✍ 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.