILL account for most of the air pollution.

(3) INDUSTRIES

The waste products from industries are thrown into the ocean. Some of organisms will disappear soon if that problem will not be avoided. These organisms include sea cows, dugongs and so many others who are endangered. (Excerpt from text by Kim saved on 30 January 2004).

Figure 4.36: An excerpt from Kim's textual information about ocean pollution

When I examined the story that Kim wrote about MV Bukoba tragedy, I found that the text was (like the others that I have selected for discussion in this chapter) logically sequenced and coherent. It contained an introduction that described how, where and when the tragedy occurred. Kim also included information about how many people died, how many survived, and how many were rescued. He did not, however, give examples of other disasters that have occurred worldwide. During the presentation sessions, Kim presented his part but did not contribute much during the question and answer session. Because he was shy, he allowed his team mate to answer most of the questions that were directed to them. My assessment of his task documents supported these findings about Kim and he was given 2 points. That means that he could be regarded as an average performer so far as verbal-linguistic intelligence was concerned.

4.6.4.3 Logic mathematical

Kim's performance abilities in all open-ended digital learning tasks and presentations were 2 points. That means he was an average performer in logic mathematical intelligence. Again, in the presentation of the texts in tasks 1 and 2, one could say it was well sequenced. Kim did use number information to represent his information. In task 3-MV Bukoba tragedy, Kim summarized his story by mentioning when the tragedy occurred, where it occurred and how many people died. Kim also used numbers in the story, and this is as shown in Figure 4.37. However, in all the three tasks, Kim did not use tables or graphs to summarize number information. These findings are supported by the school progress report where Kim had an average score of 58% in physics, chemistry and mathematics. The multiple intelligences survey questionnaire indicated that his intelligence profile was medium with a score of 6/10.

A SAD DISASTER THAT OCCURRED IN TANZANIA

On May 21st 1996 'steamer' MV Bukoba sank on Lake Victoria, 30 kilometres from Mwanza. It had a capacity to carry 430 passengers, but as many as 1, 000 are feared to have died, because it was overloaded. 1st class and 2nd class compartments were said to have carried 443 passengers. The 3rd class was cheaper and therefore carried more people; the exact figure was not known. But more than 800 people died while others were rescued with injuries. The bodies that were recovered from the water were badly decomposed. Most of the decomposed bodies were buried in a mass grave (Text saved on January 22nd, 2004).

Figure 4.37: Use of number information by Kim.

4.6.4.4 Interpersonal intelligence

In general, Kim had low performance ability in interpersonal intelligence. He was shy and kept quiet most of the time, his teammate was the one who kept talking and negotiating activities to be done. However, he participated in the tasks by typing the text that was required, searching for pictures and drawings. During the presentations, Kim presented his part, but during the discussions his team mate answered all the questions that were asked. Kim's ability in interpersonal skills was low and was supported by the results of the multiple intelligence survey questionnaire, where Kim scored 4/10 (low) for interpersonal intelligence.

From these findings, it is evident that if Kim is given more opportunity to explore a variety of visual arts materials, he could do his best in this intelligence.

4.6.5 Conclusion

The theory of multiple intelligences by Howard Gardner (1983), have provided a theoretical foundation in recognizing the different performance abilities and talents of the learners. The theory acknowledges that learners do possess more than verbal or mathematical intelligence and may have potential abilities in spatial, music or interpersonal intelligences. The main question of this study is how do learners with different intelligences tackle open-ended digital learning tasks?

Alternative assessment or performance assessment was used as an alternative approach in assessing learners' performance abilities or intelligences, from the traditional paper and pencil tests. The aim of using alternative assessment approach was to identify learners' different performance abilities that they would use in solving open-ended digital learning tasks provided for them, and how they would manage to fashion out products that were valued in this study. It was apparent that a wider range of abilities were presented in the learners' task documents and presentations that provided important indicators of the learners' potentials in their strong and weak intelligences as indicated in the theory of multiple intelligences. In the following sections, the summary of the evaluation that was done on the four selected intelligences: verbal linguistic, logic mathematical, visual spatial and interpersonal intelligences and the different ways these learners solved the problems are presented. Included in the discussion is the intelligence profile of the learners.

The identification of performance abilities of the learners in all four intelligences implies that learners had to include the use of computer programmes (*Microsoft Excel* and *Word*) to draw graphs and tables in order to record and organize number information, use

Microsoft Word to arrange their text logically using subtitles and paragraphs. All the learners were taught the different computer application skills before they started working on the open-ended digital learning tasks. Then scoring rubrics were used to evaluate the performance abilities in computer application skills that were demonstrated by the learners in their open-ended digital learning task documents and presentations.

4.6.5.1 Logic mathematical intelligence

The overall intelligence profile of the learners in logic mathematical intelligence according to the results of the multiple intelligence survey questionnaire and school progress report was medium performance. The majority of the learners lie in the middle of the continuum, with 4 learners being high on one end of the continuum, 31 are medium and 5 are low on the extreme end of the continuum. The findings of the performance abilities of the learners in logic mathematical intelligence showed that 10 learners performed above average, 4 learners had medium performance and 26 learners performed below average. This means that there is a varied combination of mathematical abilities of the learners. The majority did not have preference in using graphs, or tables in their open-ended digital learning tasks. It could be possible that the use of charts and graphs is also associated with visual spatial intelligence, and that spatial relations in math are not stressed as highly as numerical calculations in schools. Hence, more learners do not have spatial abilities.

In a more refined process of identifying how the intelligence profiles of the learners affected the learners' performance in computer application skills, a contingency table was used. The contingency table had the intelligence profiles of all the learners in three intelligences (logic mathematical, visual spatial and verbal linguistic) that were assessed in the learners open-ended digital learning tasks products and presentations. Interpersonal intelligence was assessed differently using observations of learners over behavioural performances. The results from the contingency table indicated that 4 learners who had high intelligence profile also performed above average in the computer application skills in all the three tasks. Five (5) learners who had low intelligence profile also performed below average in the computer application skills in all the three tasks. Though all the learners were taught all the computer applications skills together in class before the start of the study, learners who were strong in logic mathematical skills choose graphs, and tables for their tasks, while those who were low in logic mathematical did not use tables and graphs in their tasks.

Learners' intelligence profiles and their preferences affected the way they performed in their tasks. The results of the narrative stories of the selected learners support this finding. Coleman, who was high in his logic mathematical intelligence profile, also performed above average in all the tasks, and showed more preference in computer application skills with regard to logic mathematical intelligence. Not only that, performance abilities in logic mathematical intelligence were high even in his school progress report, where Coleman scored an average of 72% in mathematics, physics, and chemistry subjects. This shows that he could work well with numbers and has ability to work logically in mathematics and science subjects too. However, Coleman was weak in his interpersonal intelligence profile and also performed below average in interpersonal intelligence.

These results indicate that there is a relationship between learners' intelligence profiles and their performance abilities. The intelligence profiles of the learners can be a motivating factor to the preferences the learners make when solving a problem.

4.6.5.2 Verbal linguistic intelligence

Learners' intelligence profile in verbal linguistic intelligence was high, where 16 learners showed to be high while the remaining 24 were medium. These are the results from the multiple intelligence survey questionnaire and school progress report. The results of the performance abilities in computer application skills indicated that 20 learners performed above average, 8 were average and 12 learners were below average. From these results, it shows that about half the number of the learners performed above average in verbal linguistic intelligence. This might mean that verbal linguistic intelligence is one of the intelligences that are traditionally valued and most of the learners work hard to perform better. These observations can be supported by the results from the assessment of the learners as they worked together in collaboration. Many learners assisted each other (peer support) in order to complete the tasks; they also participated in oral presentation of their tasks where all the learners participated in the presentations. Moreover, learners also participated in the discussions after each presentation. Though some of the learners showed to be more elaborative than others (these might be strong in verbal linguistic), the discussions provided a platform for exchange of ideas and support of the decisions that were made in the different strategies used in the tasks.

The results of the contingency table shows that 13 learners who had a high profile in verbal linguistic also scored above average in their performance ability in computer applications skills in all the three tasks. The learners were able to use Microsoft Word document to type their texts, which were narrated in small themes and these themes were coherent. Other learners, (that is, 6 of them), whose intelligence profile was medium, had average performance, and none of the learners performed below average. There was a positive relationship between the intelligence profile of the learners and their performance abilities according to the results of the contingency table.

4.6.5.3 Visual spatial intelligence

The intelligence profile of the learners in visual spatial intelligence showed that 4 learners were high, 35 were medium and 1 was low. The visual intelligence strength in the computer application skills was measured by assessing learners who have used different application skills in (*Microsoft Word* and *PowerPoint* presentation) programmes. For example, learners did use pictures from clip art, photographs, word art, colours, line animations and use of tables and graphs; 8 learners performed above average, 9 learners were average and 23 learners performed below average. It was found that there was no correlation when the learners' intelligence profiles, (medium and low profiles), were compared with their performances in visual computer application skills. Majority of the learners had a medium profile while they performed below average in their open-ended digital learning tasks.

The results of the contingency table indicated that from the 4 learners with high intelligence profile in visual spatial intelligence, 3 learners managed to perform above average in their computer application skills in the three tasks. These learners showed preference in the use of clip art, word art, and photographs from their reading resources. Nine learners performed at average level in their computer application skills and also had medium intelligence profile. On the other end of the continuum, one learner performed below average and also had low intelligence profile. This learner did not use any visual application in his tasks. The task documents consisted of texts only.

The ability to use different computer application skills from the visual intelligence indicates that every individual possesses a unique profile of intelligences and particular area of strengths, which have to be appreciated in the assessment of learners' tasks. For example, from the selected stories that were discussed, Kim performed above average in the visual spatial intelligence, where he was able to use several computer application skills for visualization and a diagram was drawn on a manila sheet. Moreover, in Kim's school progress report the results showed that Kim had an average score of 75% in three subjects - biology, geography and computer studies. His intelligence profile was high in visual spatial intelligence and also he had high scores in subjects that are related to visual spatial intelligence.

4.6.5.4 Interpersonal intelligence

The use of open-ended digital learning tasks allowed learners to use the computers in pairs, where comprehension and learning were facilitated and accelerated. Positive learning experiences resulted where learners shared their discoveries, supported each other in solving problems and worked collaboratively on the tasks. These skills are important in solving problems especially in real-life situations. The results of the study showed that 16 learners were high, 22 medium and 2 had low performance. Assessment of interpersonal intelligence was measured using scoring rubrics that were used during the observation process. Learners worked together to solve the problems, shared ideas, and peer coaching. During this process, most learners spent time in discussing and negotiating ideas that would be used in their tasks. Learners were able to make use of different computer application skills and even others who where strong in interpersonal intelligence took the initiative to teach others. Sharing and peer coaching as one of the benefits of collaborative learning.

The positive performance of the learners in interpersonal intelligence was well demonstrated by Abigail as was narrated in the selected stories. The strong ability in interpersonal intelligence is supported by the results of the observation checklist, in which Abigail scored 3 points (high profile) in interpersonal ability. Abigail cared for her friends and was ready to help; she also showed high performance in leading her team.

If open-ended digital learning tasks can be used effectively in a classroom situation, then learners can get access to use their knowledge, skills and contributions in a varied way using their different strengths and weaknesses in the different intelligences.

4.6.6 Synthesis

These open-ended digital learning tasks provided an insight into the learners' varied abilities to pursue logic mathematical, verbal linguistic, visual spatial and interpersonal intelligences. The learners worked through the tasks to reach beyond presenting a text, but used different ways of presenting their answers from texts, pictures, drawings, presentations, and discussions and also managed to work collaboratively in a team. By using non - scholastic intelligences as the main measure of performance, it offered learners different ways to learn and show what they know.

All the tasks and presentation documents that the learners produced, and were assessed revealed learners' combination of performance abilities. The unique performance abilities that were exhibited by the learners showed evidence of how each individual possesses strong and weak intelligence profile. For example, Coleman's strong performance abilities were across several intelligences (logic mathematical, visual spatial and verbal linguistic intelligences) in each task he did. Other learners however, had a single strong intelligence and were weak in the rest of the intelligences. For example, Abigail, was strong in interpersonal skills, Rachel in verbal linguistic skills and Kim in visual spatial skills. These stories provided the basic findings on how open-ended digital learning tasks encouraged them to have their own preference in completing their tasks. The stories did not only describe how the learners worked on their strong intelligences, but also included the use of other intelligences, which on the other hand learners showed to be less comfortable with. For example when the learners where required to write their text documents, all the learners had to summarize their texts, to be used during the presentation session. Each learner showed a unique profile of how each intelligence manifested in his or her tasks.

What was important in the findings is that learners managed to use different computer application skills according to their performance preferences which could not have been distinct in a normal classroom activity where learners are assessed using paper and pencil test. Then learners did what they did because they exhibited different intelligence profiles and they made their own preferences on how to complete the tasks they were given; they did not necessarily have to give the same design of answers. There was a general image of the varieties of human capacity.

Therefore, a computer is a useful tool in accommodating multiple intelligences in open-ended digital tasks.

✍ Chapter 5 – Discussion, Conclusion & Recommendations

In this study, open-ended digital learning tasks were designed and assessed, using the concepts from the theory of multiple intelligences. The aim was to investigate the interaction between multiple intelligences and performance of learners in open-ended digital learning tasks. In this chapter, findings of the study are discussed. A summary of the rationale of the study is described and this is then followed by a discussion of results of the study; highlighting how the findings have addressed the research question. The findings are then related to the body of literature and this involves the contribution of this study to existing body of knowledge in the field. Finally, the conclusions drawn from the findings of the study are presented along with the recommendations based on the findings of the investigation while suggestions are made for future research.

5.1 Summary of the study

5.1.1 Rationale

Schools in Tanzania have made remarkable progress in deploying Information Communication Technology (ICT) to address unmet demands and competition for the teaching and learning process in schools (National ICT Policy, 2003). While most government schools have currently made rooms available to act as computer laboratories, only a few schools have received the computer hardware that was promised by the government. Some schools have taken their own initiative and obtained computers as donations from various organisations while others have made arrangements to house privately owned computers in their computer laboratories. In most cases these computers are old models with no CD drives and a small memory capacity. They are also not connected to the Internet and are not fast enough to handle any current educational software (Kafanabo, 1999; Tilya, 2003).

The biggest challenge that is now facing many schools in Tanzania is how to integrate the use of these computers into the teaching and learning process in normal classroom (learning) situations given the current state of the infrastructure. Current suggestions about viable instruction from the Computer Studies Syllabus of Tanzania (1996) suggest that effective use can be made of computers by employing "activity teaching methods" and "problem solving approach" that will encourage learners to participate actively by engaging in relevant hands-on experiences. But for various reasons this is not what is currently happening in schools in Tanzania. Bednar, Cunningham, Duffy and Perry (1995) suggest that, under such circumstances, instructional strategies and tools for teaching and learning need to be based on an appropriate theory of learning and cognition.

In a similar vein, McCombs and Stiller (1995) points out that current innovation in the use of computers should encourage schools to offer teaching instruction that is learner-centred. In learner-centred instruction, teachers regard each learner as unique and capable of learning (McCombs & Stiller, 1995). Once this is established, teachers can take advantage of each learner's rich diversity of individual differences and talents – all of which are important in solving complex real-world problems – to establish a creative learning milieu. Teachers therefore have to encourage and appreciate the multiple talents and abilities that learners possess before they can take the lead in establishing just such a learning milieu (Gardner, 1983; 1995).

Currently, there is not a single government school in Tanzania that is seriously implementing the terms of the new computer syllabus of 1996, apart from making deals that enable the computer laboratory to be used and paying lip service to the introduction of computer literacy and computer science to the secondary school program (Tilya, 2003). Given the state of the hardware, this is hardly surprising. Teachers have also not been trained or encouraged to take initiatives to help learners to use the computers for doing projects or other authentic tasks. There are a very small number of teachers who use these computers to teach very basic computer application skills such as turning monitors and the central processing units on and off, loading simple software, and controlling input with a mouse and the use of the keyboard. Some staff simply uses the word processing programs to process their examination data. This is hardly what the department envisaged (Tilya, 2003).

Moreover, the current examination and assessment methods in Tanzania consist of tests and examinations that are prepared by the teachers themselves or by the National Examination Council of Tanzania and that are weighted in favour of learners who are skilled in verbal-linguistic and logical-mathematical intelligences. Such tests and examination questions consist mostly of multiple-choice questions, matching items and short answer questions. Such formats may be popular because teachers have been trained in a didactic philosophy that emphasizes on teacher-centred mode of instruction (chalk and talk), or simply because standardized tests are much easier and less time-consuming to mark and grade. It follows therefore that learners who are weak in either of these intelligences are usually seriously disadvantaged in school.

Gardner's (1983) theory of multiple intelligences has implications that place it in stark contrast to the traditional authoritarian teacher-centred modes of instruction that favours verbal-linguistic and logical-mathematical intelligences and abilities. Gardner (1983; 1993) describes intelligence as *pluralistic*, and claims that human beings possess at least eight different intelligences that represent a variety of ways of learning and demonstrating understanding. If teachers therefore broaden their instructional and assessment repertoires by making themselves familiar with Gardner's theory and its didactic implications, they will be able to give their learners skills and opportunities to use their multiple abilities that will stand them in good stead in school and throughout their lives after school.

Gardner's premise that learner-centred instruction can be a powerful catalyst in the teaching and learning process because it encourages teachers to search for more authentic learner-centred approaches to instruction and to use alternative performance assessment. Where learners are given open-ended tasks, several answers may be considered to be correct. In fact the word *correct* in such circumstances is a sliding signifier whose meaning depends on the different performance abilities of learners and on teacher observation of their unique performance abilities and the circumstances in which they perform and work. From this perspective, the theory of multiple intelligences can be used to:

- Match teaching with the ways in which learners learn.
- Encourage learners to stretch their abilities out of their comfort zones and be able to develop all their intelligences as fully as possible.
- Honour and celebrate diversity among learners.

As computers are now continually being introduced in schools, the Tanzanian government also needs to consider what changes will become necessary in the modes of instruction. Current computer teaching in schools is inauthentic, and has no intrinsic meaning or value to learners beyond the achievement of success in school (which to learners is a simple means of getting good grades). The current challenge is how to use these computers in a more meaningful way. The teaching of science and computer studies can be carried out by maximizing the development of all the intelligences through the integration of learner-centred instruction, open-ended digital tasks, and by introducing performance assessment strategies into the curriculum to support learners' individual performance abilities.

This study has examined and analysed the interactions brought forward when learners with recognised multiple intelligences performed in accomplishing open-ended digital learning tasks. This research was predicated on the use of computers as a *tool* and the integration of an alternative teaching approach that allowed learners to use the computers to solve real-world (authentic) problems while concurrently learning different basic computer application skills and biology content knowledge. Learners' performance abilities were then assessed by a performance assessment process. In the final analysis, the study revealed that there are several interactive processes that made it possible for the learners to perform according to their intelligence profiles in all the three tasks. These processes include:

- **Intelligences** – intelligence profiles of the learners had a significant impact on how learners made their preferences on their varying performance abilities as they worked on the open-ended digital learning tasks. It also showed that each individual intelligence is independent of other intelligences. Intelligence profiles defined how each learner performed, and how it affected them across other intelligences.

- **Digital tasks** – learners were not only exposed to the use of computer skills only, they also practiced using these applications in the open-ended digital tasks (practical application) and created presentations with which they themselves used to present to their classroom peers. The practical application of computer application skills was successfully done according to their learning preferences.
- **Learner-centered instruction** – provided learners with opportunities to work on the open-ended tasks where learners where able to make their own decision and selection of what they want to do. There was considerable opportunity for learners to support each other and work together collaboratively.
- **Performance assessment** – evaluation of learners' activities and performance abilities was done using categorized methods that included presentations, discussions, cooperative learning, discovery, and problem solving.
- **Open-ended tasks** – varied authentic tasks that had meaningful, real life tasks enabled learners to demonstrate what they know and what they can do. Learners were able to simulate how people do in real working situations.
- **Teachers' performance** – the responsibility of the teacher was to make learners learning possible and that was by creating a learning environment that effectively and meaningfully supported learning. Teachers provided support and guide to the learning process.

5.1.2 Design of the study

The central question of the study required the understanding of how learners with multiple intelligences would perform in open-ended digital learning tasks. I prepared the open-ended digital learning tasks by selecting three authentic examples from the Biology Syllabus of Secondary Schools in Tanzania of 1996. I concurrently developed the scoring rubrics that we used to assess the learners' task documents and presentations. All the learners' task documents and presentations were scored by the researcher together with four teachers who participated in the observation process (i.e. one teacher from each school in the sample). The preparation of the open-ended digital learning tasks and scoring rubrics was not an easy task. Most research evidence that advocates open-ended digital learning tasks and ICT on the basis of multiple intelligences theory emanates from the developed world. Tanzanian contexts are vastly different from those of the First World and they require that First World research findings, models and scenarios be modified in various ways. Such modifications that where included in the study are

- focusing on the Biology Secondary School Syllabus that requires specified areas of concern to be taught in Tanzanian schools
- the use of serious real-world problems that existed in learners' locality (the examples that I chose were the two potentially fatal water-borne diseases, cholera and typhoid fever; environmental problems and conservation; landfills and their effects on communities; and the locally much-publicised MV Bukoba shipping tragedy)
- adapting computer facilities so that all tasks could be accomplished by learners who could only access and use the basic features of the standard Microsoft package, but who had no Internet connection and no CD drives. As I have already noted, most of the computers were very old and could not run any educational software program.

My purpose in this study was to design open-ended digital learning tasks that learners could complete by using only the limited current computer facilities and infrastructure that are currently available in Tanzanian schools. The tasks were structured in such a way that learners were able to make their own choices from the (limited) computer options available to them as they solved the authentic tasks. I utilised constructs of only *four* of Gardner's posited eight intelligences from his theory of multiple intelligences for the assessment purposes of learner performances and abilities. The four intelligences that I selected in the design were verbal-linguistic, logical-mathematical, visual-spatial and interpersonal intelligences. In the ensuing sections, I have reflected on the impact of the methodology used in the study, and provided answers to the research question with support from the findings of other studies.

5.1.3 Methodological reflections

The study was based on a qualitative research approach. I preferred this research approach because it allowed me (as the researcher) to spend time as a participant observer to assess learners' performances and abilities in classroom research settings while the learners themselves worked through the open-ended digital learning tasks. I thus observed the learners, conducted both formal and informal interviews with them, made field notes about their performances, and collected and saved all their task documents on floppy disks for analysis. All the data that I thus collected was first-hand information that accrued from co-observation of learner activities by the school teachers, from my personal engagement as a participant observer, from interactions between the researcher and the learners, and from interactions among the learners themselves (Denzin & Lincoln, 2000; Patton, 2002).

The qualitative approach also allowed me to make sense of the data by means of interpretive analysis, to interpret the performance abilities using constructs that were derived from the theory of multiple intelligences. Observation field notes, descriptions and explanations were used to give appropriate meaning to the inquiry part of the study (Tashakkori & Teddlie, 2003). This meaning arose out of an investigation into the interactions that occurred between multiple intelligences and learners performances in open-ended digital learning tasks.

I used the open-ended digital learning tasks that I had developed for this study to stimulate learners to demonstrate their various skills, abilities, and preferences in four intelligences (all of which are implied by the theory of multiple intelligences). The purpose of using three open-ended digital learning tasks was to find *patterns* of consistency in skills, performance abilities and preferences in the learners' task documents and presentations. The ability to identify related *patterns* of performance skills, abilities and preferences is a function of the *number* and quality of tasks that learners can undertake in a research study (Lane, Stone, Ankenmann, & Liu, 1992). It was therefore necessary in this study to offer learners more than one task to complete.

As the researcher, I played various roles throughout the whole study. Firstly, as the developer of open-ended digital learning tasks, I played the role of the designer and the facilitator of the tasks. Secondly, I was also a participant observer as well as being the researcher. Although it was personally rewarding for me to play these various roles, my involvement in this way could have caused problems because it might have affected the results and the way in which I interpreted the results. Since I was both a participant observer *and* the researcher, I could have influenced the support procedures that were being given to the learners as they worked on their computers and applications skills. My roles as both the designer and an evaluator of learners' open-ended digital learning tasks, documents and presentation documents, could have been the cause of research bias in the study. I therefore deliberately involved some of the school teachers in the observation and assessment of the learners' tasks documents and presentations so as to reduce the possibility of research bias to a minimum. The calculated inter-rater reliability coefficient of 0.78 meant that there was high agreement between the teachers and the researcher.

If I had been inaccurately optimistic about learners' reactions during observations, I might have accorded them in the interpretations of the data in classroom observation, presentations and interviews that were too positive and too subjective. I avoided this problem by having schoolteachers as co-observers and by holding, at the end of each observation process, reflection sessions to discuss with them the observed behaviours of the learners and their working relationships as a manifestation of their interpersonal intelligence.

The use of different data collection strategies in the study (questionnaires, interviews, observations and the completion of three open-ended digital learning tasks for each learner) also assisted me to strengthen the data that was collected. They also provided consistent information about the preferences and performance abilities of the learners, and about the interpersonal interactions that appeared as learners worked on the open-ended digital learning tasks.

The research methodology made it possible for me to implement the open-ended digital learning tasks that required learners to use their different performance abilities and skills. The open-ended digital learning tasks proved to be practical and partially effective in the local settings and with the current technology infrastructure in schools (they had old computers with small memory, no CD drives, and no Internet connection).

Nevertheless, the open-ended digital learning tasks could have been different if the research design had been slightly changed if the computer infrastructure was more advanced for example with internet connections and or with samples of educational software. There could have been an inclusion of real hands-on activities and the search for resources by the learners themselves through the World Wide Web could have been better. Learners might have conducted their own searches for supplementary reading materials outside of the school system for example try to get information from different experts in relation to what they are researching on. They might also have planned different activities for inclusion in their tasks, and they might have developed their own task documents and presentations on the basis of their own experiences. In this way, learners could have been more connected to real outside-world conditions and they might have made real contributions to ultra-school real-life situations. Real-life situations always encourage learners to use their preferred areas of strength and weaknesses in learning, and these preferences greatly influence how the learners learn (Gardner, 1983).

The presentations that were prepared by the learners made it possible for them to display their communication and negotiation skills. Learners selected their own educational strategies for presentation and they had to defend them during the presentation sessions. This worked well because many listening learners purposefully probed for more information and asked for clarification of the strategies that their colleagues proposed as their educational strategies. Optimal learning is not an individual process, and the presentations allowed learners to learn socially by communicating, sharing information and through dialogue.

The inclusion of the schoolteachers as co-observers in the study was important for them, because it allowed them to observe and appreciate what their learners could do if they were given open-ended digital learning tasks and if they were allowed to make their own presentations by selecting what they wanted to present. All the teachers who participated in the study thought this process needed more support for the learners, because the learners did not know what was expected of them as they prepared to work on their first task. This opportunity for teachers to participate as co-observers could well have improved the acceptability of open-ended digital learning tasks in the eyes of active and supporting teachers as a medium of instruction in future classroom implementations of learner-centred instruction.

Some problems that arose during the design, development and classroom implementation of the open-ended digital learning tasks are worth noting. Stringent measures to maintain the good quality control of open-ended digital learning tasks are especially necessary during the authentic topic selection and task development phases. These measures may help the researcher to obtain the kind of consistent results that are needed for this kind of study.

In view of the fact that the topics for the open-ended digital learning tasks were selected from the Biology Syllabus of Secondary Schools in Tanzania, all the learners who participated in the study might not have regarded them as “authentic” problems. This problem was identified as the greatest weakness of the tasks, especially for the learners in Iringa Region. It became clear that more care was needed in the selection of challenging and authentic tasks of real importance to the learners and their communities. Moreover, it was realised that the time allocated for completion of the tasks was too little. Not enough time was given to learners to search for the required information. If more time could have been allocated in the actual classroom situation for task completion, cognitive impact could also have been evaluated, and a much stronger case could have been made for the impact of learner-centred instruction, open-ended and authentic tasks, the use of computers (digital facilities), and performance assessment. The current implementation was, however, hampered by the lack of supportive technological infrastructure in the schools – outdated computers with no CD drives, no Internet connection, and far too few working computers for the number of learners involved.

5.2 Discussion of the results

In the previous chapters, I concentrated on providing answers to the research question of the study. The discussion in this section focuses on identifying how the findings have addressed the research question that motivated the study. I also relate below the findings to other researchers and literature, and finally reflect on interactions made prominent and visible by the use of open-ended digital learning tasks, learner-centred instruction and authentic tasks, performance assessment and teacher performance.

5.2.1 Multiple intelligences and the performance of the learners in open-ended digital learning tasks

The results from the open-ended digital learning task documents not only captured learners' intelligence profiles, but also highlighted differences in learners' performance skills. The differences in performance abilities were identified after I had marked all the task documents and presentations, and had scored them by using holistic scoring rubrics. It can be seen from the results that learners had different working preferences about how they would solve the different open-ended digital learning tasks and computer application skills that they used. Examples of this are mentioned below:

- Some learners presented their educational strategy by only using *texts* that they typed in Microsoft Word documents. These texts included all the information that they needed (this provided evidence of a strong verbal-linguistic intelligence).
- Some learners used texts. But they also included tables and graphs from Microsoft Word and Microsoft Excel in at least more than one task (this provided evidence of a strong logical-mathematical intelligence).
- Some learners used pictures and photographs from Microsoft Word Clip Art and from the lesson notes that were provided and they used these to show the visual

presentation of their ideas (this provided evidence of a strong visual-spatial intelligence).

Relatively independent intelligent abilities, skills and talents that were consistent in all three tasks were revealed by each learner as they worked through their open-ended digital learning tasks. For example, the learners who used texts, graphs and tables consistently used these features in their documents and even in their presentation slides when compared with learners who used texts only. These learners who used texts and graphs also managed to organize their text documents by using research notes, by summarising information into paragraphs and themes, and by giving several related examples in their task documents.

Other learners, who possessed high visual-spatial intelligences but who were low in other intelligences used different visual images, pictures and photographs to support their information. They also used manila sheets to draw diagrams for their presentations while others used neither the manila sheets nor images in their texts. One of the learners who rated highly in verbal-linguistic, logical-mathematical and visual-spatial intelligences but low in interpersonal intelligence, used tables and graphs to summarize number information for his text. Such were some of the different intelligence combinations that learners revealed. The different combinations of intelligences and performance abilities exhibited by the learners in the open-ended digital learning tasks are supported by Gardner's contention that there is persuasive evidence for the existence of several relatively autonomous human intellectual competencies (Gardner, 1983). When appropriate assessment instruments are used, the peculiar nature of each intelligence emerges clearly (Gardner, 1983). These results are in line with the findings of Kornhaber (1994) and Kornhaber and Krechevsky (1995), who also found that the use of open-ended tasks in schools can help learners to develop and learn better because such tasks allow them to use their whole range of intelligences rather than merely two intelligences commonly assessed in the traditional classrooms.

The interactive potential of the open-ended digital learning tasks in this study encouraged the learners to use a broad range of skills, strategies and methodologies to complete their tasks, and so provided them with quality learning experiences. Learners made their own preferences about what they would like to add to their task documents, presentations and discussions. During the presentation and discussion sessions, learners had the opportunity to debate and have discussions about what might be the best strategy to use and to supply supporting evidence for their choices.

5.2.2 Digital tasks and the performance of the learners in computer application skills

I summarised the results of the learners' task documents, presentations and intelligence profiles in a contingency table so that I could analyse the relationship between the learners' intelligence profiles and computer application skills in three different intelligences. The results of the contingency table showed that there was a correlation between the intelligence profiles of the learners and their performance abilities in computer application skills. Learners, for example, who were high in logical-mathematical intelligences, performed at an above average level in computer application skills, and learners who had a low intelligence profile in logical-mathematical intelligence, performed at a below average level in this skill. Gardner (1983) emphasised that since each learner possesses a unique combination of intellectual strengths and weaknesses, their particular intelligences profiles determine how easy (or difficult) it will be for learners to learn information when it is presented in a particular manner. If individual learners are encouraged to use their *preferred* intelligences in learning (e.g. with open-ended tasks), their intelligence profiles will greatly influence how the learners perform and learn (Gardner 1983, p. 390).

The various features of the basic Microsoft Word package, limited though they may be in First World terms, enabled me to design tasks that allowed learners to give expression to their intelligences by using the basic features of Microsoft Word. The digital tasks that the learners completed supported the expression of the different intelligences combinations that I was looking at in the learners in the sample. If learners are to be given opportunities to express all their intelligences, teachers need to provide learning environments in which learners can use their combinations of intelligences. If learners can give free expression to all their intelligences, they will be more successful in school because they will be able to express all their talents and abilities rather than just the conventional verbal-linguistic and logical-mathematical sides of their natures (Gardner, 1983; 1999; Checkley, 1997, p. 10).

My experiences with Abigail and Coleman (recounted in the previous narratives) confirmed that it is best to allow learners to execute the tasks by using their preferred intelligences. Coleman, for example, used more than one intelligence to complete his tasks. He explained his strategies well by using texts (a verbal-linguistic ability); he used graphs and tables from Microsoft Word and Excel (a logical-mathematical ability), and he used pictures from the clip art selection and a manila sheet for the visualization of information (a visual-spatial intelligence). In all these intelligences, he showed unusual aptitude. He also demonstrated these abilities in his PowerPoint presentation. It was only in interpersonal intelligence that he scored less than the high rating he scored in the other three intelligence areas. But Abigail, by contrast, although not exceptional in the three other intelligences in which Coleman so excelled, was found to be exceptionally strong in interpersonal intelligence. She was unusually open to helping and communicating with others, and she participated actively in discussions and presentations. Kallenbach (1999) noted that when learners focus on problem solving activities that draw on intelligences of their strength, they are encouraged to build on existing strengths and knowledge to learn new content and new computer application skills. This might also be extrapolated to mean that learners, who have little success in traditional classrooms where only linguistic and logical-mathematical skills are valued and encouraged, will be more successful when they are given opportunities to express all their eight intelligences in their work and performance.

The study done by Pelgrum and Plomp (1991) on computer studies applications demonstrated that information communication technology changes interactions within classroom by changing interactions between teachers and learners. Information communication technology allows learners more direct access to resources. Learners may thus search for text and other resources on computers by connecting to the Internet. The Internet also supports learning and increases the number of interactions between learners themselves through the medium of emails and chat boards. Computers also allow learners to work collaboratively, support each other in learning new computer application skills.

Hence, the digital learning tasks also compelled learners to engage in interactive learning through collaboration with one another. Learners were asked to work in pairs in the research setting because the schools in the sample did not have enough computers for each learner to be allocated to one computer. Observation showed how actively the learners worked together to prepare their task documents and summarize their reading notes by selecting whatever information they, as a team, judged to be suitable for their task documents and presentations. Thus the learners in the research setting all worked cooperatively in teams of two. The team format facilitated discussion and interaction, and most learners indicated that they had had an experience of *shared* learning because they had been able to discuss each decision and so take responsibility for their own learning. A study by Gokhale (1995) lends credence to the fact that collaborative learning fosters the development of discussion and negotiation skills, the clarification of ideas, and evaluation of the ideas and presentations of others. In the schools that participated in the study, teaching has always stressed on individual processes over social processes in learning. Therefore, teachers need to provide opportunities in which learners learn within cooperative groups while analyzing their own experiences as a guide to their learning.

As modern technology increases in sophistication and ubiquity, more and more changes in organizational infrastructure become evident. One such change is an increased emphasis on teamwork within the workforce. More and more, workers need to be able to think creatively, solve problems and make decisions *in a team*. The development and enhancement of interpersonal intelligence through collaborative learning in technological settings should therefore be one of the primary goals of contemporary education.

The design of this research compelled learners to talk to each other and negotiate all facets of their task accomplishment as they worked collaboratively on their computers. The experimental learning format gave learners the time and space they needed to discuss what they intended to do as they prepared their learning tasks, browsed through reading resources, compiled their presentations and pondered various problem solving strategies. The conditions under which they worked engendered a great deal of discussion among learners as they examined reading resources, thought about procedures, and applied themselves to what they had to accomplish. Digital tasks of the kind used in this research undoubtedly promoted interactions in classroom situations and the learning of new computer skills.

5.2.3 Leaner-centeredness and authentic tasks

The shifting of the instructional process from teacher-centeredness to learner-centeredness in this study was supported by use of authentic tasks. Authentic tasks brought out unexpected talents and abilities in learners. Most learners felt that the tasks they were required to complete were quite relevant to their own lives and to the lives of the people in their communities, because of the problems that were selected and used in their tasks. The tasks were authentic, and were anchored in the real life problems of the people in Dar es Salaam and other parts of Tanzania. The combination of technological and pedagogical advances used in the study gave learners an opportunity for information sharing, dialogue and collaboration among themselves, a prominence that they never had in conventional teaching.

It is by using authentic tasks (or real-world examples) that learning is related to the process of what learners will recognise as reality. Such tasks used in the research study for example, allowed learners to instil what they read, write and create with a significance that is personal to them (Paris, 1998). In this research, open-ended digital learning tasks were structured in such a way that they allowed learners to work on computers, to learn new computer skills apart from those they already knew, and to make extracts from the reading resources that had been saved for them on their computers. This process came at the right time to contribute to the move of integrating computer technology into the education system.

Authentic tasks appeal to the learners themselves rather than merely to teachers who focus narrowly on school syllabuses and who are trained to construct learning experiences in terms of logical-mathematical and verbal-linguistic intelligences. Spady (1994) opined that authentic tasks support learners as they engage in performances that reflect important understandings, interests and abilities. A study undertaken by Doppelt (2003, p. 258) found that a rich environment with authentic tasks provides a learning environment that engages the learner in activities that relate to the world outside school. By engaging in real-world tasks, learners exhibit more progress and achievement in one or more areas of specialization. Authentic tasks thus provide an observer with a complex and comprehensive view of learners' performances in context.

In learner-centred environments where authentic tasks are encouraged, interactions occur at various levels. In such environments learners are given opportunities to work on tasks on their own without teachers rules and directives about how to complete the tasks. In those circumstances, learners select computer programs according to their own preferences. Ideally learners can also download and use a variety of computer programs that they have not obtained from their peers or teachers. In this research, learners were taught how to use graphics and animations in PowerPoint and graphs and tables in Excel.

The learner-centred environment also encouraged learners to work collaboratively (Barak & Maymon, 1998; Denton, 1994). The design of this research required learners to combine 'hands on' activities with what Papert (1980) has termed 'hands in' activities as they produced their own documents (which they were asked finally to save onto floppy disks).

5.2.4 Performance assessment of open-ended digital learning tasks

Performance assessment process of the open-ended digital learning tasks in the study took a different route altogether. The assessment looked at how each learner was unique in his or her combination of abilities and talents. This kind of pedagogical action assessment could not be achieved with paper and pencil tests. It had to be developed from *live* observations of how learners coped with real world problems. Learners from these schools are currently assessed by multiple-choice question instruments, matching items tests, and other investigative tools that require short answers to questions. What such instruments assess inevitably focuses on verbal-linguistic and logical-mathematical intelligences alone (one can see examples of such tests among those that have been prepared by teachers and the National Examination Council of Tanzania on appendix 1.1 and 1.2).

By contrast, the results of the assessment process that I designed for this study showed that learners are quite capable – given the right conditions – of getting busy with the tasks in hand, immersing themselves in their work, and producing admirable products and presentations. In the process, they communicated well among themselves and generated their own unique responses to the problems with which they were faced.

The design of the research process in this study obliged learners to produce various kinds of performances as part of their learning process. It was these performances that both I and the co-participating observer teachers assessed by means of (among other tools) assessment protocols (scoring rubrics) that I had designed to suit the conditions of the research. The co-participating observer teachers and I assessed learners by using a combination of assessment instruments and products. These assessment instruments and products comprised learners' task documents and presentation slides (which we assessed by means of holistic scoring rubrics), discussions and dialogues (which we assessed by means of observation checklists, interviews and questionnaires). I then combined all the data that we obtained in this way with the hope of discerning identifiable patterns of performance abilities among the learners. The study did not present any achievement results because the study was conducted for only three weeks in each school. The result was that the programme had no related measure that I could use to evaluate the learner's achievement results.

5.2.5 Teachers' performances

When learner-centred instruction is used in didactic situations, the pedagogical role of the teacher is no longer that of sole provider of information about computer application skills to learners. When I taught the necessary computer skills to learners afresh in each sample school, the learners learned new computer-related skills. I taught each new group how to use Microsoft PowerPoint, Microsoft Excel and Microsoft Word and also how to manipulate and incorporate tables, Word clip art and Word art (should they so wish). This support from me as the researcher was essential because these learners were keen to carry out the tasks but lacked the requisite computer skills. Michaelson and Black (1994) suggest that if group members have the desire to participate but do not have the necessary skills or knowledge, they should be taught what they need to know before they begin to work on tasks.

During their team presentations, the learners discussed their educational strategies with their peers. They then gave their peers the opportunity to ask questions, to ask for more information and details, and to interrogate their strategies. The teacher and researcher also contributed in the discussions by asking questions that evoked in learners the need to think on a more advanced level about the real-world challenges and implications of what they were doing. Such questions helped learners to begin to think of problems outside of their "comfort zones" and to extend their criticism and appreciation of what their peers were trying to accomplish with rather limited resources.

The pedagogical role of the teachers (and the researcher herself) was transformed in these conditions as they provided essential support to guide learners through their tasks and conceptualisations, and as they pushed learners to explore new dimensions by means of problem solving, communication, collaborative skills and feedback. This all produced a 'rich' and layered instructional process that was fundamentally interactive in nature. The most obvious interactions that were seen were between

- the teachers and the learners as they gave one another support and guidance while working on the open-ended digital learning tasks
- learners working collaboratively on tasks
- learners presenting PowerPoint slides, discussions and dialogues and all others who were listening and participating.

These interactions engendered the unique range of experiences that learners enjoyed while they worked on their real-world problems. The ultimate goal of using technology in the learning process was achieved. Learners learned new skills and developed understandings of real world problems from the technology rich learning experience.

5.3 Scientific reflection

This section focuses on what this research has contributed to the scientific body of knowledge with respect to process and methodology.

5.3.1 Contributions of this study

The combination of all the processes used in the study – open-ended tasks, digital learning tasks, learner-centred instruction and performance assessment, is a contribution to research that focuses on what elements are necessary under certain conditions if learners are to be allowed to enjoy positive learning processes. The fact that these very elements are absent from traditional teaching and learning processes in Tanzania makes this study important in the teaching and learning of computer studies and computer-dependent learning formats in schools in Tanzania.

The open-ended digital learning tasks in the design of the study stimulated learners to use various skills interchangeably while they solved authentic tasks and learned new computer application skills. During the interviews, learners spoke of wanting to relate what they had learned in class to solve problems in other classes and also to teach others. These results show that one can get learners to work collaboratively and share their information with one another with a format that utilises relatively few technology-based tasks – provided that such tasks are also authentic and open-ended. This kind of format prepares learners to be good competitors in a work force because tasks of this kind extend learners latent and dormant human abilities and talents and because they affirm and give due weight by implication to the *social* basis of learning. This view of learning is currently highly regarded in progressive education systems worldwide because the realisation is very slowly dawning that well educated learners are those who are able to make contributions to the society in which they live by contributing to the common good and solving problems in their own backyard (so to speak) and in the wider human scheme of things.

One may venture to say, on the basis of this research, that open-ended digital learning tasks can be flexible and useful tools for learner-centred instruction. We can see from the results that the open-ended digital learning tasks used in the study provided learners with opportunities to work collaboratively while using more than the two conventionally considered intelligences. What is even more valuable for Tanzania and other developing countries is that it became evident that with relatively few basic computer skills and the available infrastructure and resources in the schools where computers have no Internet connection or CD drives, it is feasible to construct a pedagogy that utilises computer-based teaching and learning by using open-ended digital learning tasks that are tailor-made for the conditions in which the learning has to take place.

What was most exciting was to realise that with some imagination and innovative learner-centred teaching methods, learners in Tanzania can enjoy all the advantages of the learner-centred teaching methods that learners in many developed countries currently enjoy. The use of innovative teaching practices affects how learners understand the world in which they live and social relations within and beyond the school (Hinostroza, 2002). A study such as this helps us to understand that relatively simple technologies and basic computers can radically and beneficially change the goals of instruction so that they become focused on more than merely the perpetuation of traditional teaching and learning methods – whether in computer skills or elsewhere in the curriculum (Hawkins & Collins, 1992).

Learner-centred instruction functions best when it depends on authentic tasks and on team efforts among learners. In this study, various performance abilities could be encouraged because the performance assessment process was integrated. The use of open-ended digital learning tasks and the theory of multiple intelligences have shifted the emphasis from the teacher being the sole provider of information to a situation in which the teacher becomes a facilitator who supports and helps learners to explore things and achieve new levels of insight *by themselves* (Harris, 2002). When this happens, learners become more independent, they support one another, and they develop new communication, social and computer application skills.

Because I used Gardner's theory of multiple intelligences as the basic theoretical framework for this study, it was also especially useful for the interpretation of the findings of the study. My reflection on this study leads me to believe that its primary significance resides in its applicability to conditions in Tanzania and in other less developed countries where computer and other educational facilities are often rudimentary, defective or non-existent. This is the first study of this kind to be conducted in Tanzania. Its significance can best be understood if one reflects that most of the world's population resides in developing countries where learners and teachers alike are deprived of the facilities that those in developed countries take for granted.

A search of the literature and empirical studies turns up no evidence of studies about the theory of multiple intelligences and ICT that have been conducted either in Tanzania or in any other place in sub-Saharan Africa. But several studies have been conducted in **the United States** (Blythe & Gardner, 1990; Campbell, 1997; Armstrong, 1994; Kallenbach & Viens, 2004; Krechevsky, 1991; Meyer, 1997; Hoerr, 1994), **Australia** (O'Brien & Burnett, 2000; Vialle, 1997), **Canada** (Goodnough, 2003, 2001; Hill & Smith, 1998), and **Israel** (El-Hassan & Maluf, 1999). This study, which is a pioneer study in this field on the African Continent, therefore makes a contribution to the literature on the application of learner-centred instruction, the use of open-ended digital learning tasks, and performance assessment using the theory of multiple intelligences. These contributions could have a helpful bearing on applications of ICT to schools curricula in the instructional process. The contribution that this study makes is that it provides a model for revising the curriculum so that it encourages or even mandates (under certain circumstances) learner-centred learning.

The methodology that was employed in this study also constitutes a prototype that could be adopted or adapted by other researchers in Africa who intend to investigate the relevance of the theory of multiple intelligences within the context of a developing world environment. This study in particular provides guidelines for technology-driven curriculum development in Tanzania where available technology can (with proper planning, imagination, effort and foresight) be used to create special opportunities for implementing a learner-centred approach that takes the cognitive diversity of learners into account.

5.4 Conclusions of the study

The future uses of technology in schools in Tanzania can be made more purposeful and meaningful if teachers would begin now to change their instructional processes by adopting more learner-centred forms of instruction. Such changes would mean that teachers at least would have the appropriate mindset wherewith to implement learner-centred forms of instruction as more advanced and functional forms of technology continue to penetrate schools in Tanzania. A learner-centred educational environment would create a milieu in which both teachers and learners would be comfortable and familiar with new and better forms of teaching and learning (such as the open-ended digital learning tasks used in this study) in Tanzania.

The use of open-ended digital learning tasks provided opportunities for the learners involved in the study (1) to learn a useful new range of computer application skills and (2) to use some personal performance preferences and abilities that they had perhaps never used before with much benefit in the Tanzanian schooling system. The utility of this study centres on the need to demonstrate that a learner-centred instructional design based on basic computer resources and inadequate computer hardware can improve the learning experience of learners who need to be taught the science content of the Tanzanian biology syllabus (and, by extension, can be used to benefit learners in innumerable other developing world educational contexts where conditions are less evolved than conditions in highly developed countries).

Such a change in teaching and learning paradigms requires a radical change in the long-ingrained attitudes and expectations of teachers themselves and education policy makers at all levels. If such a change is to take place, teachers need to be encouraged and supported to accept different paradigms of teaching and learning. Introducing new paradigms will affect the way in which teachers plan, select, develop, introduce and support learning tasks so that learners become more self-starting, self-actualising, self-reliant and more community minded than they are allowed to be under the conventional authoritarian education system that no longer answers (if it ever did) to the needs of teachers, learners and the country as a whole.

5.4.1 Theory of multiple intelligences

I used Gardner’s theory of multiple intelligences as my justification for effecting radical changes to the existing methods of instruction in Tanzania. It was foundational to my research that I should use an alternative process of instruction in which open-ended digital learning tasks would be used to impart knowledge and competence in a pre-selected part of the Tanzanian biology syllabus. My preliminary research made it clear to me that only open-ended digital learning tasks (in this instance) could create a situation on which learners would be able to free range to those talents and abilities that remained unexploited in conventional classroom situations. I needed a format in which the learners in the research sample would be able to exercise all their eight intelligences without restraint or discouragement (although my research design only took account of four of the intelligences). From this initial design, a number of issues that constitute important conclusions for this study emerged.

The theory of multiple intelligences acknowledges that while all learners may not be verbally or mathematically gifted, they will undoubtedly be more capable – and perhaps even gifted – in other areas of intelligence such as visual-spatial or interpersonal intelligence. If learners are understood and assessed in terms of Gardner's eight rather than the conventional two intelligences, they will be have a much better chance of being regarded as capable and promising students – at least in matters supported by their unique combination of personal intelligences.

As it may be observed from the results, learner-centred instruction with open-ended digital learning tasks can be used effectively to identify and appreciate learners' unique and distinct patterns of performance abilities. Because all the intelligences are important for scholastic and life achievement, both strong and weak intelligences (which, as this study has shown, can be determined in learners) have to be optimally used in the learning process and in the production of learning products. All the intelligences have to be identified, described, encouraged and drawn out in a learner's life. These include musical, bodily-kinaesthetic, interpersonal, intrapersonal, visual-spatial, and moral intelligences. Logical-mathematical and verbal-linguistic intelligences are those intelligences that are emphasized to the exclusion of all the others in traditional education.

5.4.2 Open-ended authentic tasks

Although the learning outcomes were encouraging, it is not possible within the framework of this study to make certain judgements or definite statements about the impact of the open-ended digital learning tasks and learner-centred instruction on the learners cognitively. It was obvious however, that if learners are given open-ended digital learning tasks, and if they are assessed by performance assessment processes, they are able to perform better than they can do in conventional educational environments. But this is a commonly accepted datum about learner-centred instruction using concepts of the theory of multiple intelligences.

5.4.3 Varied performance profiles and preferences

My subsidiary purpose in using a learner-centred instructional process in this study was to demonstrate how learners can get increased value from learner-centred educational processes provided that they are given the right conditions (represented in this case by the open-ended digital learning tasks and the ambience of the research setting). The value of learner-centred instructional processes, which has been demonstrated many times in research and actual educational conditions, are that they enable learners to use many of those human qualities and talents that are normally stunted in the artificial circumstances of conventional education.

It was important for me to be able to show that a learner-centred instructional process could be effective even in a developing country like Tanzania with inadequate or less than optimal computer hardware and software. Since most of the world's learners have to acquire whatever education they can in inadequate or less than optimal educational conditions (if they access to any education at all), research that validates the feasibility of learner-centred instructional processes can act as an inspiration in a rapidly changing world where technology and computers are often provided but no rational policy has been devised to facilitate their use and implementation.

It was also important for me to show that the learners with whom I worked were able to engage in a journey of self-discovery (however brief) and to develop an intellectual curiosity so that they would be stimulated to find out and learn things for themselves. It may be seen from the examples of those learners that were presented in the different stories (in form of narratives) that these learners acted and accomplished their tasks according to their personal combination of (four of the) intelligences cited by Gardner (1983). There was a noticeable difference between the way in which learners performed in general and how the tasks impacted on the way in which learners performed. Learners were thus able to work collaboratively and make choices about their work and finally derive meaning from the interactions between their tasks and themselves. Hausfather (2001) affirms that meaning in the learning process is negotiated through interaction with others, where multiple perspectives on reality exist. This is best achieved when learners are given ill structured domains and are allowed to work collaboratively.

These are opportunities that are absent from conventional teaching methods in Tanzanian (or indeed any other) classrooms even though they have consistently been proved to elicit superior performances and results from learners. Conventional educational dogma states that computers are only for learning the most basic application skills and biology (like any other science subject) has to be mastered by memorizing a collage of often unrelated and often meaningless factoids that float in conceptual vacuity unrelated to any personal or community context.

Apart from its use to identify learners' intelligence profiles, the assessment process made it clear that the learners had extended their repertoire of basic computer application skills according to their different abilities. Learners were thus able to make intelligent use of the reading resources that I had saved onto their computer hard drives, and could summarize information required for their tasks by using Microsoft Word to type up their documents, to draw graphs and tables (indicating verbal-linguistic and logical-mathematical intelligence) and to copy and paste pictures and photographs from clip art and reading resources (indicating visual-spatial intelligence). All learners also managed to prepare PowerPoint presentations although none of them knew how to use PowerPoint when the research began. These learners prepared five to seven slides in the beginning and nine to twelve slides in the third presentation. This suggests that if more time had been available for learners, they could have learned how to use advanced computer applications. They also improved their ability to communicate as they presented and defended their task activities (indicating verbal-linguistic intelligence). They exhibited equally impressive improvements in their group work, in presentations and discussions, and in levels of self-confidence (indicating interpersonal intelligence).

5.5 Recommendations

Although much of the theory of multiple intelligences is not new, it is timely to indicate in another research study how it may be utilised to raise questions about the soundness of conventionally accepted didactic methods in Tanzania and indeed throughout the world where the prestige of the kind of conventional educational methods that take cognisance only of two forms of intelligence often seems unquestionable. In the modern world (perhaps stimulated by advances in technology and the paradigm of solitary learning implied by the personal computer) there is (outside of education colleges) a renewed interest in and emphasis on how learners learn best, and at least a theoretical interest in methods and techniques that accord the *learner* a greater dignity and capability than he or she is accorded by traditional methods of mass education. It is one of the most notable strengths of the theory of multiple intelligences that it implies a belief in the capabilities and capacities of *individuals* (Hopper & Hurry, 2000).

5.5.1 Recommendations for policy and practice

This section gives recommendations that may be used by researchers into effective instructional processes that enhance the teaching and learning of computer application skills while imparting content knowledge in the context of learning through open-ended digital learning tasks. The suggestions that I submit for improving future instructional designs are all focused on promoting the use of learner-centred activities and assessment by means of performance assessment in situations that encourage and appreciate learner diversity in performance abilities. One of the major current concerns of learners, parents and other member of the communities is to discern what learners may do once they have left school and how they may become valued contributors to society. I therefore recommend this type of instructional design to educators in Tanzania and the developing world to:

- Use teaching methods that take account of the variety of ways in which learners learn when they using all their intelligences and not just the conventionally regarded two; verbal linguistic and logic mathematical.

- Take into account the multiple intelligences of learners by using *authentic* tasks.
- Reward rather than punish individuality and initiative in learners and that they make this clear in their didactic methods (traditionally conformity and strive to obedience are rewarded and individuality and imagination are punished).
- Allow learners to demonstrate what they know and understand by means of personal and team demonstrations and presentations rather than by their ability to memorise facts without context.
- Measure learners' performance abilities by using authentic assessment procedures that identify consistent performances on the part of learners.
- Use methods that are open-ended and that therefore place the responsibility on learners to engage in all the steps of learning – just as they would do if they were working in the real world.
- Make use of whatever technological resources they have in the developing world (however inadequate they may currently be) to give their learners the best possible technological and computer education before they leave school.

All individuals who enter the workforce nowadays require technological competence. It is essential that learners become technologically literate by the time they leave school. They need to know how to use different programs and their applications. They also need to know how to search for information that is important for their work from different sources apart from the textbooks. Web-based information is nowadays regarded as indispensable in all serious educational endeavours. John Dewey (1902) wrote: "Education should not be looked upon as the mere acquisition of academic subject matter, but as part of life itself." Over a hundred years later, Dewey's insight exerts no effect on the (implicit) philosophy and practice of most educators.

5.5.2 Recommendations for examination and assessment institutions

As long as materials are taught and assessed in only one way, one has to accept that one may be only reaching certain kinds of learners. The most successful lessons in this research occurred when learners happily and eagerly accepted all the challenges presented by the tasks, i.e. when they made their own decisions, selected their own strategies, and creatively applied different computer application skills to their open-ended digital learning task documents. Learners thus became aware of the different ways in which they could learn best and of the constructive possibilities of becoming responsible for their own learning.

From the observations made in the study, I recommend that educators should consider adopting performance assessment processes to assess learners' performance abilities and competencies. It is important to include more than one assessment instrument because learners' intelligences or competencies can be identified by a suitable combination of close-ended and open-ended tasks.

For example, the traditional assessment tool that are currently being used in the schools that participated in the study, are often not helpful in assisting learners to improve, to comprehend and to integrate what they have learned. Because they comprise of multiple choices, true and false, fill in the blanks (as can be seen in appendix 1.1 and 1.2) which does not encourage learners to apply their higher order thinking skills. Mostly they are used to measure the recall skill in which learners often study and memorize the lessons in order to take the required test.

On the other hand, an alternative assessment or performance assessment method owns to elicit learners knowledge, abilities and skills in different ways that resemble real-world as closely as possible. It is an extended form of assessment that has aspects of performance based within it. Learners learn how to apply their knowledge and skills to real tasks and projects that they might be facing to in real-life. Authentic assessment also assesses higher order thinking skills. Alternative assessment enhances learners' analytical skills – creativity, ability to work collaboratively and integrate the lesson to written and oral expression skills. Also authentic assessment increases the chances that what they have learned will be useful to them beyond their current classroom (Mitchell, 1992; Krischner, 2001). It can be that the results obtained from such evaluations are much likely to reflect the intelligence profiles of learners.

5.5.3 Recommendations for future research

The development of the open-ended digital learning tasks in the study required learners to use selected reading resources on their computers and to complete the task documents in a classroom situation. This process did not give the learners an opportunity to conduct real hands-on processes of inquiry or to search for information for their tasks by themselves. Future research could be directed towards using hands-on activities that will allow learners to be engaged in real-life inquiry processes that will challenge the strong and weak intelligences of learners as they search for required information and use computers to complete their tasks. This will give learners opportunities to plan their own activities, to use different methods of data collection, to manage the data that they have collected, and to use different performance skills to complete their tasks. This process should also stimulate peer interaction and allow learners to exercise their weaker intelligences.

In the learner-centred classroom, the role of the teacher changes from that of sole provider of knowledge to that of coach, facilitator and guide in the teaching and learning process. Scaffolding and feedback processes are important in this kind of context.

5.6 Final conclusions

This research was designed to give learners an opportunity to participate in a learner-centred learning process that was facilitated by the use of computers and that would therefore stimulate the multiple intelligences of learners (as indicated in Gardner's theory of multiple intelligences). This study then investigated the interaction between four selected multiple intelligences and learners' performances in open-ended digital learning tasks that stimulated research into science content.

This learner-centred instruction provided a rich and layered learning environment that integrated technology into the teaching and learning processes in selected Tanzanian classrooms. Firstly, learners with diverse performance abilities were accommodated in the instructional process and multiple approaches by learners were encouraged. Secondly, the learner-centred instruction provided an opportunity for the researcher to use authentic learning tasks that were designed to facilitate, simulate and recreate real-life complexities from learners' own personal communities. In the process of exploring and solving the tasks, these learners also used their innate performance abilities, talents and performance preferences. These would never have been visible if the researcher had not used the learner-centred method that was at the heart of the research. Finally, the performance assessment methods that were used to evaluate the learners included observations, presentations, the use of different sources of information, and the collection of completed tasks from the learners so that the patterns of performance abilities exhibited by the learners could be collated and identified. Based upon the data, I believe that this type of instruction can reform the teaching and learning of computer skills in Tanzanian schools.

On the overall, this study has managed to provide evidence on the profiles of how learners' with particular strengths perform when having to perform open-ended digital tasks. It provided insight into the depth and quality of using Microsoft Word while executing these tasks. For example learners who had strong performance abilities in logic mathematical intelligence were evident in using spreadsheets to draw tables and graphs to summarize their number information; they also managed to use numbers in their texts. Moreover, learners' who had strengths in visual spatial intelligence used different computer resources to create visual experiences. These learners' who were strong in visual spatial intelligence for example, used photographs and pictures from clip art, word art, tables and graphs using features from Microsoft Word and Microsoft Excel respectively.

✍ References

Ackerman, P.L. (1987). Individual differences in skill learning: An integration of psychometric and information processing perspectives. *Psychology Bulletin, 102(1)*, 3-27.

Al-Bataineh, A., & Brooks, L. (2003). Challenges, Advantages, and Disadvantages of Instructional Technology in the Community College Classroom. *Community College Journal of Research and Practice, 27(6)*, 473-484.

Alessi, A.M. & Trollip, S.R. (2001). *Multimedia for Learning: Methods and development* (3rd ed.). Boston: Ally and Bacon.

Anderson, M. (1992). *Intelligence and development: A cognitive theory*. Oxford, England: Blackwell.

Anderson, R.S. (1998). Why talk about different ways to grade? The shift from traditional assessment to alternative assessment. *New Directions for Teaching and Learning, 74 (Summer)*, 5-16.

Armstrong, T. (1998). *Awakening genius in the classroom*. Alexandria, VA: Association for Supervision and Curriculum Development.

Armstrong, T. (1994). Multiple Intelligences: Seven ways to approach curriculum. *Educational Leadership*, *52(3)*, 27-30.

Baker, E. L. (1992). *The role of domain specifications in improving the technical quality of performance assessment* (Technical Report). Los Angeles: University of California, Center for Research on Evaluation, Standards and Student Testing.

Barak, M., & Maymon, T. (1998). Aspects of Teamwork Observed in a Technological Task in Junior High Schools. *Journal of Technology Education*, *9(2)*, 4-18.

Becker, H.J. (1998). Running to Catch a Moving Train: Schools and Information Technologies. *Theory into Practice, 37(1)*, 20-30.

Bednar, A., Cunningham, D.J., Duffy, T., & Perry, D. (1995). Theory in practice: How do we link? In G. Anglin (Ed.), *Instructional technology: Past, present and future* (2nd ed., pp.100-112). Englewood, CO: Libraries Unlimited.

Bergen, D. (1993). Authentic Performance Assessments. *Childhood Education, 70(2)*, 99-101.

Binet, A. (1905). New methods for the diagnosis of the intellectual level of subnormal. *L'Annee Psychologique, 12*, 191-244.

Binet, A., & Simon, T. (1905). Application des methods nouvelles au diagnostic du niveau intellectual chez des enfants normaux et anormaux d'hospice et d'ecole primaire. *L'Annee Psychologique, 11,* 245-266.

Black, P., & William, D. (1998). Inside the black box: Raising standards through classroom assessment. *Phi Delta Kappan, 80(2),* 139-148.

Blank, R.K., Porter, A., & Smithson, J. (2001). *New Tools for Analyzing Teaching, Curriculum and Standards in Mathematics & Science: Results from the survey of enacted Curriculum Project.* Washington, DC: Council of Chief State School Officers.

Blom, J.J.C., & Smolenaars, H.J.M. (1992). Use of computers for educational purposes at the Wageningen Agricultural University. *Journal of Agricultural Education Extension*. Retrieved on 17th May 2004 at http://library.wur.nl/ejae/v1n1-4.html

Blythe, T., & Gardner, H. (1990). A school for all intelligences. *Educational Leadership, 47(7),* 33-37.

Boekaerts, M. (1993). 'Being concerned with well-being and with learning'. *Educational Psychologist, 28,* 377-404.

Borman, K.M., LeCompte, M.D., & Goetz, G.P. (1986). Ethnographic and qualitative research design and why it doesn't work. *American Behavioural Scientist, 30(1),* 42-57.

Bracewell, R., Breuleux, A., Laferriere, T., Benoit, J., & Abdous, M. (1998). *The Emerging Contribution of Online Resources and Tools to Classroom Learning and Teaching.* Retrieved on 12th February, 2004 at http://www.tact.fse.ulaval.ca/ang/html/rev98es/html

Bransford, J., Brown, A., & Cocking, R. (2000). *How People Learn: brain, mind, experience, and school.* Washington, DC: National Academic Press.

Brand, S.T., & Donato, J.M. (2001). *Story telling in emergent literacy, fostering Multiple intelligences.* Delmar: Thomson Learning, USA.

Brody, N. (1992). *Intelligence* (2nd ed.). San Diego, CA: Academic Press, Inc.

Brookhart, S. (1999). Response to Delanshere and Petrosky's "Assessment of Complex Performances: Limitations of Key Measurement Assumptions". *Educational Researcher, 28(3),* 25-28.

Brown, J.S., Collins, A., & Duguid, P. (1989). Situated Cognition and the culture of learning. *Educational Researcher, 18(1),* 32-42.

Brualdi, A.C. (1996). Multiple Intelligences: Gardner's Theory. ERIC Clearinghouse on Assessment and Evaluation. Washington, DC: *Eric Digest ED 410226*.

Bryce, J. (1997) Evaluative assessment to enhance student learning. *Australian Council for Educational Research. 25-31*.

Burns, T.C., & Ungerleider, C.S. (2002). Information and communication technologies in elementary and secondary education. *International Journal of Educational Policy, Research and Practice, 3(4)*, 27-54.

Campbell, B. (1991). Multiple Intelligences in the Classroom. *The Learning Revolution, 27, 2-13.*

Campbell, L. (1997). Variations on a theme – How teachers interpret multiple intelligences theory. *Educational Leadership, 55(1)*, 14-19.

Campbell, L., Campbell, B. (1999). *Multiple intelligences and students achievement: Success stories from six schools*. Alexandria, VA. Association for Supervision and Curriculum Development.

Campbell, L., Campbell, B., & Dickinson, D. (2004). *Teaching and learning through multiple intelligences.* Boston: Pearson.

Cannella, G.S. (2004). Multiple Intelligences in Early Childhood Education: A post Structural /Feminist Analysis. In J.L. Kincheloe (Ed.), M*ultiple intelligences reconsidered* (pp. 201-220). New York: Peter Lang Publishing.

Cantu, D. (1999). An Internet-based multiple intelligences model for teaching high school history. Retrieved on 14th June, 2005 at *www.mcel.pacifica.edu/jahc/jahc113/k12113.cantuindex.html*

Ceci, S. (1990). *On intelligence … more or less: A bio-ecological treatise*. Englewood Cliffs, NJ: Prentice-Hall.

Ceci, S. (1996). *On intelligence: A bio ecological treatise on intellectual development*. Harvard obscure at times, but a sophisticated critic of IQ.

Chapman, C. (1993). *If the Shoe Fits…How to Develop Multiple Intelligences in the Classroom.* Palatine, Illinois: IRI/Skylight Publishing, Inc.

Checkley, K. (1997). The first seven … and the eighth: A conversation with Howard Gardner. *Educational Leadership, 55(1)*, 8-13.

Chen, J. (2004). Theory of Multiple Intelligences: Is it a scientific theory? *Teachers College Record*, *106(1)*, 17-23.

Child, D. (1997). *Psychology and the Teacher*. London: Cassell.

Chiu, M.M. (2004). Adapting teacher interventions to student needs during cooperative learning: How to improve student problem solving and time on-task. *American Educational Research Journal, 41(2),* 365-399.

Chonjo, P.N., Osaki, K.M., Possi, M., & Mrutu, S. (1996). *Improving science education in secondary schools: A situational analysis selected government secondary schools in mainland Tanzania.* Dar es Salaam: Report of study sponsored by GTZ and MOEC.

Christison, M. A. (1999). Multiple Intelligences. *ESL magazine, 2(5),* 10-13.

Cohen, J. (1999). Social Emotional learning past and present: A psycho educational dialogue. In J. Cohen (Ed.), *Educating minds and hearts: Social emotional learning and the passage into adolescence* (pp. 3-23). New York: Teachers College Press.

Cohen, J. (2001). Social and Emotional Education: Core Concepts and Practices. In J. Cohen (Ed.), *Caring Classrooms/ Intelligent Schools: The Social Emotional Education of Young Children* (pp. 3-29). New York, NY: Teachers College Press.

Cohen, L., Manion, L. & Morrison, K. (2000). *Research Methods in Education* (5th ed.). New York: Routledge Falmer, Taylor and Francis Group.

Coley, R.J., Cradler, J., & Engle, P.K. (1999). *Computers and Classrooms: the status of technology in U.W Schools*. Princeton, NJ: Educational Testing Service, Policy Information Center. Retrieved on 7th April, 2003 at http://www.etc.org./research/pic/compclass.html

Cotton, J. (1995). *The Theory of Assessment: An Introduction*. London: Kogan Page Limited.

Crawford, V., & Toyama, Y. (2002). *Assessment of student technology proficiency and an analysis of the need for technology proficiency assessments: a review of state approaches.* Paper presented at the American Educational Research Association Annual Meeting, New Orleans.

Creswell, J.W. (1998). *Qualitative Inquiry and Research Designs: Choosing Among Five Traditions.* Thousand Oaks, London: Sage.

Creswell, J.W. (2003). Research *Design: Qualitative, Quantitative, and Mixed Approaches* (2nd ed). Thousand Oaks, London: Sage.

Cronin, J.F. (1993). Four Misconceptions about Authentic Learning. *Education Leadership, 50 (7),* 78-80.

Darling-Hammond, L., Ancess, J., & Falk, B. (2001). *Authentic Assessment in Action: Studies of Schools and Students at Work*. New York: Teachers College Press.

de Feiter, L., Vonk, H., & van der Akker, J. (1995). *Towards more effective science teacher development in Southern Africa.* Amsterdam: VU University Press.

de Lange, J. (1987). *Mathematics insight and meaning*. Utrecht, The Netherlands: OW & OC.

Delandshere, G., & Petrosky, A. R. (1998). Assessment of complex performances: Limitations of key measurement assumptions. *Educational Researcher, 27(2),* 14-24.

Denton, H. (1994). The Role of Group/Teamwork in Design and Technology: Some Possibilities and Problems. In F. Banks (Ed.), *Teaching Technology* (pp. 145-151). London: Routledge.

Denzin, N.K. (1988). *The research act.* New York: McGraw Hill.

Denzin, N.K., & Lincoln, Y.S. (2000). The Discipline and Practice of Qualitative Research. In N.K Denzin & Y.S. Lincoln (Eds.), *Handbook of Qualitative Research* (2nd ed) (pp. 1-28). Thousand Oaks, London: Sage.

Dewey, J. (1902). *The Child and the Curriculum*. Chicago: University of Chicago Press.

Diaz-Lefebvre, R. (2004). Multiple Intelligences, Learning for Understanding, and Creative Assessment: Some Pieces to the Puzzle of Learning. *Teachers college Record, 106(1),* 49-57.

Doolittle, P. (1994). Teacher portfolio assessment. *ERIC/AE Digest.* Eric Document Reproduction Service, No. ED385608.

Doppelt, Y. (2003). Implementation and Assessment of Project-Based Learning in a Flexible Environment. *International Journal of Technology and Design Education,* 13(3), 255-272

Driver, R., & Bell, B. (1986) Students thinking and learning of science: A constructivist view. *School Science Review, 67(240),* 443-455.

Dunbar, S.B., Koretz, D., & Hoover, H.D. (1991). Quality control in the development and use of performance assessments. *Applied Measurement in Education, 4,* 289-304.

Eisner, E.W. (1999). The uses and limits of performance assessment. *Phi Delta Kappan, 80(9),* 658-660.

Elbow, P. (1986). "Trying to teach while thinking about the end" and "evaluating students more accurately". In Elbow, P (Eds.), *Embracing contraries explorations in teaching and learning.* New York: Oxford Press.

El Hassan, K., & Maluf, G. (1999). An Application of Multiple Intelligences in a Lebanese Kindergarten. *Early childhood Education Journal, 27(1),* 13-20

Elias, M., Zins, J.E., Weissberg, R.P., Frey, K.S., Greenberg, M.T., Haynes, N.M., Kessler, R., Schwab-Stone, M.E., & Shriver, T.P. (1997). *Promoting social and emotional learning: Guidelines for educators.* Alexandria, VA: Association for Supervision and Curriculum Development.

Emmons, R.A. (2000). Is Spirituality an Intelligence? Motivation, Cognition and the Psychology of Ultimate Concern. *The International Journal for the Psychology of Religion, 10(1),* 3-26

Erlandson, D.A., Harris, E.L., Skipper, B.L., & Allen, S.D. (1993). *Doing Naturalistic Inquiry: A Guide to Methods*. Newbury Park, CA: Sage Publications.

Esselaar, P., Hesselmark, O., James, T., & Miller, J. (2001). *A country ICT survey for Tanzania. A research report,* Dar es Salaam, Tanzania, November 2001. Sponsored by SIDA.

Feldman, D.H. (1998). How Spectrum Began. In J. Chen, M. Krechevsky, J. Viens, & E. Isberg (Eds.), *Building on Children's Strengths: The Experience of Project Spectrum* (pp. 1-17). Columbia University, New York: Teachers College Press.

Flesch-Kincaid Grade Level Scores Program. Retrieved on 12th May 2004, from http://www.gopdg.com/plainlanguage/readability.html

Fredericksen, J.R., & Collins, A. (1989). A Systems Approach to Educational Testing: *Educational Researcher, 18(9),* 27-32.

Fuchs, I.S., Fuchs, D., Hamlett, C.L., & Karns, K. (1998). High achieving student's interactions and performance on complex mathematical tasks as a function of homogeneous and heterogeneous pairing. *American Educational Research Journal, 35* (2), 227- 267.

Gall, M.D.; Borg, W.R. & Gall, J.P. (1996). *Educational Research: An Introduction* (6th ed). New York: Longman.

Galton, F. (1892). *Hereditary genius: An inquiry into the laws and consequences* (2nd ed.). London: Watts and Co. (Original work published in 1869).

Gardner, H. (1983). *Frames of Mind: The theory of multiple intelligences: Tenth anniversary edition*. New York: Basic Books.

Gardner, H. (1987a). *An Individual-centered curriculum. In the schools we've got, the schools we need.* Washington, D.C.: Council of Chief State School officers and the American Association of Teacher Education.

Gardner, H. (1987b). Developing the Spectrum of human Intelligences. *Harvard Educational Review, 57*, 187-193.

Gardner, H. (1987c). Zero based arts education: An introduction to arts PROPEL studies in art education. *A Journal of Issues and Research, 30*, 71-83.

Gardner, H. (1991b). Assessment in context: The alternative to standardized testing. In B.R. Gifford & M.C. O'Connor (Eds.), *Changing assessments. Alternative views of aptitude, achievement and instruction.* Boston: Kluwer publishers.

Gardner, H. (1992). *The Unschooled Mind: How Children Think and How Schools Should Teach.* New York: Basic Books.

Gardner, H. (1993). "Choice Points" as Multiple Intelligences Enter the School. *Intelligence Connections.* Retrieved on 9th January, 2004 at http://www.multi-intell.com/articles/gardner2.htm

Gardner, H. (1993a). *Frames of Mind: The theory of multiple intelligences* (10th anniversary edition). New York: basic Books.

Gardner, H. (1993b). Educating for understanding. *American School Board Journal, 180*, 20-24.

Gardner, H. (1993c). *Multiple intelligences: The theory in practice*. New York: basic Books.

Gardner, H. (1995). Reflections on Multiple Intelligences: Myths and messages. *Phi Delta Kappan, 77(3)*, 200-209.

Gardner, H. (1996). *Intelligences: Multiple Perspectives*. Orlando, Harcourt Bruce College Publishers.

Gardner, H. (1996b). Probing more deeply into the theory of multiple intelligences. *NASSP Bulletin*, 1-7.

Gardner, H. (1997). Multiple Intelligences as partner in school improvement. *Educational Leadership, 55(1)*, 20-21.

Gardner, H. (1999). Are there additional intelligences: The case for naturalistic, spiritual, & existential intelligences. In J. Kane (Ed.), *Education, information and* *transformation: Essays on learning and thinking* (pp. 111-131). Upper Saddle River, NJ: Merrill.

Gardner, H. (1999b). *Intelligence Reframed: Multiple intelligences for the 21st century.* New York: Basic Books.

Gardner, H. (1999c). *The disciplined mind: Beyond facts and standardized tests, the K-12 education that every child deserves.* New York: Penguin.

Gardner, H. (2000). A Case against Spiritual Intelligence. *The International Journal for the Psychology of Religion, 10(1),* 27-34.

Gardner, H., & Hatch, T. (1989). Multiple intelligences go to school: Educational implications of the theory of multiple intelligences. *Educational Researcher, 18(8),* 4-10.

Gardner, H., Kornhaber, M.L., & Wake, W.K. (1996). *Intelligence: Multiple Perspectives.* Forth Worth: Harcourt Brace College Publishers.

Gardner, H., & Walters, J.M. (1985). *The Development and Education of Intelligences. Essays on the Intellect.* Alexandria, Virginia: Association for Supervision and Curriculum Development.

Gilman, L. (2001). The Theory of Multiple Intelligences. Retrieved on 31st March, 2004 at www.indiana.edu.innopac.up.ac.za:80/intell/mitheory.html

Gipps, C., & Stobart, G. (2003). Alternative Assessment. In T. Kellaghan & D.L. Stufflebeam, (Eds.), *International Handbook of Educational Evaluation,* (p. 549-575). Dordretcht: Kluwer Publishers.

Gokhale, A.A. (1995). Collaborative Learning Enhances Critical Thinking. *Journal of Technology Education, 7 (1), 22-30.*

Golman, D. (1995). *Emotional intelligence*. New York: Bantam Books.

Goodnough, K. (2003). Facilitating Action Research in the Context of Science Education: Reflection of a University Researcher. *Educational Action Research, 11(1),* 41-63.

Goodnough, K. (2001). Multiple Intelligences theory: A framework for personalizing science curricula. *School, Science and Mathematics, 101(4),* 180-193.

Goodrich, H. (1996/1997).Understanding Rubrics. *Educational Leadership*, 54(4), 14-17.

Granat, D. (1997). I am smart, you're smart. *Washingtonian, 32*, 60-63.

Green, J. (1995). *The Green Book*. Nashville, TN: Professional Desk References. Inc.

Greeno, J.G. (1989). A perspective on thinking. *American Psychologist, 44*, 134-141.

Haertel, E. (1999). Performance Assessment and Education Reform. *Phi Delta Kappan, 80(9),* 662-666.

Haertel, E. (1992). Performance measurement. In A. Alkin (Ed.), *Encyclopaedia of educational research* (6th ed) (pp. 984-989). London: Macmillan.

Hammersley, M. (1992). *What's Wrong with Ethnography: Methodological Explorations*. London: Routledge.

Hannafin, M., Land, S.M., & Oliver, K. (1999). Open learning environments: Foundations, methods and models. In C.M. Reigeluth (Ed.), *Instructional-Design Theories and Models* (Vol. II, pp. 115-140). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Harris, S. (2002). Innovative pedagogical practices using ICT in schools in England. *Journal of Computer Assisted Learning, 18*, 449-458.

Hart, D. (1994). *Authentic Assessment: A Handbook for Educators*. Menlo Park, California: Addison Wesley.

Hattie, J.A. (1992). *Self – Concept*. Hilldale, N.J: Erlbaum.

Hatch, T. (1993). From research to reform: Findings better ways to put theory into practice. *Educational Horizons, 71(4),* 197-202.

Hatch, T., & Gardner, H. (1986). From testing intelligence to assessing competencies: A pluralistic view if intellect. *The Roeper Review, 8,* 147-150.

Hatch, T., & Gardner, H. (1990). If Binet had looked beyond the classroom: The assessment of multiple intelligences. *International Journal of Educational Research*, 14(5), 415-429.

Hausefather, S. (2001). Where's the content? The role of content in constructivist teacher education. *Educational Horizons*, 15-19.

Hawkins, J., & Collins, A. (1992). Design-experiments for infusing technology into learning. *Educational Technology, 32(9),* 63-67.

Hawkridge, D. (1990). Computers in third world schools: the example of China. *British Journal of Educational Technology, 21*(1), 4 -20.

Herrington, J. & Oliver, R. (1999). Using situated learning and multimedia to investigate higher-order thinking. *Journal of Interactive Learning Research, 10(1),* 3-24.

Herrnstein, R.J., & Murray, C. (1994). *The bell curve: Intelligence and class structure in American life.* New York: Free Press.

Hill, J.R. & Hannafin, M.J. (2001). Teaching and Learning in Digital Environments: The Resurgence of Resource-Based Learning. *Educational Technology Research Development, 49(3),* 37-52.

Hill, A., & Smith, H.A. (1998). Practice meets theory in technology education: A case of authentic learning in the high school setting. *Journal of Technology Education, 9(2),* 29-45.

Hinostroza, J.E., Guzman, A., & Issacs, S. (2002). Innovative uses of ICT in Chilean Schools. *Journal of Computer Assisted Learning, 18(4),* 459-469.

Hodson, D. (1998). *Teaching and learning science: Towards a personalized approach. Buckingham: Open University Press.*

Hoerr, T.R. (2002). *Applying Multiple Intelligence in schools*. New Horizons for Learning.

Hoerr, T.R. (1992). How our school applied multiple intelligences theory. *Educational Leadership, 50(2),* 67-68.

Hoerr, T.R. (1994). How the New City School Applies the Multiple Intelligences. *Educational Leadership*, 52(3), 29-33.

Hopper, B., & Hurry, P. (2000). Learning Multiple Intelligences way: The Effects on Students Learning Using the Theory of Multiple Intelligences. *Pastoral Care, NAPCE* (26-32).

Huba, M.E., & Freed, J.E. (2000). *Learner-Centered Assessment on College Campuses: Shifting the Focus from Teaching to Learning*. Needham Heights, MA: Allyn & Bacon.

Johnsen, S. (1996). What are alternative assessments? *Gifted Child Today magazine, 19(4),* 12-14.

Johnson, R. (1976). The relationship between cooperation and inquiry in science classrooms. *Journal of Research in Science Teaching, 13,* 55-63.

Johnson, R. B., & Christensen, L. B. (2000). *Educational research: Qualitative and qualitative approaches.* Boston: Allyn & Bacon.

Johnson, D.W., & Johnson, R.T. (1989). *Cooperation and competition: Theory and research,* Edina, MN: Interaction Book Company.

Johnson, D., Johnson, R., & Holubec, E.J. (1993). *Circles of learning: Cooperation in the classroom.* Edina, MN: Interaction Book Company.

Johnson, B., & Turner, L.A. (2003). In Abbas Tashakkori and Charles Teddlie (Eds.), *Handbook of Mixed Methods in Social and Behavioural Research* (pp. *297-319).* Thousand Oaks: Sage.

Jonassen, D.J. (1995). Supporting Communities of Learners with Technology: A vision for Integrating Technology with Learning in Schools. *Educational Technology, 32* (4) 60-63.

Kafanabo, E.J. (1999). *Exploring the potentials of computer supported curriculum development in Tanzania.* Unpublished MSc. Thesis, Enschede: University of Twente.

Kallenbach, S. (1999). Emerging Themes in Adult Multiple Intelligences Research. *Focus on Basics, 3(A),* 16-20.

Kallenbach, S., & Viens, J. (2004). Open to interpretation: Multiple intelligences theory in adult literacy education. *Teachers College Record, 106(1),* 58-66.

Kane, M.T., Crooks, T.J., & Cohen, A.S. (1999). Validity measures of performance. *Educational Measurement: Issues and Practice, 18(2),* 5-17.

Kincheloe, J.L. (2004). Getting personal: Rethinking Gardner's personal intelligences. In J.L. Kincheloe (Ed.), *Multiple Intelligences Reconsidered* (pp. 132-158). New York: Peter Lang.

King, A. (1999). Discourse patterns for mediating peer learning. In A. M. O'Donnell & A. King (Eds.), *Cognitive perspectives on peer learning* (pp. 85-115). Mahwah, NJ: Erlbaum.

King, A. (1994). Guiding knowledge construction in the classroom: Effects of teaching children how to question and how to explain. *American Educational Research Journal, 31*(2), 338-368.

Kirk, J. & Miller, M. (1986). *Reliability and Validity in Qualitative Research.* London: Sage.

Kirschner, P.A. (2004). Design, Development, and Implementation of Electronic Learning Environments for Collaborative Learning. *Educational Technology Research & Development, 52(3),* 39-46.

Kirschner, P.A. (2001). Using integrated electronic environments for collaborative teaching/ learning. *Research Dialogue in Learning and Instruction, 2(1),* 1-10.

Klein, P.D. (1998). A response to Howard Gardner: Falsifiability, empirical evidence and pedagogical usefulness in educational psychologies. *Canadian Journal of Education, 23(1),* 103-112.

Klein, P.D. (1997). Multiplying the problems of intelligence by eight: a critique of Gardner's theory. *Canadian Journal of Education, 22*, 377-394

Knight, G.P., & Bohlmeyer, E.M. (1990). Cooperative learning and achievement: Methods for assessing causal mechanisms. In S. Sharan (Ed.), *Cooperative Learning-Theory and Research* (pp. 1-22). New York: Praeger.

Koretz, D., Klein, S., McCaffrey, D., & Stecher, D. (1994). *Can Portfolios Assess Student Performance and Influence Instruction?* Santa Monica, CA: RAND.

Kornhaber, M.L. (2004). Assessment, Standards, and Equity. In James A. Bank & Cherry A. McGee Banks (Eds.). *Handbook of Research on Multicultural Education* (2nd ed.)(pp. 91-10).. San Francisco, CA: Jossey-Bass.

Kornhaber, M. (1999). Multiple intelligences theory in practice. In J. Block, S.T. Everson, & T.R. Guskey (Eds.), *Comprehensive school reform: A program perspective* (pp. 179-191). Dubuque, IA: Kendall/Hunt Publishers.

Kornhaber, M. (1994). *The Theory of Multiple Intelligences: Why and How Schools Use It*. Cambridge, MA: Harvard Graduate School of Education.

Kornhaber, M., & Gardner, H. (1991). 'Critical thinking across multiple intelligences'. In S. Maclure & P. Davies (Eds.), *Learning to Think: Thinking to Learn (pp.147-170)*. Oxford, Pergamon.

Kornhaber, M., & Krechevsky, M. (1995). Expanding definitions of learning and teaches: Notes from the MI underground. In P. Cookson & B. Schneider (Eds.), *Transforming schools*. New York, Garland Press.

Kornhaber, M., Krechevsky, M., & Gardner, H. (1990). Engaging intelligences. *Educational Psychologist, 25(3/4),* 177-199.

Kornhaber, M.L., Veenema, S., & Fierros, E.G. (2003). *Multiple intelligences: Best ideas from research and practice*. Boston: Allyn and Bacon.

Kotovsky, K., Hayes, J.R., & Simon, H.A. (1984). Why are some problems hard? Evidence from Tower of Hanoi. *Cognitive Psychology, 17(2)*, 248-294.

Kovalchick, A., & Dawson, K. (2004). *Education and Technology An Encyclopedia*, Vol.2 (Eds.). Santa Barbara, California: ABC-Clio.

Kramarski, B., Mevarech, Z.R., & Arami, M. (2002). The effects of metacognitive instruction in solving mathematical authentic tasks. *Educational Studies in Mathematics*, *49(2)*, 225-250.

Krechevsky, M. (1991). Project Spectrum: An Innovative Assessment Alternative. *Educational Leadership*, 48(5), 43-48.

Krechevsky, M. (1998). *Project Spectrum: Preschool assessment handbook*. New York: Teachers College Press.

Krechevsky, M. & Gardner, H. (1990). Multiple chances, multiple intelligences. In D.E. Inbar (Ed.), *Second chance in education: An interdisplinary and international perspective*. London Falmer Press.

Krechevsky, M., & Seidel, S. (1998). Minds at Work: Applying Multiple Intelligences in the Classroom. In R.J. Sternberg & W. Williams (Eds.), *Intelligence, Instruction & Assessment: Theory into Practice* (pp. 17-42). Mahway, New Jersey: Lawrence Erlbaum Associates.

Landis, J.R., & Koch, G.G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, *33(1)*, 159- 174.

Lane, S., Stone, C.A., Ankenmann, R.D., & Liu, M. (1992). *Empirical evidence for the reliability and validity of performance assessments*. Paper Presented at the Annual Meeting of the American Educational Research Association, San Francisco.

Lane, S., & Glaser, R. (1996). Assessment in the service of learning. In E. De Corte & F. E. Weinert (Eds.), *International Encyclopaedia of Development and Instructional Psychology* (pp. 805-807). Tarrytown, NY: Elsevier Science Inc.

Law, N., & Plomp, T. (2003). Curriculum and Staff Development for ICT in Education. In T. Plomp, R.E Anderson, N. Law, & A. Quale (Eds.), *Cross-National Information and Communication Technology Policies and Practices in Education* (p. 15-30). Greenwich, Connecticut: Information Age Publishing.

Lazear, D.G. (1992). *Teaching for Multiple Intelligences*. Fastback 342 Bloomington, IN: Phi Delta Kappan Educational Foundation (ED 356227).

Lentz, F. E. (1988). Direct Observation and Measurement of Academic Skills: A Conceptual Review. In Edward S. Shapiro & Thomas R. Kratochwill (Eds.), *Behavioral Assessment in Schools. Conceptual Foundations and Practical Applications (p. 76-120)*. New York: The Guilford Press.

Leonard, D.C. (2002). *Learning Theories*. Westport, CT: Greenwood Publishing Group.

Lesgold, A.M. (1988). Problem solving. In R.J Sternberg & E.E Smith (Eds.), *The Psychology of Human Thoughts.* New York: Cambridge University Press.

Levin, H.M. (1994). Multiple Intelligence theory and everyday practices. *Teachers College Record, 95(4),* 571-575.

Linn, R. L. (1993). Educational Assessment: Expanded Expectations and Challenges. *Educational Evaluation and Policy Analysis, 15(1),* 1-16.

Linn, R. & Baker, E. (1996). Can Performance-Based Student Assessment be Psychometrically Sound? Performance Based Student Assessment: Challenges and Possibilities. In J. B. Banon and D. P. Wolf (Eds.), *95th Year Book of the National Society for the Study of Education (*pp. 52-83). Chicago: Chicago University Press.

Linn, R.L., Baker, E.L., & Dunbar, S.B. (1991). Complex Performance-Based Assessment: Expectations and Validation Criteria. *Educational Researcher, 20(8),* 15-21.

Littleton, K., & Hakkinen, P. (1999). Learning Together: Understanding the process of Computer-Based Collaborative Learning. In P. Dillenbourg (Ed.), *Collaborative Learning: Cognitive and Computational Approaches* (pp. 20-30). Killington, Oxford: Pergamon Elsevier Science Ltd.

Lohman, D.F. (1996). Intelligence, Learning and Instruction. In E. DeCorte & F.E. Weinert (Eds.), *International Encyclopedia of Developmental and Instructional Psychology* (pp. 660-665). Boulevard, Lansford Land: Pergamon Elservier Science.

Lopez, A. (2000). *Science Teaching's Quantum Leap.* UNESCO Courier. World of Learning. Online – retrieved on the 15th June 2004. http://www.unesco.org/courier/2000_05/uk/apprend.htm

Malkus, U., Feldman, D., & Gardner, H. (1988). Dimensions of mind of early childhood. In A.D. Pellegrini, (Ed). *The psychological bases of early education* (pp. 25-38). Chichester, London: John Wiley and Sons.

McCombs, B.L., & Stiller, J.R. (1995). *Development and validation of the learner-centered battery: Self-assessment tools for teachers and administrators*. Aurora, CO: Mid-Continent Regional Educational Laboratory.

McCombs, B.L., & Whisler, J.S. (1997). *The Learner-centered classroom and school: Strategies for increasing student motivation and achievement.* San Francisco, CA: Josey-Bass Publishers.

McEwen, B., & McEwen, T. (1996). Diversity in the Classroom. In H. Perreault (Ed.), *Classroom Strategies: The Methodology of Business Education. National Business*

Education Association Year book, Number 34, (pp. 74-86). Reston, VA: National Business Education Association Publishers.

McFarlane, A.E., Harrison, C., Somekh, B., Scrimshaw, P., & Harrison, A. (2000). *The Impact of ICT on Attainment. Preliminary Study 1 for the Impact 2 Project.* Electronically published report to UK Government: http://www.becta.org.uk/research

McKenzie, W. (1999). Surf Aquarium Consulting. Retrieved on 1st August, 2003. http://surfaquarium.com/MIinvent.htm.

McLaughlin, M., & Vogt, M. (1996). *Portfolios in Teacher Education*. Newark, Del: International Reading Association.

McMahon, S.D., Rose, D.S. & Parks, M. (2004). Multiple Intelligences and Reading Achievement: An Examination of the Teele Inventory of Multiple Intelligences. *The Journal of Experimental Education, 73(1),* 41-52.

McNabb, M.L. (2001). In search of appropriate usage guidelines. *Learning & Leading with Technology, 29(2),* 50-53.

Means, B. (1997). *Critical Issue: using technology to enhance engaged learning for at risk students.* Retrieved on 26th September, 2003 at www.ncrel.org/sdrs/areas/issues/students/atrisic/400 Retrieved on 12th April, 2004.

Means, B., & Olson, K. (1997). *Technology and education reform.* Washington, D.C.: U.S. Department of Education.

Means, B., & Oslon, K. (1995). *Technology's Role in Education Reform: Findings from a national study of innovating schools*. Washington, DC, US Department of Education. Office of Educational Research Improvement.

Means, B., Blando, J., Olson, K., Middleton, T., Morroco, C., Reinz, A., & Zorfasr, J. (1993). *Using technology to support education reform.* (Office of Educational Research and Improvement). Washington, DC: Department of Education (Retrieved on July, 2004) – Available on www.ed.gov/pubs/EdReformStudies/TechReforms/

Mehrens, W.A. (1992). Using Performance Assessment for Accountability Purposes. *Educational Measurement: Issues and Practice, 11(1),* 3-9, 20.

Meier, D. (2000). Educating a democracy. In J.Cohen & J.Rogers (Eds.), *Will standards save public education?* (pp. 3-31). Boston: Beacon Press.

Merriam, S.B. (2002). Introduction to Qualitative Research. In Sharan, B. Merriam and Associates (Eds.), *Qualitative Research in Practice: Examples for Discussion and Analysis,* (pp. 3-17). Josey-Bass: A Wiley Company.

Merriam, S.B. (1998). *Qualitative Research and Case Study Applications in Education. Revised and Expanded from Case Study Research in Education*. San Francisco: Jossey-Bass.

Merriam, S.B. (1988). *Case study research in education: a qualitative approach*. San Francisco: Josey-Bass.

Messick, S. (1994). The interplay of evidence and consequences in the validation of performance assessments. *Educational Researcher, 23(2*), 13-23.

Mettetal, G., Jordan, C., & Harper, S. (1997). Attitudes toward a multiple intelligences curriculum. *Journal of Educational Research, 91(2),* 115-122.

Meyer, M. (1997). The greening of learning: Using the Eighth Intelligence. *Educational Leadership, 55(1), 32-34.*

Michaelson, L.K., & Black, R.H. (1994). "Building Learning Teams: The Key to Harnessing the Power of Small Groups in Education." In S. Kadel and J.A. Keehner (Ed.s), *Collaborative Learning: A Source Book for Higher Education. Vol. 2*. State College: National Center on Postsecondary Teaching, Learning and Assessment, Pennsylvania State University.

Michelle, R. (1992). *Testing for Learning: How New Approaches to Evaluation can Improve American Schools*. New York: Free Press.

Miller-Jones, D. (1989). Culture and Testing. *American Psychologist, 44,* 360-366.

Moll, L. (1988). Some key issues in teaching Latino students. *Language Arts, 65(5),* 465-472.

Morgan, H. (1992). *An analysis of Gardner's theory of multiple intelligences*. Paper presented at the Annual Meeting of the Eastern Educational Research Association. (ERIC Document Reproduction Service No. ED 360088).

Morrison, G.R., Lowther, D.L., & DeMeulle, L. (1999). *Integrating Computer Technology into the Classroom.* Upper Saddle River, New Jersey: Prentice Hall, Inc.

Moskal, B.M. & Leydens, J.A. (2000). Scoring rubric development: validity and reliability. *Practical Assessment, Research & Evaluation, 7(10).* Retrieved on 10th March, 2005 at http://PAREonline.net/getvn.asp?v=7&n=10.

Moursund, D. (1999). *Project-based learning using information technology*. Eugene, OR: International Society for Technology in Education.

Muir, M. (1994) Putting computer projects at the heart of the curriculum. *Educational Leadership, 51(7),* 30-32.

Murphy, C., & Greenwood, L. (1998). Effective integration of Information and Communication Technology in Teacher Education. *Journal of Information Technology for Teacher Education, 7(3),* 413-429.

Muwanga-Zake, J.W.F. (2004). Is Science Education in a Crisis? Some of the problems in South Africa. *Science in Africa, Africa's First Online Science Magazine, Vol. 2.*

National Information Communication & Technologies (ICT) Policy (2003). *The United Republic of Tanzania: Ministry of Communications and Transport.*

Nelson, C.A., Post, J., & Bickel, W. (2003). Evaluating the Institutionalization of technology in Schools and Classrooms. In T. Kellaghan & D.L. Stufflebeam (Eds.), *International Handbook of Educational Evaluation* (pp. 843-870). Great Britain, Dordrecht: Kluwer Academic Publishers.

Newman, F.M., & Wahlage, G.G. (1993). Five Standards of Authentic Instruction. *Educational Leadership, 50(7),* 8-14.

Nicaise, M. (1997). Computer-Supported apprenticeships in math and science. *Journal of Computers in Mathematics and Science Teaching, 16(4),* 443-465.

Nitko, A.J. (2001). *Educational Assessments of Students (3rd Ed).* Upper Saddle River, NJ: Merrill.

Nystrand, M. (1986). *The Structure of Written Communication: Studies of Reciprocity Between Writers and Readers*. London: Academic Press.

O'Brien, P., & Burnett, P.C. (2000). Counselling children using Multiple Intelligences framework. *British Journal of Guidance and Counselling, 28(3),* 353-371.

Ogunniyi, M.B. (1996). Science, Technology and Mathematics: the problem of developing critical human capital in Africa. *International Journal of Science Education, Vol. 18 (3),* 267-284.

Olina, Z., & Sullivan, H.J. (2004). Student Self-Evaluation, Teacher Evaluation and Learner Performance. *Educational Technology Research and Development, 52(3),* 5-22.

Oliver, K. (2000). Computers as cognitive tools. In S.P. Lajoie & S.J. Derry (Eds.), *Patterns of hypermedia design* (pp 197-227). Mahwah, NJ: Lawrence Erlbaum.

Oliver, K. & Hannafin, M. (2001). Developing and Refining Mental Models in Open-ended Learning Environments: A Case Study. *Educational Technology Research and Development*, *49 (4)*, 5-32.

Ortiz, A., & Maldonado-Colon, E. (1986). Reducing inappropriate referrals of language minority students in special education. In A. Willing, & H. Greenberg, *Bilingualism and learning disabilities* (pp. 37-50). New York: American Library Publishing Company.

Papert, S. (1980). *Mind storms: children, computers and powerful ideas.* Brighton, Sussex: Harvester.

Paris, S.G. (1998). Why Learner-Centered Assessment is better Than High Stakes testing. In N.M. Lambert & B.L. McCombs (Eds.), *How Students Learn: Reforming Schools Through Learner-centered Education* (pp. 189-209). Washington, DC: American Psychological Association

Patton, M.Q. (1990). *Qualitative Evaluation and Research Methods* (2nd ed.). Newbury Park, CA: Sage.

Patton, M.Q. (2002). *Qualitative Research and Evaluation Methods* (3rd ed.). Thousand Oaks, London: Sage.

Pelgrum, W., & Anderson, R. (1999). *ICT and the Emerging Paradigm for Life Long Learning: A worldwide educational assessment infrastructure, goals, and practices* (Amsterdam, IEA).

Pelgrum, W.J., & Plomp, T.J. (1991). *The use of computers in education worldwide*. International Association for Educational Achievement, Oxford: Pergamon Press.

Pelgrum, W.J., & Plomp, T.J. (1993). *The IEA study of computers in education: Implementation of an innovation in 21 education systems*. Oxford: Pergamon Press.

Pellegrino, J.W., Baxter, G.P., & Glaser, R. (1999). Addressing the “two disciplines” problem: Linking theories of cognition and learning with assessment and instructional practice. In A Iran-Nejad & P.D. Pearson (Eds.), *Review of research in education*, Vol. 24 (pp. 307-353). Washington, DC: American Educational Research Association.

Pellegrino, J.W., Chudowsky, N., & Glaser, R. (Eds.). (2001). K*nowing that students know: The science and design of educational assessment.* Washington, DC: National Academic Press.

Perkins, D. N. (1992). *Smart schools.* New York: The Free Press.

Perrone, V. (1991). *Expanding Student Assessment.* Alexandria, VA: Association for Supervision and Curriculum Development.

Piaget, J. (1952). *The Origin of Intelligence in Children.* New York: International University.

Plucker, J., Callahan, C.M., & Tomchin, E.M. (1996). Wherefore art thou, multiple intelligences? Alternative assessments for identifying talent in ethnically diverse and economically disadvantaged students. *Gifted Child Quarterly, 40*, 81-92.

Popham, W.J. (2002). *Classroom Assessment: What teachers need to know*. Boston, MA: Allyn & Bacon.

Quellmalz, E.S., & Kozma, R. (2003). Designing Assessments of Learning with Technology. *Assessment in Education: In Principles, Policy and Practice, 10(3),* 389-407.

Random House Dictionary (1990). *Webster's Desk Dictionary of the English Language.* New York, Portland House: Distributed by Crown Publishers.

Reizen, S.A.; & Kaser, J.S. (1989). Assessing science learning in elementary school: why, what and how. *Phi Delta Kappan, 70(9),* 718-723.

Ryan, G.W. & Bernard, R.H. (2000). Data Management and Analysis Methods. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of Qualitative Research* (2^{nd} ed) (pp. 769-802). Thousand Oaks, London: Sage.

Ryser, G. (1994). Developing Reliable and Valid Authentic Assessment for the Classroom. *The Journal of Secondary Gifted Education, 6,* 62-66.

Sadler, D.R. (1998). Formative Assessment: Revisiting the Territory. *Assessment in Education: Principles, Policy & Practice, 5(1),* 77-84.

Scarr, S. (1985). An authors frame of mind: Review of Frames of Mind by Howard Gardner. *New Ideas in Psychology, 3(1),* 95-100.

Scarr, S. (1989). Protecting general intelligence: Construct and consequences for interventions. In R.L. Linn (Ed.), *Intelligence: Measurement, theory, and public policy.* Urbana and Chicago: University of Illinois Press.

Schack, G.D. (1993). Involving Students in Authentic Research. *Educational Leadership, 50(7), 29-31.*

Selinger, M. (2001). Setting authentic tasks using the internet in schools. In M. Leask (Ed.), *Issues in teaching using ICT* (p. 96-104). London: Routledge Falmer.

Sharan, S. (1984). Cooperative and Traditional Teaching: An Overview of Results. In S. Sharan, P. Kussell, R. Hertz-Lazarowitz, S. Raviv, & Y. Sharan (Eds.), *Cooperative Learning in the Classroom: Research in Desegregated Schools* (pp. 131-147). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Sharan, S., & Hertz-Lazarowitz, R. (1981). Classroom social climate, self-esteem and locus of control. In S. Sharan & R. Hertz-Lazarowitz (Eds.), Changing *schools: The small-group teaching project in Israel.* Tel-Aviv: Ramot, Tel-Aviv University.

Sharan, S., Hertz-Lazarowitz, R., & Kussell, P. (1984). Social Attitudes. In S. Sharan, P. Kussell, R. Hertz-Lazarowitz, S. Raviv, & Y. Sharan (Eds.), *Cooperative Learning in the Classroom: Research in Desegregated Schools* (pp. 107-130). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Shavelson, R. J., Baxter, G.P., & Pine, J. (1992). Performance Assessments: Political rhetoric and measurement reality. *Educational Researcher, 21(4),* 22-27.

Shavelson, R.J., Baxter, G.P., & Pine, J. (1990). *What alternative assessments look like in science.* Paper presented at Office of Educational Research and Improvement Conference, The Promise and Peril of Alternative Assessment, Washington, DC.

Shearer, B.C. (1991). “An investigation into the Validity, Reliability and Clinical Utility of the Hillside Assessment of Perceived Intelligences”. Doctoral Dissertation. The Union Institute, Cincinnati, Ohio. Dissertation Abstracts International, 52, 12.

Shearer, B.C. (1998a). *Teen-MIDAS.* Columbus, Ohio: Greydon Press.

Shearer, B.C. (1998b). *The MIDAS for Adults*. Columbus, Ohio: Greydon Press.

Shearer, B. C. (1997). *Development and Validation of a Multiple Intelligences Scale for Children*. Kent, OH: Multiple Intelligences Research and Consulting, Inc. (Eric Document Reproduction Service, No. ED415475).

Shearer, B.C. (1999). Assessing the Multiple Intelligences: What good can come of it? www.About_com http--www_angelfire_com-oh-themidas-article1.htm

Shearer, B.C, & Jones, J.C. (1994). *The validation of the Hillside Assessment of perceived intelligences (HAPI): A measure of Howard Gardner’s theory of multiple intelligences.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Shepard, L. (2000). The role of assessment in a learning culture. *Educational Researcher, 29 (7),* 4-14.

Shepard, L.A., & Bliem, C.L. (1995). Parents thinking about standardized tests and performance assessments. *Educational Researcher*, *24(8),* 25-32

Shepard, R., Fasko, D., & Osborne, F. (1999). Intrapersonal intelligence: Affective factors in thinking. *Education, 119(4),* 525-541.

Silver, H.F., Strong, R.W., & Perini, M.J. (2000). *So each may learn: Integrating learning styles and multiple intelligences.* Alexandria, VA: Association for Supervision and Curriculum Development.

Silverman, D. (2001). *Interpreting Qualitative Data: Methods for Analysing Talk, Text and Interviews.* Thousand Oaks: Sage.

Slavin, R.E. (1996). *Success for all*. Lisse: Swets & Zeitlinger.

Slavin, R.E. (1994). *Using Student Team Learning* (2nd ed). Baltimore, MD: John Hopkins University, Center for Social Organization of Schools.

Slavin, R.E. (1985). Cooperative learning: Applying contact theory in desegregated schools. *Journal of Social Issues, 41(3),* 45-62.

Snow, R.E. (1996). Individual Differences, Learning and Instruction. In E. DeCorte & F.E. Weinert (Eds.), *International Encyclopedia of Developmental and Instructional Psychology* (pp. 649-660). Boulevard, Lansford Land: Pergamon Elservier Science.

Snow, C.E., & Jones, J. (2001). Making a Silk Purse… *Education Week, 20(32),* 60.

Spady, W.G. (1994). Choosing outcomes of significance. *Educational Leadership, 51(6),* 18-22.

Spearman, C (1927). *The abilities of man.* New York: Macmillan.

Spradley, J.P. (1979). *The Ethnographic Interview.* New York: Holt, Rinehart & Winston.

Sternberg, R.J. (1998). Applying the triarchic theory of human intelligence in the classroom. In R.J. Sternberg & W.M. Williams (Eds.), *Intelligence, instruction and assessment* (pp. 167-181). Mahwah, N.J: Erlbaum.

Sternberg, R.J. (1994). Diversifying Instruction and Assessment. *The Educational Forum, 59(1),* 47-52.

Sternberg, R.J. (1985). *Beyond IQ: A triarchic theory of intelligence*. Cambridge: Cambridge University Press.

Stiggins, R., & Bridgeford, N. (1982). *Final research report of the national institute of education on the nature, role and quality of classroom performance assessment.* Portland, Oregon: Northwest Regional Educational Laboratory.

Swanson, D.B., Norman, G.R., & Linn, R.L. (1995). Performance-Based Assessment: Lessons from the Health Professions. *Educational Researcher*, *24(5),* 5-11, 35.

Synder, S. (1997). Developing Musical Intelligence: Why and How. *Early Childhood Education Journal*, *24(3),* 165-171.

Tashakkori, A., & Teddlie, C. (2003). The Past and Future of Mixed Methods Research from Data Triangulation to Mixed Model Designs. In A. Tashakkori and C. Teddlie (Eds.), *Handbook of Mixed Methods in Social and Behavioural Research* (pp. 671-701). Thousand Oaks: Sage.

Teasley, S., & Roschelle, J. (1993). Constructing a joint problem space: The computer as a tool for sharing knowledge. In S.P. Lajoie, & S.J. Derry (Eds.), *Computers as Cognitive Tools* (pp. 229-257). Hillsdale, NJ: Lawrence Erlbaum Associates.

Teele, S. (2000). *Rainbows of intelligence: Exploring how students learn*. Thousand Oaks, California: Corwin Press.

Teele, S. (1996). Redesigning the educational system to enable all students to succeed. *National Association of Secondary Principals, NSSP Bulletin*, *80,* 65-75.

Teele, S. (1995). *The multiple intelligences school: A place for all students to succeed*. Redland, CA: Citrograph.

Teele, S. (1992). *Teele inventory of multiple intelligences*. Redlands, CA: Sue Teele and Associates.

Terman, L.M. (1916). *The measurement of intelligence: An explanation of and a complete guide for the use of the Stanford revision and extension of the Binet-Simon intelligence scale.* Boston: Houghton Mifflin.

Tesch, R. (1990). *Qualitative research: Analysis types and software tools.* New York: Falmer.

The United Republic of Tanzania (1996). *Biology Syllabus for Secondary Schools: Form 1-4.* Ministry of Education and Culture, Dar es Salaam: Tanzania Institute of Education.

The United Republic of Tanzania (1996). *Computer Studies Syllabus for Secondary Schools: Form 1-6.* Ministry of Education and Culture, Dar es Salaam: Tanzania Institute of Education.

Thompson, S. (2001). The Authentic Standards Movement and its Evil Twin. *Phi Delta Kappan, 82(5),* 358-362.

Thurstone, L.L. (1938). *Primary mental abilities.* Chicago: University of Chicago Press.

Tilya, F.N (2003). *Teacher Support for the Use of MBL in Activity-Based Physics Teaching in Tanzania*. PhD Thesis, University of Twente, Enschede. Print Partners Ipskamp.

Tinsley, H.E.A., & Weiss, D.J. (2000). Interrater Reliability and Agreement. In Howard E.A. Tinsley, & Steven D. Brown (Eds.), *Handbook of Applied Multivariate Statistics and Mathematical Modelling* (pp. 95 – 124). San Diego, CA: Academic Press, A Harcourt Science and Technology Company.

Tunsall, P., & Gipps, C. (1996). Teacher Feedback to Young Children in Formative Assessment: A Typology. *British Educational Research Journal, 22(4)*, 389-404.

Uribe, D., Klein, J.D., & Sullivan, H. (2003). The Effect of Computer Mediated Collaborative Learning on Solving Ill-Defined Problems. *Educational Technology Research Development, 51(1), 5-19.*

Van der Zee, K., Thijs, M., & Schakel, L. (2002). The Relationship of Emotional Intelligence with Academic Intelligence and the Big Five. *European Journal of Personality, 16(2),* 103-125.

Vaughan, F. (2002). What is Spiritual Intelligence? *Journal of Humanistic Psychology, 42(2),* 16-33.

Verschaffel, L., Greer, B., & De Corte, E. (2000). *Making Sense of Word Problems*. Lisse: Swets and Zeitlinger.

Vialle, W. (1997). In Australia: Multiple Intelligences in multiple settings. Association for Supervision and Curriculum Development. *Educational Leadership*, 55(1), 65-69.

Visser, J. (1993). *Differentiation: Making it work: Ideas for staff development*. NASEN: Tamworth.

Von Glasersfeld, E. (1988). *Cognition, construction, of knowledge and teaching.* Eric Document Reproduction Service No. ED 294 754.

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

Walters, J., & Gardner, H. (1985). The Development and education of Intelligences. In F. Link (Ed.), *Essays of the intellect* (p. 1-21). Washington, DC: Curriculum development Associate/Association for Supervision and Curriculum Development.

Weare, K. (2004). *Developing the emotionally literate school.* London; Thousand Oaks, Calif.: Paul Chapman Publications.

Webb, N.M., & Farivar, S. (1994). Promoting helping behaviour in cooperative small groups in middle school mathematics. *American Educational Research Journal, 31(2),* 369-395.

Webb, N.M., & Farivar, S. (1999). Developing productive group interaction in middle school mathematics. In A.M. O'Donnell & A. King (Eds.), *Cognitive perspectives on peer learning* (pp. 117-149). Mahwah, NJ: Erlbaum.

Wechsler, D. (1939). *The Measurement of Adult Intelligence*. Baltimore: Williams and Wilkins.

Wechsler, D. (1949). *Wechsler Intelligence Scale for Children*. New York: Psychological Corporation.

Wexler-Sherman, C., Gardner, H., & Feldman, D. (1988). A pluralistic view of early assessment: The Project Spectrum approach. *Theory into Practice, 27(1),* 77-83.

White, R.T. (1988). *Learning Science.* Cambridge, Massachusetts: Basil Blackwell.

Wiggins, G. (1989). "Teaching to the (Authentic) Task". *Educational Leadership, 46(7),* 41-47.

Wiggins, G. (1991). "Standards, Not Standardization: Evoking Quality Student Work". *Educational Leadership, 48(5),* 18-25.

Wiggins, G. (1992). Creating tests worth taking. *Educational Leadership, 49(8),* 26-33.

Wiggins, G. (1993). *Assessing Student Performances.* San Francisco: Josey-Bass Publishers.

Wiggins, G. (1996/97). Practicing what we preach in designing authentic assessments. *Educational Leadership*, 54(4), 18-25.

Wiggins, G. (1997). Show what you know as you go. *Edutopia online*. The George Lucas Educational Foundation. Retrieved on 11th July, 2004 at http://glef.org/php/print.php?id=Art_291&template=printarticle.php

Wiggins, G. (1998). *Education Assessment Designing to Inform and Improve Student Performance.* San Francisco, CA: Josey-Bass Publishers.

Wilson, L.O. (1998, 2002). *What's the big attraction? Why teachers are drawn to using multiple intelligences theory in their classrooms.* New Horizons for Learning. Retrieved 10th of March 2005 at http://www.newhorizons.org/

Wilson, E.O. (1998). *Consilience: The unity of knowledge*. New York, NY: Knopf.

Worchel, S. (1979). Cooperation and the reduction of intergroup conflict: Some determining factors. In W. Austin & S. Worchel (Eds.), *The social psychology of intergroup relations (pp. 262- 273).* Monterey, Cliff: Brooks/Cole.

Worthen, B.R. (1993). Critical issues that will determine the future of alternative assessment. *Phi Delta Kappan, 74* (6), 444 -454.

Zeliff, N.D. (2000). Alternative Assessment. In Rucker J. & Schoenrock (Eds.), *Assessment in Business Education. National Business Education Association Year book*, Number 38, (pp. 91 – 102). Raston, VA: National Business Education Association publishers.

Zessoules, R., & Gardner, H. (1991). Authentic Assessment: Beyond the Buzzword and into the Classroom. In V. Perrone (Ed.), *Assessment in Schools* (pp. 47-71). Washington, DC: Association for Supervision and Curriculum Development.

Zessoules, R., & Wolf, D., & Gardner, H. (1988). A better balance: ARTS PROPEL as an alternative to discipline-based art education. In J. Burton, A. Lederman, & P. London (Eds.), *Beyond discipline-based art education*. North Dartmouth, MA: University Council on Art Education.

Zevenbergen, R., Sullivan, P., & Mousley, J. (2001). Open-ended tasks and barriers to learning: Teacher's perspectives. *APMC, 6(1),* 4 – 9.

✍ Appendices

Appendix 1.1: Computer studies Terminal Examination prepared by the school teacher

Terminal Examination [2003]

Form III

SECTION A
Answer all questions in this section, choose the most correct answer from the four alternatives given and write its corresponding letter in the box provided: 5-questions.

1. The binary code that is widely used with microcomputer is
   a) ASCII (b) EBCDIC (c) BCD (d) Unicode
2. Computer science emphases on
   a) Repairing Computers (b) Computer diagnosis (c) Designing and programming (d) Using applications
3. One Kilobyte is equivalent to
   (a) 1000 byte (b) 1024 bits (C) 1000bits (d) 1024 bytes

SECTION B
This section consists of Ten (10) questions: all questions carry equal marks, **attempt any five questions**

4. a) List down two disadvantages of machine language.
   b) Define the following terms
      i) Low level language
      ii) High level language

5. a) What are the advantages of high level languages.
   b) State five categories of use of the high level languages.

6. b) Give typical applications of the following languages.
   i) FORTRAN
   ii) BASIC
   iii) COBAL
   iv) PASCAL

Source: School Academic Office.

Appendix 1.2 Computer studies National Examination, prepared by the National Examination Council of Tanzania (NECTA)

THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL.
CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

036/1 **COMPUTER STUDIES 1**
(For school candidates only)

TIME: 3 Hours Tuesday November 18, 2003.

INSTRUCTIONS

1. This paper consists of sections A, B, C, and D.

2. Answer ALL questions in sections A, B, and C, and FOUR (4) questions from section D.

3. Show all the steps in your working, giving answers at each stage.

4. Electronic calculators are not allowed in the examination.

5. Cellular phones are not allowed in the examination room.

6. Write your Examination number on every page of your answer booklet(s)

This paper contains of 6 printed pages. Candidate No:…………………………………

SECTION A

1. For each of the items (i)-(x) choose the correct answer from among the given alternatives and write its letter beside the item number

(i) The device that can eliminate the manual step of keying in the data is called a
   A. key-to-disk machine
   B. optical scanner
   C. keypunch machines
   D. electronic register
   E. mouse

(ii) An impact printer gets its name by
- A. having the same print quality as an electric typewriter
- B. transferring a pattern of dots on paper
- C. transferring a whole or partial character by striking the ribbon
- D. using heat to transfer an image onto the paper
- E. creating continuous character images using light

(iii) The following is not the function of the control unit:
- A. To co-ordinate transfer of data to and from primary storage
- B. To change the sequence in which instructions are executed when directed to do so
- C. To recognise data and to execute instructions
- D. To perform arithmetic operations
- E. To direct and to control input and output devices.

(iv) An optical recogniser can read
- A. Magnetically encoded numbers
- B. Any combination of numbers and letters
- C. Barcodes in supermarkets
- D. Electronically encoded characters or patterns.

(v) The following is a direct access storage device:
- A. A tape
- B. A card
- C. A disk
- D. A printer
- E. A joystick.

(vi) A programming language that uses normal sentences in English is called a
- A. Machine language
- B. First generation language
- C. Procedure oriented language
- D. Natural language
- E. High level language.

(vii) Fundamental steps in developing computer programs and application software include all of the following except
- A. Maintenance
- B. Language selection
- C. Analysis and design
- D. Supervisor approval
- E. Implementation.

(viii) The REM statement is used to:
- A. Document a program
- B. Reserve room in computer's memory for subscripted variables
- C. Remember values that are assigned to LET statements
- D. Permit the use of matrix operations
- E. Skip one line before executing the next command.

(ix) When used in a PRINT statement, the colon (:) will
- A. cause an error message
- B. resulting in printing expressions, numbers and messages closer together

C. result in printing expressions, numbers, characters and messages in the next field
D. cause the computer to skip one line before printing
E. result in printing null characters on the screen.

(x) Data can be entered directly into the computer system from a terminal when using the
A. TERM statement
B. ENTER statement
C. READ statement
D. LET statement
E. INPUT statement.

SECTION B (10 marks)

2. Match the items in the list A with the responses in list B by writing the letter of the corresponding response beside the item number.

List A

(i) TAB
(ii) LET
(iii) Scripted variables
(iv) Modem
(v) Logical
(vi) Structured design
(vii) Problem definition
(viii) Coding
(ix) Coder
(x) Technical design

List B

A. Allow companies to electronically, store, rearrange and print key paragraphs
B. Examples of first generation computer
C. Possible carrier with computer manufacturer
D. The use of a device to encode and transform data into digital codes
E. Used in BASIC program to represent lists or table numbers
F. Another name for a computer programmer
G. An error that will not result in an error message
H. A type of number that is only evenly divisible by itself
I. A file organisation method that involves storing logical records in a given sequence, usually based on the key control field in the record
J. Will cause the values of the variable to be stored in computer memory
K. The activity of producing software in a formal project environment
L. A hardware device that is used in data communication

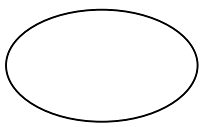
M. used to produce attractive output in a computer program
N. a program that combines separate modules into a one executable program
O. The overall purpose is to find the best possible way to develop software
P. Procedures and rules used to develop data communication software
Q. The step of application development where input requirements are determined
R. Rules that are used with a particular programming language
S. The process of writing the necessary instructions in a computer programming language
T. A type of implementation procedure

SECTION C (40 marks)

Answer **ALL** questions in this section.

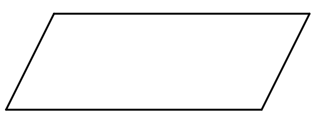
3. What does each of the following flowchart symbols represent?

(a)

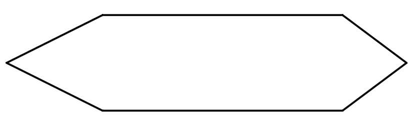


(b)

(c)



(d)



4. (a) What is the difference between an algorithm and a pseudo code?
   (b) When numbers are used in BASIC program, commas should not be included (e.g. 1000 should not be written as 1,000) Why?
5. (a) Distinguish between an assembler and an interpreter as used in programming languages.
   (b) Explain two circumstances under which you would format a floppy diskette.

6. (a) (i) What is a Binary Coded Decimal (BCD)?
(ii) Represent the decimal number 2003 as a BCD code.
(b) (i) What is a hexadecimal number system?
(ii) Convert the hexadecimal number EC to a decimal (base ten) number.
7. (a) Why can't we use zero (0) as a step value in the FOR and NEXT loops?
(b) Correct errors in the following nested FOR/NEXT loop:

```
FOR I = 1   TO   5

    FOR   J   =   Q TO R
   .
   .
   .
   .
   NEXT   I
 NEXT    J
```

(c) What rules should be remembered when using nested FOR/NEXT loops?
8. What are the qualities of a good algorithm?
9. (a) Write a BASIC statement that will join A$ and B$ and produce C$. If A$ = JOSEPH and B$=MILENZO what will C$ be equal to after this statement is executed?
(b) What is a general format of the LET statement? Give one example.
10. (a) List down three program structures
(b) What is data?
11. Write down the output of the following program

```
    COUNT = 0
  LIMIT = 3
 ANAMES = "ABDALLAH HAMIS"
 DO UNTILL COUNT = LIMIT

         COUNT = COUNT + 1
         PRINT ANAMES
         PRINT
         LOOP
         PRINT "THE END"
         END
```

12. (a) What are the functions of the main memory?
(b) Line numbers in a BASIC program serve two purposes. What are the operators at the same level operated?

SECTION D (40 Marks)

Answer FOUR (4) questions from this section.

13. (a) Write down the order in which arithmetic operators are evaluated. How are the operators at the same level operated?
    (b) Evaluate the expression {4*A/ (22/7)} ^1/2 where A=154.
    (c) List down the three types of information processing systems.
14. (a) Dry run the following nested FOR/NEXT loop and write down the output:

```
10   FOR   i  =  1  to  (3 * 4) STEP -4
20      FOR   j = 1 To 2  STEP  - 1
30            PRINT   i,  j
40        NEXT  j
50   NEXT  i
```

    (b) (i) What is a variable?
        (ii) Differentiate a numerical variable from a string variable.
15. (a) What steps are followed in setting up a counter for loop control?
    (b) What input statements are available in BASIC? Explain the use of each statement
    (c) What is the need of using RESTORE STATEMENT?
16. (a) What is the advantages of using arrays?

    (b) Write a BASIC program which prints the large number in an array of ten numbers.
17. (a) Development of a program can be broken down into six phases. State them.
    (b) Differentiate library functions from one user defined function
18. (a) Explain three types of errors which a programmer may encounter when preparing a BASIC program.
    (b) (i) What is an email?
        (ii) List two and two advantages and two disadvantages of the mail

THE END.

Source: The National Examination Council of Tanzania, From II Computer Studies Examinations – 2003.

Appendix 3.1: Multiple intelligence survey test questionnaire

University of Pretoria
Faculty of Education
Multiple Intelligence Survey

Part 1:

Complete each section by putting a tick (✓) next to each statement you feel accurately describes you. If you do not identify any statement, leave the space provided blank. Then total the column in each section.

Section 1:

________ I enjoy categorizing things by common features
________ Environmental issues are important to me
________ I like swimming and diving because they are enjoyable activities
________ I enjoy working on a garden
________ I believe preserving our National Parks is important
________ I like arranging things in categories as it makes sense to me
________ I like animals and they are important in my life e.g. a dog, cat.
________ In my home we sometimes reuse some of the items.
________ I enjoy studying biology - botany and or zoology
________ I spend a great deal of time outdoors looking at plants, insects, animals, and the landscape.

________ Total for section 1.

Section 2:

_______ I easily pick up on patterns, styles and order.
_______ I like to focus on specific noise and sounds
_______ moving to a beat and rhythm is easy for me
_______ I have always been interested in playing a musical instrument e.g. a guitar, drum, trumpet, key board or piano
_______ The writing of poems is my favourite
_______ I remember things by putting them in a particular writing style.
_______ I have little concentration while listening to a radio or television
_______ I enjoy many kinds of music
_______ Playing music is more interesting than drama plays
_______ Remembering song lyrics (words) is easy for me.

_______ Total for section 2.

Section 3:
_____ I keep my things in a neat and orderly fashion
_____ I like to do things in a step by step directions, it is always a big help for me.
_____ Solving problems comes easily to me – calculations, algebra, and measurements
_____ I get easily frustrated with disorganized people
_____ I can complete calculations quickly in my head
_____ Puzzles that are challenging are fun for me
_____ I can not begin an assignment until all my questions are answered
_____ A structure (drawing, diagram) helps me to be successful
_____ I find working on a computer spreadsheet or database rewarding
_____ Things have to make sense to me or I am not happy at all.

_____ Total for section 3.

Section 4:
_____ It is important to see my role in the "big picture" of things
_____ I enjoy discussing questions about life, why humans exist
_____ Religion is important to me
_____ I enjoy viewing art pictures and carvings.
_____ Relaxation and deep thinking exercises are important for me
_____ I like visiting exciting sites in nature, like waterfalls.
_____ I enjoy reading ancient and modern philosophers
_____ Learning new things is easier when I understand their value
_____ I wonder if there are other forms of intelligent life in the universe
_____ Studying history and ancient culture helps give me perspective.

_____ Total for section 4.

Section 5:
_____ I learn best while working with others and team work
_____ The more people are around the happier I become
_____ Study groups are very productive for me
_____ I have many friends
_____ Participating in debates is important to me
_____ I like television and radio talk shows
_____ I have an ability to organize, communicate and sometimes manipulate others
_____ I do not like working alone, I have a lot of feelings for others
_____ Clubs and after class activities for example games are fun to me
_____ I like to socialize a lot at school, work or home

_____ Total for section 5.

Section 6:
______ I learn best by moving around, touching things with my hands or acting things out
______ Sitting still for a long period is difficult for me
______ I enjoy outdoor games and sports
______ I value non-verbal communication such as sign language
______ skilled at handcrafts –woodwork, sewing, sculpture etc.
______ Arts and crafts are enjoyable pastimes
______ Expression through dance and touch is beautiful
______ I like working with tools for manipulation and other hands on learning
______ I live an active lifestyle
______ I learn by doing and perform fine and gross motor skills effectively

_____ Total for section 6

Section 7:
______ I enjoy reading all kinds of materials
______ Taking notes helps me remember and understand
______ I faithfully contact friends through letters and or emails
______ It is easy for me to explain my ideas to others
______ I spell words accurately and easily
______ Word puzzles like crosswords and jumbles are fun
______ I write for pleasure
______ I like to write, read and listen
______ I like to tell jokes and stories
______ I have a good memory for names, places, dates, jokes, and stories
______ Debates and public speaking are activities I like to participate in.

______ Total for section 7.

Section 8:
______ I am keenly aware of the moral beliefs
______ I learn best when I have an emotional attachment to the subject
______ Fairness is important to me
______ My attitude effects how I learn
______ Social justice issues concern me
______ Working alone can be just as productive as working in a group
______ I need to know why I should do something before I agree to do it
______ I like to be involved in causes that help others
______ When I believe in something I will give 100% effort in it
______ I am willing to protest or sign a petition to the right or wrong

______ Total for section 8.

Section 9:

______ I can think in images and pictures
______ Re-arranging a room is fun for me
______ I like to draw, paint, sculpt and participate in art activities
______ I remember well using graphic organizers
______ Performance art can be very rewarding for me
______ Spreadsheets are great for making charts, graphs and tables
______ Three-dimensional puzzles bring me much enjoyment
______ I like to see movies, video, slides, photos, paintings
______ I can recall things in mental pictures
______ I am good at reading maps, charts, and diagrams

______ Total for section 9.

Appendix 3.2: Open-ended digital learning tasks used in the study

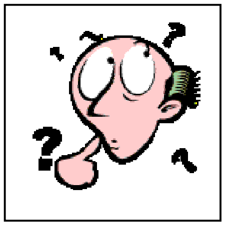
Open-ended Digital Task 1

Don't Drink The Water!!!

Is it Cholera or Typhoid fever?

Prepared by:
Ms. Eugenia Kafanabo
Year 2003.

Introduction:



A big problem; Don't Drink The Water!
But why? What should be done?

Hundreds of people in your community have already become ill and some of them have died from consuming microbe-infested water unknowingly. Now you are among those responsible for educating your community about the organisms and the disease they can cause, and how the sickness can be prevented from becoming an epidemic. **It is a big challenge to you!!** However, you have accepted the responsibility of educating the people in your community. Now all of them know you can make it, for the sake of the community's health and well-being.

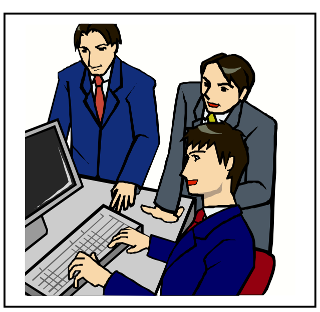
What is to be done?

As this is a big task, you will have to work with your friends as a team. You and your co-investigator have to decide who will do what, so that at the end of the day, you will have your task done.

Now, you and your co-investigator need to select one of the diseases to deal with that is either **Cholera or Typhoid Fever.** The microorganisms of these diseases have contaminated your community's drinking water supply. You will need to design a simple and efficient strategy to educate your community for this problematic situation. Your community anxiously awaits your successful solution!

Task:

Here you come, please save the day!! Work hard to get the required answers.



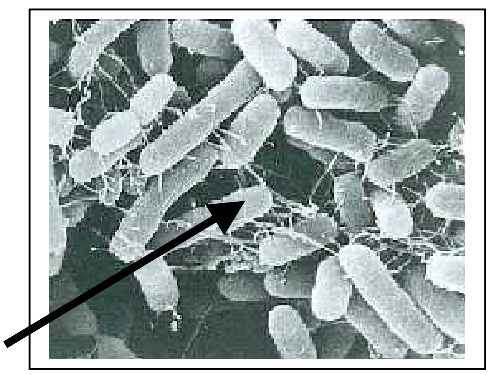
As a team, using computers, search for information that will help you solve the problem in your community. You are allowed to use other resources e.g. books, newspapers, and medical doctors. Make sure you get all the information needed e.g. what is the name of the microorganism that causes cholera or typhoid fever? How is the microorganism spread? What are the symptoms of the disease it causes? What is the cure? How can it be prevented?

When you all get the information needed, you have to come up with a simple and efficient strategy to educate your community. The design you suggest, must be supported by relevant data; for example, how many people have been infected so far, how many have died, what are the other economic problems that have been caused by the disease. If you do not have any supportive information, the local government will not accept your suggestion (in spite of the fact that their members are suffering from pain, and others are dying).

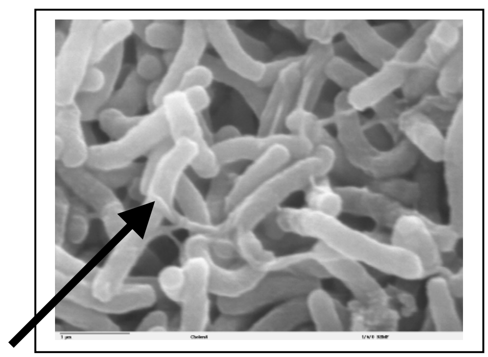
When all is done and your findings are accepted, your people in the community will be educated, and will not suffer anymore from the disease. Then you might have saved many lives and become hometown heroes, to be celebrated by your local television personalities. ☺

Process:

Step one:
The biggest problem of your community distress: is a cholera and typhoid fever disease.



Salmonella typhi causes Typhoid fever.



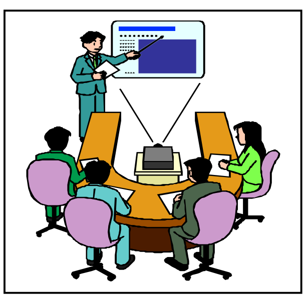
Vibrio cholerae causes cholera.

- Choose one case, either **Cholera or Typhoid fever**, read about it and then summarize the information about the microorganism that causes the disease, the name of the microorganisms, symptoms from which the victims are suffering (either cholera or typhoid fever), how the microorganism is spread, what can be the possible cure, how the disease can be prevented from spreading more and more. Then relate it to the problem in your community e.g. do you have good sanitation (toilets with water).
- To get the information you need, use computers and CD's provided, books, newspapers, or you're nearest medical doctor can explain clearly about the microorganism.

Step two:
Design your educational strategy:

- By using a flyer (vipeperushi), poem, radio/ or TV program propose a very simple and easy way on how to educate your people in your community on how they can eradicate the disease-causing microbe, (in order words prepare an educational program for your community). Use the information you have gathered from the resources in the computer, books or newspapers to design your educational strategy.
- In the flyer, poem, radio/ TV program, you should include the name of the microorganism, what are the causes of the microorganisms in the water, symptoms of the disease, how the disease is spread, and how it affects people's daily lives e.g. how many people have been infected to date, how many people have died from the disease. Moreover, include information of what has to be done to control and prevent the microorganism in future.

Step three:
You will have to present your strategy to your community and its leaders (that is oral presentation will be done to the researcher and your peers in class):



- Use a power point presentation program and include the reasons for selecting the desired disease, the strategy selected (flyer, radio/ TV program, and poem). Also, give your reasons why this strategy will be effective to the selected community.
- Recommend your plan of action.

Resources:
You can use any other resource you are comfortable with for your study, however, you are supposed to use the resources provided to you on a CD first. Importantly, the information provided on the CD is well selected for the best use of the study.

Evaluation:

The health of your friends and neighbours is not enough; the researcher will also grade you on the following criteria:

- Did you identify the correct disease and the type of microbe?
- Did you complete the design of the strategy selected as indicated in step two, and is complete for implementation?
- Did you make a reasonable case to convince your local lawmakers that your strategy is the best for your community?
- Did you write using Microsoft word about the selected disease, the identified microbe, transmission, symptoms, treatment, prevention and control of the disease? Mention the proposed strategy?
- Presentation is done on PowerPoint, well elaborated for other to understand?

All the best - ☺

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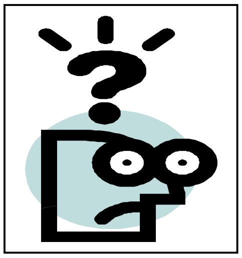
Open-ended Digital Task 2

Land fills problems!!!

Air Pollution and Health Hazards!

Prepared by:
Ms. Eugenia Kafanabo
Year 2003.

Introduction:



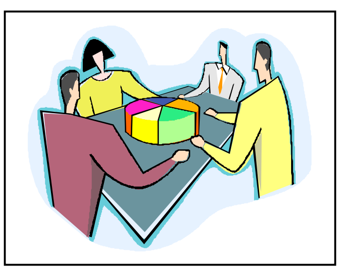
A big issue; Landfill problem! But why? Air and water are polluted, causing a lot of health hazards, what should be done?

The proper disposal of solid waste is a big concern in Dar es Salaam and Tanzania as a whole. Efforts have been made world wide to encourage everyone to reduce, reuse, recycle and rethink about the products they are consuming. In addition, every year the world celebrates Earth Day in recognition of these efforts.

In the city of Dar Es salaam alone, a lot of solid wastes are produced and the rates at which landfills are filling up are making disposing process a problem. Already the selection of new landfill sites has brought a lot of concern to the surrounding communities for example in Vingunguti area. You are now living within a community that has part of its area selected as a landfill for the disposal of the city's solid waste. Members of your community fear for their health. This landfill issue has divided your community and it is causing great stress among your community leaders.

As an educated person, you wish to help your community and your leaders about the landfill issue, its problems and effective ways of doing it. Your community is ready to hear what are your plans to save them from any health hazards that may result if the landfill will be established in your neighbourhood.

What is to be done?



As this task needs thinking and persuasion, you will have to work with your friend as a team. You and your co-investigator have to decide who will do what, so that at the end of the day, you will have your task done.

Now, you and your co-investigator need to identify what are the major problems when a landfill is established, what are the major health hazards caused by a landfill, what are the environmental problems of a landfill? You all need to come up with a good strategy about what should be done, as waste products continue to be produced and have to be disposed. Your community members and leaders are anxiously waiting for your successful solution!

Task:

Here you come to save the day!! Work hard to suggest for the best ways.

As a team, using computers and CD's provided, search for information that will help you identify the problem in your community. You are allowed to use any other resources e.g. books, newspapers, and medical doctors. Make sure you get all the information needed e.g. what are the possible diseases that can be caused by the presence of the landfill? What are the symptoms of the diseases? What will be the environmental problems? What is to be done?

When you all get the information needed, you have to come up with an efficient strategy to educate your community. As part of the campaign against the start of a new landfill in your community; what you have to design and suggest, must be supported by relevant data; for example how many people have already been affected with the same problem? How many have died, what is the other economical problem to be caused by the diseases? If you do not have any supportive information, your leaders in the local government, city council and representative from the health department will not accept your suggestions (in spite the fact that the consequences of the landfill near residential areas is known, and members in the community will suffer from pain, and maybe others will die).

Upon completion of your successful campaigns, and your findings are accepted, the people in the community will be educated, and maybe there will be relocation of the landfill to other places. Then you might have saved many lives and become hometown heroes, to be celebrated by your community, leaders and the city council. ☺

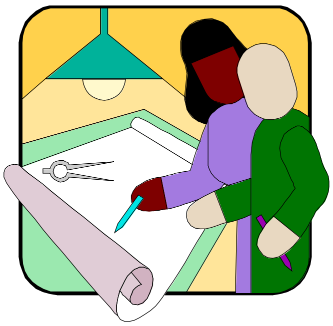
Process:

Step one:

Explain on the possible diseases that you fear will affect members of your community if the landfill will be started:

- Read all the resources you have been provided on the CD, and you are free to use any other references, which you feel to be comfortable with, for example books, newspapers and medical doctors. Summarize all the information about the possible diseases and environmental problems that can affect your community, and what should be done.
- You can visit the National Environment Management office for further information.

Step two:
Propose a campaign strategy to debate your side of the landfill issue (use posters, letters to all leaders, and rally or radio program).



- Search for simple available information to be used in your campaign strategy (use of posters, letters to all leaders, rally or radio program).
- Arrange according to the economic importance (advantages and disadvantages) to be caused if the landfill will be started.
- Select the strongest reasons for your campaign against the start of the new landfill and the biggest problem facing solid waste disposal today and in the future (environmentally).

Step three:
Present your campaign program planned for your community and the leaders (oral presentation to be done to the researcher and peers in class).

- Use a power point presentation and include the reason for selecting the desired campaign strategy, and your reasons why this strategy will be important to the community leaders.
- Recommend your plan of action.

Resources:

You can use any other resource you are comfortable with for your study; however, you are supposed to use the resources provided to you on a CD first. Importantly, the information provided on the CD is well selected for the best use of the study.

Evaluation:

The health of your community members is not enough; the researcher will also grade you on the following criteria:

- Did you suggest the possible diseases to be caused in the presence of a landfill?
- Did you complete the design of the strategy selected as indicated in step two, and is complete for implementation?
- Did you make a reasonable case to convince your local lawmakers that your strategy is the best for protecting your community?
- Did you write using Microsoft word about the selected campaign strategy, the identified diseases, proposed strategy?
- Presentation prepared on PowerPoint?

All the best - ☺

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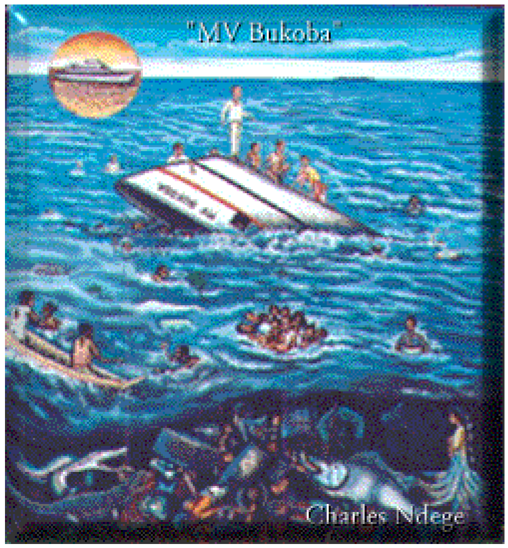
Open-ended Digital Task 3

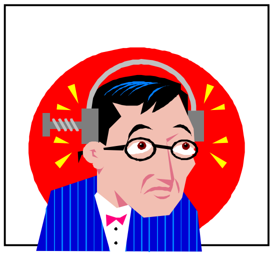
MV Bukoba Tragedy!



What can Numbers Tell Us About Her Fatal Voyage?

Prepared by:
Ms. Eugenia Kafanabo
Year 2003

Introduction:

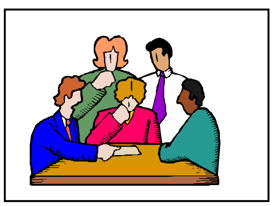


A big problem; MV Bukoba Tragedy! What happened? But why? What should be done?

MV Bukoba disaster occurred in 1997, and took the hottest topics in many disasters that Tanzania as a country had ever faced. The disaster claimed about a thousand people, whom many where presently the working potential of the country and also the future potential of the country. The government of Tanzania made a big loss both economically and socially!

From the provided data (in the CD) about the people who died in the MV Bukoba, what can you tell us about the disaster? This is a project you are supposed to establish an important topic of your choice to explain to us in the form of short story how this disaster has brought an impact to its people and the government of Tanzania economically and socially.

What is to be done?



As this is a big task and needs many inputs, you will have to work with your friends as a team. You and your co-investigators have to decide who will do what, so that at the end of the day, you will have your task done.

Now, you and your co-investigators have to identify interesting information in the resources provided so that you can write a good and educative story. The story has included most of the information that will be used to educate the government on how to overcome such tragedies in future. Your community anxiously waits for your successful suggestions!

Task:

Here you come to save the community!! Work hard to get possible suggestions.

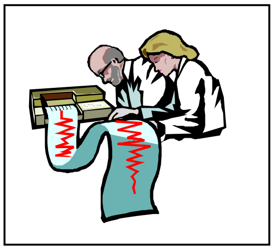
As a team, using computers, search for information that that tells us how did the tragedy occur. How many people died in the MV Bukoba Ship? What was the main problem? You are allowed to use other resources e.g. books and newspapers. Make sure you get all the information needed e.g. How many people where onboard MV Bukoba? How many women, men, children died? Which region suffered most from the people who died? How many tonnes of goods where lost? Give examples of the goods.

This study you are assigned to work with a partner. Both of you will have to get informed with the circumstances of the MV Bukoba disaster, you and your partner will use the information available on the CD provided, or newspapers in the library archives. You are supposed to write a story but supported by data shown on spreadsheet tables with appropriate graphics, to illustrate specific statistical conclusions as well as statistics related to the story.

The story to be created is very important to get your views on what is to be done by the government as part of its measures on transport system in Tanzania.

Process:

Step one:



Critically study the resources you have been provided with and make sure that you use the information to write a good and educative story.

- Review some of the background information on the MV Bukoba, its voyage, its passengers and its crew. This will help to give life to the statistical research you will do in the study.

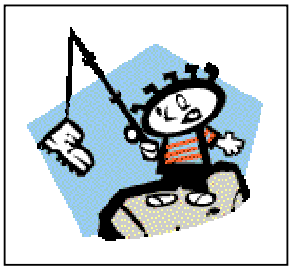
Open-ended Digital Task 4

The health of our ocean is being threatened!

Are organisms safe in the sea!!!

Prepared by:
Ms. Eugenia Kafanabo
Year 2003.

Introduction:



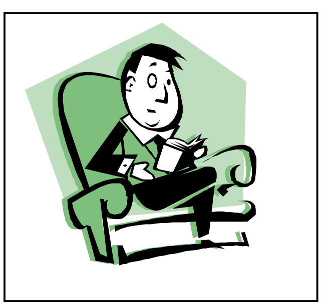
See what you have fished out?? Why is the ocean used as a dumping site? There is a big problem to the health of the oceans!!

Pollution, habitat destruction and over fishing take a serious toll on the destruction of the health of the oceans. There is need to preserve and restore the rich diversity of the ocean life and the quality of the ocean waters. For example, all the trash, oil spill, and raw sewage that are thrown into the ocean have brought many problems to living organisms in the oceans. Our trash kills - particularly plastics that end up in the sea, they pose hazards to marine life. Marine animals are drowned or strangled and get killed in many of the discarded items e.g. lost fishing gear. Other organisms suffer and even die from eating plastics and other garbage.

We need to think towards preserving the ocean and its organisms. It is a big challenge to all of us. What are the immediate solutions to these problems? How will it be done?

Now, you have entered a competition in your school, you have to prepare an exhibition about the ocean, marine organisms, and effects of ocean pollution, fishing, and tourism to marine organisms. Show how people will protect the ocean from further destruction. The interest of the exhibitors is to get more information on different strategies you will give on how to conserve/ protect the oceans. Go ahead, read the information provided and prepare an exhibition on how you will convince the world that you care about the environment.

What is to be done?

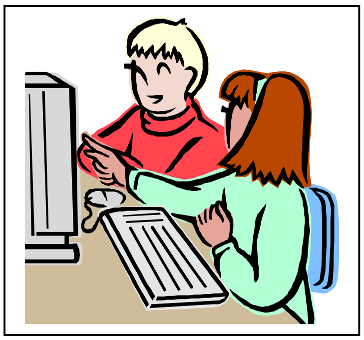


As this is an interesting topic, what you will have to do is to study the resources properly so that you can suggest a better way of conserving the health of the ocean. You have to decide what you want to do, and how it will be done.

Now you and your friend have to select three major problems that seem to be a big threat to the health of the ocean in your country. These three problems have to be very important factors that affect the ocean and its organisms. Judges who will attend the exhibition will come from the Ministry of Education and Culture, University of Dar es Salaam and 2 neighboring schools. You are supposed to show what is in the oceans, what are the major problems and tell them how important it is to conserve the ocean now! Moreover, you will be competing with other learners' from other countries who are facing a similar problem. You **need to win** in this exhibition, so think of the best way to do it!

Task:

Go Go Go, you need to win this exhibition!!!



As a team, using computers, search for information that will help you get all the information you need for the competition. You are allowed to use other resources e.g. books, and newspapers. Make sure you get all the information needed e.g. what are the major problems of the health of the ocean, which organisms are killed most and why, what human activities can be controlled and how?

When you all get the information needed, both of you have to come up with good ideas of how you are going to prepare the exhibition. You both need to remember that in your exhibition the following information is needed:

- How is the ocean important to human beings?
- What are the three major problems that have affected the health of the ocean in your country? Provide supporting and relevant data; for example, what type of waste and how many tonnes of waste is disposed off into the ocean?
- Which organisms are more threatened?
- How you will conserve the health of the ocean in you country?
- What are the other economic problems caused by these problems?
- What are your suggestions to the government?

When all is done, the exhibition will be judged accordingly. The suggestions you will give might help in the development of different strategies to help protect the ocean and its organisms. Your school will be proud of you if you win.

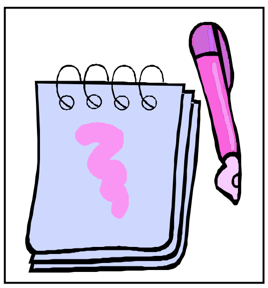
Process:

Step one:

The biggest problem in your country now is the people do not see the reason for protecting the ocean, marine organisms, and the beaches.

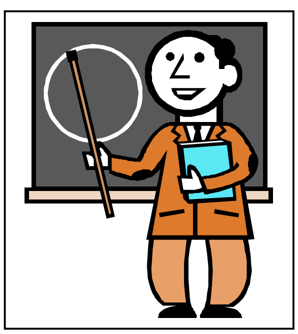
- Choose three major problems, which you think, are the major problems to the ocean in your country. As you will be competing with other learners' all over the world, the problems you select have to be well supported with data that will convince the judges and other scientists that these are the major problems in your country and they need to be addressed.
- To get the information you need, use computers and CD's provided, books, newspapers, or any other source of information, so that you can explain clearly about these problems.

Step two:



Prepare your exhibition using posters that will be taken to the competition. These posters have all the evidence of how the health of the ocean is threatened, what are the human activities that causes all these problems, what organisms are killed most, what is to be done.

You will have to present your strategies to your peers and teachers for suggestions and improvement before the final day of the competition (oral presentation will be done).



- In your power point presentation, you will have to say why you selected the three major problems facing the health of the ocean and its organisms. Also, explain your strategies and how they will be effective to protect the ocean and its organisms in future.
- Recommend your plan of action.

Resources:

You can use any other resources you think you are comfortable with for your study, however, you are supposed to use the resources provided to you on a CD first. Importantly, the information provided on the CD is well selected for the best use of the study.

Evaluation:

The posters for the exhibition are not enough; the researcher and your peers will also grade you on the following criteria:

- Did you identify the three major problems threatening the health of the ocean and its organisms?
- Did you provide enough evidence to convince the judges and scientists that your strategies are the best way forward for the conservation of the ocean and marine organisms as suggested in step two?
- Are the strategies feasible in your country?
- Did you write using Microsoft word about the major problems of the ocean, and suggestions for conserving the ocean?
- Is the poster neat and colourful with good relevant pictures?
- Presentation was done on PowerPoint.

All the best - ☺

Appendix 3.3: Observation checklist for interpersonal intelligence

As an individual, and in the team /groups:		
Low (1)	**Medium (2)**	**High (3)**
Is not talking to anybody in the team or with other members in other groups.	*Rarely talks to somebody* in the team or with other members in other groups.	*Is talking to other members in the team,* and also other members in other groups.
Is not easy to ask him/her for help (has no helping hand for others)	Is ready to help others when in need (has a helping hand).	Is open and ready to help others when in need, others ask him/her for help (easy to provide help).
Is not working in a team and does not help in compiling teamwork e.g. typing, drawing and writing	Once in a while works in a team and help in compiling team work e.g. typing, drawing, and writing.	Happy working in team and help in compiling team work e.g. typing, drawing, and writing.
Is not teaching or sharing ideas with others where there is need and *is not* ready to help or share skills with others	Can teach or share ideas with others where there is need and is ready to help or share skills when asked	Teaches, share ideas or directs others were there is need and *willingly* ready to help and share skills with others.
Leader- Not able to initiate or organize activities in the team.	Hesitates in initiating and organizing activities in the team, waits to be asked.	Facilitate team work, can organize colleagues in his/ her group (e.g. leadership abilities).
Friends - *does not seem to have a lot of friends* dislikes working with peers.	*Have few friends, can work with peers* with a bit of persuasion.	*Have a lot of friends,* shows understanding and closely work with peers.

Appendix 3.4: Learner interview schedule

Department of Curriculum and Instruction

Faculty of Education

Year 2003

Students interview schedule

1. What did you like about in doing this project?

2. What did you like most, and why?

3. What was your contribution to the team?

4. How did you like working in the team?

5. What did you like least, and why?

6. What did you do first and why?

7. Did you ask for help? Who helped you?

8. Whom did you come into conflict with most? and why?

9. Why did you decide to start working by reading or drawing or asking for assistance?

10. Do you always ask for assistance from your other teachers? Are they cooperative and ready to help when you ask for assistance?

11. Do your teachers give you any feedback? For example, correct you where you have gone wrong, or praise you when you have done a good job or tell the rest of the class of what you have done as an example to others?

Appendix 3.5: Teacher interview protocol

Department of Curriculum and Instruction

Faculty of Education

Year 2003

University of Pretoria

Teachers interview schedule

1. What performance differences did you observe from the learners?

2. What did the learners like doing best?

3. How best can you describe your learners now in terms of their performance in computer application skills, cooperation with each other, and their presentations? E.g. what is the learner good at?

4. Was team activity of any good to the learners?

5. What do you always tell your learners if you want to encourage them on what he /she is doing discourage him/her and tell him/her what you want?

6. If it has to be taking a decision for what your learner is doing now, what best would you like?

7. What is your decision for your learner based on? E.g. future possibility of the learners going for further studies, and getting a good job or something else? Please explain?

8. What are the characteristics of a clever person?

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Appendix 3.6: Teacher biographical questionnaire schedule

Department of Curriculum and Instruction

Faculty of Education

Year 2003

University of Pretoria

Teacher's questionnaire schedule

Dear teacher, you are invited to complete this questionnaire about your personal biography as a requirement for this research done in your school. The information you will provide will be useful in the completion of the research. I assure you that the information provided will remain confidential and used only for the research purpose, not otherwise stated. Your cooperation is highly appreciated. Thank you very much for your time.

Name of School:…………………………………………………………………

Name of Teacher:………………………………………………………………….

Teaching Subject (s):……………………………………………………………..

Education qualifications: ………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……

Teaching experience (in years):…………………………………………………

Gender:
Select (✓) the correct box below:

Male: ☐ **Female:** ☐

Appendix 3.7: Parents interview schedule

Department of Curriculum and Instruction

Faculty of Education

Year 2003

University of Pretoria

Parents Interview schedule.

1. Can you describe your child's typical weekday schedule from the time she/he gets up in the morning to the time she/ he goes to bed at night?
2. How best can you describe your child? E.g., what is he/ she good at?
3. If it has to be taking decisions for what your child is doing or going to do, what best would you like for his/ her future?
4. What is your decision for your child based on? E.g., future possibility of him/her is getting a good job or something else.
5. What exactly do you do to help your child in his/ her development intelligently e.g. groom the child to be good in academics – in sciences, mathematics, music etc, or be good socially or be good both socially and academically.
6. In your culture (name it here) what is it that is very important to be achieved?
7. Do you ever suggest to your child what the community is like and what you think will suit him/her?
8. Do you ever talk with your child about what you want him/ her to be (culturally)?
9. What do you tell him/ her e.g. encourages him/her on what he /she is doing, discourage him/her and tell him/her what you want?
10. What are the characteristics of a clever person?

Appendix 3.8: Parent biographical questionnaire schedule

Department of Curriculum and Instruction

Faculty of Education

Year 2003

Parents Questionnaire Schedule.

Dear parent/ guardian, you are invited to complete this questionnaire about your personal information as a requirement for this study. The information you will provide will be useful in the completion if the research, and I assure you that the information provided will remain confidential and used only for the research purpose not otherwise stated. Your cooperation is highly appreciated. Thank you very much for your time and valuable inputs.

Residence:……………………………………………………………………………

Name of parent/guardian:……………………………………………………………
………………………………………………………………………………………………

Parents/ guardian education qualifications: ………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………

Work experience in years:……..……………………………………………………

Gender:

Select (✓) the correct box:

Male: ☐ **Female:** ☐

Appendix 3.9: Scoring rubric to assess learner's performance in different tasks according to the different intelligences

Below average	Average	Above average
Task 1: Cholera or Typhoid fever - using the following strategies: - flyer, poem, radio and a TV programme.		
Logic mathematical Intelligence:		
Does not provide number of people who have been infected and died from the diseases locally or internationally.	*Provides number of people* who have been infected and died of the diseases in local context.	*Provides number of people* who have been infected and died of the diseases in local and international context.
Does not mention the economic importance (in monetary terms) of the diseases to the country.	*Mentions the* economic importance (in monetary terms) of the diseases to the country.	*Mentions the* economic importance (in monetary terms) of the diseases to the country and examples of other countries.
Verbal linguistic intelligence:		
A poem/song is not included in the text.	*A poem/song is included* in the text.	*A meaningful poem/song is included* in the text.
Writing skills - *sentences are in point form*, less connection to make a coherent text.	Writing skills – *sentences are connected* to make a coherent text.	Writing skills – *sentences are well connected* to make a coherent text.
No example is included to enrich the concepts apart from the examples given.	*One example is included* to enrich the concepts apart from the examples given.	*Several examples are included* to enrich the concepts apart from the examples given.
No organization of the ideas in the text.	*There is organization of ideas* in the text.	*The ideas are well organized* in the text.
Interpersonal intelligence:		
Very little discussion with team mate.	Works well with teammate, *less discussion and communication* between groups.	Works well with teammate*, allows discussion and communication* between groups.
Does not contribute to the discussions in the presentation session	Very little contribution is done to the discussion in the presentation session.	Highly contributes to the discussion during the presentation session.
Visual spatial intelligence:		
Pictures or photographs are not included in the text or presentation slides	*A single picture or photograph is included* in the text or presentation slides.	*Pictures and photographs are included* in the text and presentation slides
Does not use word art or pictures from clip art.	*Uses either* word art or pictures from clip art.	*Uses* word art and pictures from clip art, and manila sheet.
Does not use a flyer as an educational strategy to educate people about the diseases.	*Selects a flyer as an educational strategy, have a general layout,* pictures or photographs not included, uses normal fonts.	*Selects a flyer as an educational strategy, have a good layout of the flyer* with pictures and/or photographs, uses different fonts.
Task 2: Landfills and effects to the environment - using the following strategies - campaign using posters, letters to the village leaders, rally or radio programme.		
Logic mathematical Intelligence:		
Does not mention the approximate amount of garbage produced per day in the big cities of Tanzania.	*Mentions approximate* amount of garbage produced per day in the big cities of Tanzania.	*Mentions approximate* amount of garbage produced per day in the big cities of Tanzania and compares with other countries.
Does not give approximate number of people who have been affected with air or water pollution as a result of landfills.	*Gives approximate* number of people who have been affected with air or water pollution as a result of landfills.	*Gives approximate* number of people who have been affected with air or water pollution as a result of landfills, with supporting examples from other countries.
Does not mention the approximate amount of money used and needed by the governments to keep the cities clean from waste products.	*Mentions the approximate amount of money* used and needed by the governments to keep the cities clean from waste products in Dar es Salaam only.	*Mentions the approximate amount of money* used and needed by the governments to keep the cities clean from waste products in Dar es Salaam and an example of any other country.

Verbal linguistic intelligence: *Does not mention an educational strategy and no supporting reasons.*	*Selected an educational strategy but with no supporting reasons*	*Selected an educational strategy with good supporting reasons*
Writing skills -*sentences are in point form*, less connection to make a good rally or radio programme.	Writing skills – *sentences are connected* to make a good rally or radio programme.	Writing skills – *sentences are well connected* to make a good rally or radio programme.
A letter to the village leaders *does not contain the main ideas* of the educational strategy about effects of landfills.	A letter to the village leaders *contains the main ideas* of the educational strategy about the effects of landfills.	A letter to the village leaders *contains the best ideas* of the educational strategy about the effects of landfills.
Interpersonal intelligence: *Very little discussion* with teammate.	Works well with teammate, *less discussion and communication* between groups.	Works well with teammate, *allows discussion and communication* between groups.
Does not contribute to the discussions in the presentation session	*Very little contribution* is done to the discussion in the presentation session.	*Highly contributes* to the discussion during the presentation session.
Visual spatial intelligence: *Does not use* manila sheet as posters to show the effects of landfills.	*Uses a* manila sheet as a poster to show the effects of landfills, *pictures not well* elaborated.	*Uses a* manila sheet as a poster to show the effects of landfills with *well-elaborated pictures.*
Does not use pictures or photographs to explain about simple recycling process of waste products in a locality in power point slides.	*Uses pictures or photographs* to explain about simple recycling process of waste products in a locality in power point slides.	*Uses pictures and photographs* to explain about simple recycling process of waste products in a locality in power point slides.
Task 3: MV Bukoba tragedy - using the following strategies - a story.		
Logic mathematical Intelligence:		
Does not mention the dates and number of people who died in the tragedy.	*Mentions the dates and number of people* who have died in the tragedy.	*Mentions the date, number of people* who died in the tragedy. *Mentions the distance* from Mwanza town.
Does not mention the number of people who survived the tragedy.	*Mentions the number of people* who survived the tragedy.	*Mentions the number of people* who survived the tragedy.
Does not give any example of ship tragedies in other countries and the number of people who have died.	Gives an example of one country and the number of people who have died.	Give several examples of ship tragedy in different countries and the number of people who have died in each country.
Did not use tables, graphs where possible	*Uses either a table or graph* where possible.	*Uses both tables, and graphs* where possible.
Verbal linguistic intelligence:		
Did not use words like "Once upon a time", "On this specific day", "on this day"..	*Uses words like* "Once upon a time", "On this specific day", "on this day"..	*Uses language effectively by using words like* "Once upon a time", "On this specific day", "on this day"..
Writing skills -*sentences are in point form*, less connection to make a story.	Writing skills – *sentences are connected* to make a story.	Writing skills – *sentences are well connected* to make a story.
No extra example is included to enrich the story apart from the examples given in the resources.	*One example is included* to enrich the story apart from the examples given in the resources.	*Several examples are included* to enrich the story apart from the examples given in the resources.
No organization of ideas in the story.	*There is organization of ideas* in the story.	*The ideas are well organized* in the story.
Interpersonal intelligence:		
Very little discussion with teammate.	Works well with teammate, *less discussion and communication* between groups.	Works well with teammate*, allows discussion and communication* between groups.
Does not contribute to the discussions in the presentation session	*Very little contribution* is done to the discussion in the presentation session.	*Highly contributes* to the discussion during the presentation session.
Visual spatial intelligence:		
Pictures or photographs are not included in the text or presentation slides	*A picture or photograph is included* in the text or presentation slides.	*Pictures and photographs are included* in the text and presentation slides

Appendix 3.9b: Scoring rubric for performance abilities in computer application skills

Intelligence Logic mathematical	**Below average (1)**	**Average (2)**	**Above average (3)**
	Did not use tables or graphs to show ability to record and organize number information. Did not use logic sequence to categorize events – did not use subtitle, and paragraphs. Did not make use of numbers in text to emphasize a point.	Used a table or graph to show ability to record and organize number information Used logic sequence to categorize events - used paragraphs only. Used numbers in text to emphasize a point.	Used both tables and graphs to show ability in recording and organizing number information. Used logic sequence to categorize events –used subtitles and paragraphs. Frequent use of numbers in the text to emphasize a point.
Visual spatial (Excel programme) (Clip art) (word art/ auto shapes) (Colours) (Animations – power point) (Lines/ bolding & fonts)	Did not make use of charts and tables from excel program and MS Word. Did not use pictures from clip art or pictures from reading resources (copy and paste). Did not use other decorating features from word art, or auto shapes to decorate the text. Did not use colours in typed text to emphasize a point. Did not use animations in presentation slides. Did not use bold/different fonts/ underline in the text.	Used chart or tables from excel or MS Word. Used one picture from clip art or pictures from reading resources (copy and paste). Used only one feature from word art, or auto shapes to decorate the text. Used colours for typed text to emphasize a point. Used animations in presentation slides (simple animations). Used bold and or different fonts – comic sans, underlined headings.	Good use of both charts and tables from excel and MS Word. Used more than one picture from clip art and from reading resources (copy and paste). Good use of other decorating features from word art, or auto shapes to decorate the text. Proper use of colours in typed text to emphasize a point. Used animations in presentation slides (good, not distractive). Good use of bold, different fonts did not underline headings.
Verbal linguistic (Used bullets) (Spell-check) (Paragraphs) (Word document)	Unable to put story in a narrative form, assembled points as selected from the readings and used bullets. A lot of spelling mistakes in the sentences less accurate use of words. No thematic coherence to describe a procedure in their text, less use of paragraphs. Did not use language to invent rhymes to describe a point in the task.	Was able to put a story into narratives and mixed with assembled points from the readings. Few spelling mistakes in the sentences (used spell check) and accurate use of selected words. Mixed themes in the paragraph used to describe a procedure in the text. Tried to use language to invent rhymes to describe a point in the task.	Used a story into narratives and created a coherent document. Very few spelling mistakes in the sentences (used spell check) and accurate use of words – specific word choice. Good thematic coherence e.g. describes a procedure and even added information not in the readings in paragraphs. Used language to invent rhymes to describe a point in the task.

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Appendix 3.10: Application letters for research clearance

Faculty of Natural and Agricultural Sciences
Faculty of Education

Centre for Science Education
Sentrum vir Wetenskaponderwys
Igatja lezefundo nolwazi
Lekala la thutamahlale

Tel: (012) 420 3088
Fax: (012) 420 4210
E-mail jrogan@postino.up.ac.za
University of Pretoria
Pretoria 0002

9th October, 2003.

u.f.s
The Vice Chancellor,
University of Dar Es Salaam.

u.f.s
Dean
Faculty of Education.

Head of Department
Curriculum and Teaching.

Dear Sir,

Re: Request for Research Clearance

The above heading is concerned. I am a member of staff in the Faculty of Education, Department of Curriculum and Teaching. I am currently a PhD student at the University of Pretoria, South Africa, and registered in the Faculty of Education, Department of Curriculum and Instruction – Groenkloof Campus.

For the requirements of my study, I wish to conduct a study in four secondary schools in Tanzania about multiple intelligences and computer integration. At present my research topic is “An investigation into the interaction between multiple intelligences and the performance of learners in open-ended digital learning tasks”.

I am requesting for a Research Clearance to be able to conduct my research study in four secondary schools, three of the schools are in Dar Es Salaam Region and one in Iringa Region. These secondary schools are purposefully selected for the study, because they have a computer laboratory, which is a prerequisite for the study. The intended study is planned to be conducted from January 5, 2004 to April 30, 2004. Hope my request would receive your consideration.

Thanking you in advance, I remain, sincerely.

Ms. Eugenia Kafanabo,

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University of Pretoria, PhD Student.
Appendix 3.11: Letter for participant's participation in the study

Department of Curriculum and Instruction

Faculty of Education

University of Pretoria

November, 2003

Dear participant,

You are invited to participate in a research study aimed at investigating the interaction between multiple intelligences and performance of the learners in open-ended digital learning tasks.

Your participation in this research project is voluntary and confidential. You will not be asked to reveal any information that will allow your identity to be established, unless you are willing to be contacted for individual follow up interviews. Should you declare yourself willing to participate in an individual or group interview, open-ended digital tasks, filling in of questionnaires and observations, confidentiality will be guaranteed and you may decide to withdraw at any stage should you wish not to continue with the research study.

Accompanying this letter is a document explaining how you will participate in the study.

The results from this study will be used as a requirement to write a thesis of my study, as a PhD student from University of Pretoria, South Africa.

If you are willing to participate in this study, please sign this letter as a declaration for your consent i.e. that you participate in the study willingly and that you may withdraw from the research willingly and that you understand that you may withdraw from the study at any time. Participation in this phase of the study does not obligate you to participate in follow up individual interviews, however, should you decide to participate in follow-up interviews your participation is still voluntary and you may withdraw at anytime. Under no circumstances will the identity of interview participants be made known to (any parties /organizations that may be involved in the research process and/or which has some form of power over the participants).

Participants signature…………………………………...: Date: ………………………….

Researchers signature……………………………………: Date: …………………………

Yours Sincerely

Ms. Eugenia Kafanabo
PhD. Student, University of Pretoria – RSA.

Appendix 3.12: Consent letter for parents/ guardians

Department of Curriculum and Instruction

Faculty of Education

November, 2003

Dear Parent/ Guardian,

____________________________________ Secondary School has been chosen to participate in a research study about multiple intelligences and computer integration in schools. The school has been selected out of the entire schools in the Region of Dar es Salaam and Iringa as a result of their outstanding use of computers in their school activities. Students in Form two and Form three, doing science subjects that is Biology, Physics, Chemistry and Mathematics, and computer studies will participate in the study.

This study will take place in Dar es Salaam and Iringa Regions, at _____________________ Secondary School. The study is expected to last for three weeks in each school that will participate. I, Ms. Eugenia Kafanabo will conduct the study; as a PhD Student from University of Pretoria, South Africa, and an experienced teacher in the field of science, with specialization in Biology. During my PhD studies, I have gained interest in computers in education, teaching and learning sciences using computers.

The results of this study I hope will help curriculum developers, policy makers and teachers in discovering and understanding how computers can be used as a tool in the teaching and learning process of science subjects, while allowing learners to work on their different performance abilities. This knowledge will also enable teachers and schools to provide special instructional materials that might improve learners' performance abilities. Moreover, the results of the study might provide valuable information for the future development of effective computer related activities by the teachers.

In this study, I feel that it is worthy to work with the learners' in the selected schools. Please review the information on the following page in order to make a decision concerning parental consent for your child to participate in the study.

Sincerely,

Ms. Eugenia Kafanabo

PhD. Student, University of Pretoria – RSA.

PARENT/ GUARDIAN CONSENT FORM

The information provided in this form and the accompanying covering letter is presented to you in order to fulfill legal and ethical requirements for The University of Pretoria (institution supervising this doctoral dissertation study) and The University of Dar Es Salaam as regulations for the involvement in ethical considerations when working with human participants in the study.

The dissertation committee at University of Pretoria, South Africa, and University of Dar Es Salaam, Tanzania has both given approval to conduct this research study. The purpose of this study is to investigate the interaction between multiple intelligences and performance of learners in open-ended digital learning tasks, in 4 intelligences (i.e. verbal linguistic, logic mathematical, visual spatial and interpersonal intelligences). Form two and form three students doing science subjects and computer studies will participate in the research study.

Your child will be involved in this study in the following ways:

- Filling in questionnaires for the identification of the intelligence profiles
- Participating in three open-ended digital learning tasks using computers
- Presentation and discussion of the tasks in class using computers
- Focus group interviews that will be conducted by the researcher

Each learning task will take one week to completion. Each day, the learners will participate in all the activities presented to them by the researcher, upon which they will have to work for two to three hours per day, for 5 working days of the week. There are no foreseeable risks to the learners' involved. Specific information about individual learners will be kept **strictly confidential** and will be obtainable from the Head Mistress/ Head Master of the school if desired. The results that will be published publicly will not reference any individual learner's original identity, as the study also intends to analyze the relationships between learners.

The purpose of this form is to ask for permission if your child can participate in the study, and to allow the researcher to use the information already available at the school or information obtained from the actual study to be used for publication. Parent consent for this research study is voluntary. Please sign on the space below for your consent. The parent's signature below also assumes that the child understands and agrees to participate cooperatively in the study.

If you have additional questions regarding the study, the rights of participants or potential problems, please call the head of school, ____
Or the researcher, Ms. Eugenia Kafanabo (PhD. Student – University of Pretoria), cell phone number 0744 464853 in Tanzania.

____
Student's name.

____
Signature of Parent/Guardian.   Date

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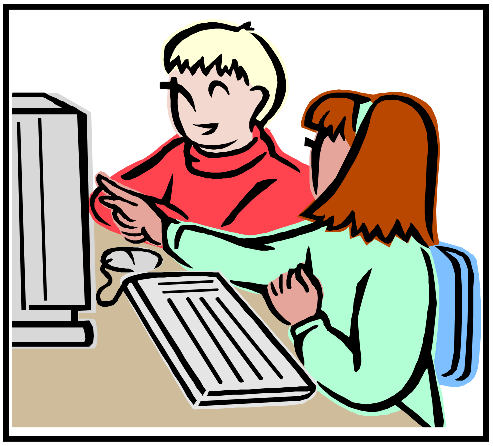
Appendix 3.13: Certificate of attendance for learners

Research on Open-Ended Digital Learning Tasks



Certificate of Attendance

This is to certify that

____

Participated in the research study conducted by the Researcher from the University of Pretoria in collaboration with the University of Dar es Salaam in Tanzanian Secondary Schools from January 2nd to March 30th 2004.

E.J. Kafanabo
Researcher & PhD Student
University of Pretoria, RSA.

Appendix 4.1: Poem prepared by learners for their educational strategy

Poem about Typhoid fever

I can design my education strategy by using poem which we think is a very simple and easy way to educate people.

This disease caused, by the typhoid bacillus,
And the name of microbe, is called Salmonella typhi,
This disease is bad, because it kills many people,
What is that disease, the disease is typhoid fever.

Symptoms of the disease, there are so many
Variety of symptoms, it occur to the person
That has contracted with Salmonella typhi,
What is that disease, the disease is typhoid fever

The spread of microorganism, they spread through human,
You can get the disease, if you drink or eat food or beverages,
That has been handled, by the people carrying the bacteria,
What is that disease, the disease is typhoid fever.

Treatment of water, is by boiling the water,
Treatment of food, is by washing it,
It is the most reliable method, to make food and water safe,
What is that disease, the disease is typhoid fever.

Prevention of the disease, is by protect the public water supplies,
Educate the public, about prevention of typhoid fever,
Cleanliness in food, preparation and handling,
What is that disease, the disease is typhoid fever.

The problem facing community, is the dirty of environment,
They do not have good sanitation, they drink dirty water,
And they do not wash hands, and have no enough toilets,
What is that disease, the disease is typhoid fever.

Typhoid fever effect, 17millionn people,
In the word wide, every year,
With approximately 600,000 deaths,
What is that disease, the disease is typhoid fever.

I am at the end, and I want to give you some advice,
Do not drink dirty water; wash your hands after eating,
You should have good sanitation, and clean the environment,
What is that disease, the disease is typhoid fever.