The Relationship between Learners' Intelligence Profiles and Performance in Computer Application Skills

Eugenia J. Kafanabo
Department of Educational Psychology and Curriculum Studies
University of Dar es Salaam, Tanzania

Abstract
This paper reports on an investigation that was conducted to explore the relationship between learners' intelligence profiles and their skills and ability to use computer applications while working on open-ended digital learning tasks. The theory of Multiple Intelligences by Howard Gardner (1983) was used as a framework for the study. The qualitative research approach was used, which involved 40 secondary school learners in Tanzania, who completed three open-ended digital learning tasks. Performance assessment procedures were used to assess the learners' performance abilities, identify the relationship between the learners' intelligence profiles and their skills and ability to use computer applications. The results of the study suggest that there is a positive relationship between learners' cognitive abilities (intelligence profiles), and the open-ended, digital learning tasks that are related to their academic level. As a result, the study recommended the use of learner-centred instruction that appreciates learners' diverse skills, abilities, talents and performance as they work on open-ended tasks.

Introduction

In 1983, Howard Gardner introduced the theory of Multiple Intelligences (MI). Gardner argued that all individuals have unique personal intelligence profiles that can be manifested in different forms of strengths and weaknesses. A person's relative strength and weakness also helps to account for their individual differences (Gardner, Kornhaber, and Wake, 1996). These intelligence profiles, however, consist of a combination of seven different intelligence types: verbal linguistic, logic mathematical, visual spatial, bodily kinesthetic, musical, interpersonal, and intrapersonal intelligences (Gardner, 1983, 1993). In 1999, Gardner added to this list an eighth, naturalistic intelligence, and a ninth, the existentialist intelligence type.

Since then, this theory has been embraced by many educators as a tool for understanding and effectively meeting the diverse learning needs of learners in schools, albeit with some criticism (Campbell, 1991, Armstrong, 1993, 1994; Hoerr, 2004). This theory of multiple intelligences considers learners with diverse intelligence profiles, emphasises the tasks that provide opportunities for learners to work in a variety of ways and uses an assessment of learners which is 'intelligent fair', hence the wide application. Gardner (1983, 1993) and Sternberg (1985) supported the use of 'intelligence fair' assessment. They both suggested that learners should be assessed on their performance abilities using different assessment methods, in an attempt to investigate patterns of individual performance abilities across learning tasks. These methods include the use of observation, presentations, portfolios, and interviews. This study was aimed at determining whether there is a relationship between learners' intelligence profiles and their skills and ability to use computer applications.

Purpose of the study

This article presents the findings of a qualitative research study that was conducted in Tanzania to explore the relationship between learners' intelligence profiles and their skills and ability to use computer applications and to suggest possible approaches to the teaching and learning of computer use in Tanzania. The study was conducted in four secondary schools, and involved 40 school learners doing a computer course. Using the theory of multiple intelligences as the framework, the researcher introduced the learners to open-ended digital learning tasks, and used performance assessment tools to assess their skills and ability to use computer applications. The research questions that guided this study are:

1. What are the main intelligence profiles identified in the group of learners who participated in the study?
2. How do learners differ in their skills and ability to use computer applications when working on open-ended digital learning tasks?
3. What is the relationship between learners' intelligence profiles and their skills and ability to use computer applications?

Background

In the second half of the twentieth century, several reforms were undertaken in the curricula of most schools in the world. One of these changes involved the introduction of computers as a teaching tool in an effort to produce an alternative means of teaching and learning in the schools (Murphy and Alexander, 2002). Consequently, the use of computers in schools throughout the world is no longer confined to the major industrialised countries. The 1999 International Association for the Evaluation of Educational Achievement (IEA) study by Quellmalz and Kozma (2003) and another study conducted by Pelgrum and Anderson (1999), entitled "Second Information Technology in Education Study: Module 1 (SITES M1)" confirm the findings of other researchers that indicate that significant investment in educational information and communication technologies (ICT) has been made throughout the world and that a great deal of this investment has taken place in schools. The widespread use of educational ICT has enriched schooling and made it a rewarding experience in addition to further enhancing the quality of education that learners receive (Means and Olson, 1995; Bracewell, Breuleux, Laferriere, Benoit and Abdous, 1998; Coley, Cradler and Engel, 1999).

Some of the studies also revealed that the benefits accruing from educational ICT include the transformation of 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. The improved curricula are believed to put an emphasis on learners' performance and hands-on activities likely to fully engage them in the learning process as well as application of computer skills in a real world setting (Computer Studies Syllabus of Tanzania, 1996; National ICT Policy, 2003). Considering the diversity of learners' performance abilities (Gardner, 1983; 1996), schools need to plan for quality learning experiences that ought to include multiple approaches to teaching and learning. More often than not, however, initiatives that have been included in the teaching and learning process have been unable to produce broad, durable outcomes (Alexander, Murphy and Woods, 1997, Murphy and Alexander, 2002). Generally, learners' skills and ability to use computer applications can be realised by promoting learners' intelligence profiles and their performance abilities. The intelligence profile of a learner is considered to be a central determinant of how the learner will perform when given open-ended digital learning tasks (Campbell, 1991, Armstrong, 1994, Gardner, 1983). Therefore, it is imperative for computer teachers to know the pedagogical strategies that can help them identify learners' intelligence profiles and alternative methods of assessment using performance assessment strategies. By considering the relevance of the intelligence profiles of learners to their performance, the study will explore the initiatives that would facilitate a change from teacher-centred to learner-centred activities, open-ended tasks and the use of performance assessment to assess computer application skills.

Initiatives to change from teacher-centred to learner-centred instruction

It is clear that traditional teaching, which is mostly teacher-centred, has failed in many ways to deliver the kind of education that is absolutely necessary in the modern world that depends increasingly on computer–related application skills, perceptions and attitudes. Because computer technology is continually changing and being improved, being skilled in all the arts, methods, techniques and procedures is essential 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 the planet. Of course, there will always be a place for the paraphernalia of the old forms of teaching. However, with the concept of the multiple intelligences theory, the use of the multiple intelligences approach to teaching and learning is regarded as 'learner-centred', whereby classroom activities revolve around the needs of the learner and in which the teacher plays the role of facilitator (Murphy and Alexander, 2002). Lambert and McCombs (1998: 7) suggested , however, that learner-centred teaching strategies extend far beyond the artificial boundaries of formal schooling, as learners acquire authentic learning, and this can only be done by changing the didactic model on which teachers base their teaching. A comprehensive definition of learner-centred teaching is given by McCombs and Whisler, (1997: 9):

> Learner-centred perspective combines a focus on individual learners (their heredity, experiences, perspectives, backgrounds, talents, interests, capacities and needs) with a focus on learning (the best available knowledge about learning and how it occurs and about teaching practices that are most effective in promoting the highest levels of motivation, learning and achievement of all learners).

The overarching value then of the theory of multiple intelligences (Gardner, 1983, 1993) for teachers in the teaching and learning process is that it focuses on individual learners' intelligence profiles, which are an inexhaustible treasure house of potential. 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 ongoing, 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 primarily measure logic, mathematical and verbal linguistic skills (Gardner, 1983; Armstrong, 1994; Gardner 1996). Of course, such skills are important in the learning process, but they need to be evaluated alongside a great number of other kinds of intelligences that the theory of multiple intelligences postulates.

Due to the variation in intelligence profiles that learners have, they do not learn in the same way, hence they cannot be assessed in a uniform fashion using traditional tests (such as multiple-choice inventories, short answer questions and matching items tests) (Gardner, 1983; Sternberg, 1985; Lazear, 1992). Conclusively, it can be said that these types of tests require learners to reveal their knowledge and skills in a manner that is already predetermined by teachers and, therefore, limited by the tester. Advocates of Gardner's theory of multiple intelligences believe that such tests are essentially unfair or at least extremely limited in what they can reveal about learners' performance abilities and so they suggest that a better approach to assessment be used. The new assessment approach, which is also called "performance assessment" or "authentic assessment", is important in the teaching and learning process as it requires learners to explain, describe or otherwise elaborate on materials by demonstrating their proficiency in applying their own unique range of intelligences to a problem (Wiggins, 1989; Krechevsky and Gardner, 1990; Krechevsky, 1991; Wiggins, 1993). Performance assessment or authentic assessment methods include the use of learners' portfolios, independent projects, learners' journals, and authentic tasks. These methods help to simulate the 'real world' that is outside the educational milieu (Lazear, 1992; Armstrong, 1994).

Proponents of the theory of multiple intelligences regard performance assessment as an alternative form of assessment to traditional standardised 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 students' intelligences fairly, one's assessment should look for signs or evidence of all eight (or more) intelligences directly, rather than through the lens of linguistic or logical intelligences (Hatch and Gardner, 1986).

The works of these different theorists provide a summary of the various approaches to understanding intelligence. Following the same ideas used in other studies, this study used the theory of multiple intelligences to investigate the relationship between learners' intelligence profiles and their performance in open-ended digital learning tasks. The theory of multiple intelligences considers learners with diverse intelligence profiles, and also emphasises the use of tasks that provide opportunities for learners to work in a variety of ways and an assessment of learners that is 'intelligent fair'. There have been extensive empirical data showing how the theory of multiple intelligences has been used and has shown positive results in different research studies (Gardner, 1987; Gardner and Hatch, 1989; Krechevsky, 1991; Hoerr, 1992; Armstrong, 1994; Campbell, 1997; Kallenbach, 1999).

Open-ended digital learning tasks

Zevenbergen, Sullivan and Mousley (2001) define an open-ended task as one that has the potential to include a *range* of 'correct' responses, so that 'correctness' in such situations encompasses a far wider range of potential answers than the typical closed questions. Closed questions are used in most teaching situations and typically have only one 'right' answer. 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 can discuss not only their responses, but also the *process* through which they arrived at their responses, as well as their preferences and the contextual matrix out of which such responses arose (Goodnough, 2003). This format sets up multiple potential pathways that learners can explore to negotiate and arrive at co-constructed knowledge and success in performance. Such a multi-faceted system makes it possible for learners to express their multiple intelligences, enabling them 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: 5). A system such as this enables even the so-called 'weak' pupils to shine and gain access to forms of knowledge and understanding from which they would have been excluded through the use of conventional authoritarian educational methods.

In this format, learners are encouraged to use any source of information. Even computers may be used to assist them in solving 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 can identify the learning tasks that arouses their interest. If this is done, learners will become active in exploring avenues of knowledge and finding possible solutions to problems and, if more than one solution exists, selecting the best one. In this way, learners communicate with each other, discuss and experiment and demonstrate what they know rather than what they do not know (de Lange, 1987).

Computers are ideal for giving learners the opportunity to engage intellectually with technologically advanced tools, demonstrate personal expertise and to interpret and make representations of what they know of the world (Jonassen, 1995). Open-ended tasks can also help learners to move away from low-grade learning that is demonstrated by memorisation and the mechanical recitation of facts to the realms where they use higher order thinking and apply their skills and knowledge to express different intelligences (Gardner, 1993). It is also vital 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), proposed four determining elements of an open-ended learning environment that can enhance learning by means of learners' performance. These four elements are (1) an enabling context, (2) resources, (3) tools, and (4) scaffolds. *An enabling context* provides a realistic (authentic) framework wherein problems are situated. *Resources* allow learners to frame and resolve problems. *Tools* help learners to process, manipulate and discuss information. Teacher and tool-based *scaffolds* guide learners' problem-solving strategies and processes.

In the open-ended learning environment described above, *learners* are of central importance, whereby they are allowed to make decisions on the information they need from different sources and the approach they should adopt to solve problems. The enabling context, resources, tools and scaffolds characteristic of the open-ended learning environment are in a 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 for assessment tailored to the needs of a variety of intelligences of learners. The performance assessment process is discussed in the following section.

The use of performance assessment to assess computer application skills

Gardner (1983) believes that intelligences can best be assessed using the performance assessment process. This kind of assessment is a valuable and creative alternative to traditional standardised multiple choice tests because it requires learners to perform significant tasks directly. Doing so 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). If learners are assessed by means of a carefully constructed performance assessment process, they will be free to express many other forms of intelligence other than when they are exposed to the purely mathematical, computational and verbal forms that traditional tests purport to measure. Computer learning situations can provide an ideal format for assessing these multiple intelligences that are an important part of our lives, but which are only now beginning to be recognised in institutional learning.

This study is using an approach that is located within the theory of multiple intelligences advanced by Howard Gardner (1983). The theory contrasts with the dominant psychometric model of assessment. The suggested mode of assessment—performance assessment—is favoured, with particular reference to performance abilities, when learners are given open-ended digital learning tasks (Pellegrino, Baxter and Glaser, 1999). The aim of the study was to use performance assessment as a means of investigating the relationship between learners' intelligence profiles and their performance when working on open-ended digital learning tasks in the classroom.

Generally, it is believed that learners' multiple intelligences can be enhanced by the use of technology, especially in the classroom. This can be done if teachers can base their teaching methods on Gardner's theory of multiple intelligences that encourages the use of authentic tasks to provide enriching opportunities in each of the areas of the intellect. Teachers, therefore, do not have to change what they teach when teaching basic computer skills, but they should ideally be able to adopt teaching techniques that are suited to the needs and mentality of their learners. In fact, teachers can achieve this form of teaching by using authentic tasks that are relevant to real-world situations, and that are both interesting and stimulating to the learners. In addition, assessment of these tasks has to be authentic and predicated on real-world solutions as their criteria.

Why use performance assessment?

Child (1997) observed that it has been difficult to determine the scholastic potential of a learner by observing schoolwork and using standardised tests of intelligence, because the tests focus primarily on two ways of learning: verbal linguistic and logic mathematical. The inherent danger in this approach has to do with the fact it makes observation of schoolwork and standardised tests of intelligence the only way of measuring learners' performance, as it only covers one or two ways in which learners learn (Child, 1997). A better assessment approach also supported by Gardner (1983; 1999) is the use of authentic or alternative assessments that would allow learners to use learning resources in their own way, using their different intelligences (Lazear, 1992, Wiggins, 1998), because each individual is unique, and hence he or she cannot completely be defined through any one method of assessment (Teele, 2000).

Supported by Wiggins (1998), he says that assessment is authentic when testing is anchored on the kind of work real people do, rather than on merely eliciting easy-to-score responses to simple questions. In this regard, authentic assessment constitutes a true assessment of performance, because it reveals whether learners can intelligently use what they have learned in their previous learning situations and can be innovative in a new situation to apply this knowledge (Wiggins, 1998).

Based on the theory of multiple intelligences, I have created in this study a learning environment that will foster the application of different intelligences by using authentic learning tasks that were developed using the topics from the Biology Syllabus for secondary schools of Tanzania (1996), and assessed learners' skills and ability to use computer applications using the performance assessment approach. Performance assessment calls for learners to demonstrate their capabilities directly by creating some product or engaging in some activity (Gardner, 1983; Haertel, 1992), and there is heavy reliance on observation and/or professional judgment in the evaluation of the responses, using scoring rubrics (Mehrens, 1992).

The results of this study can be useful for teachers for various reasons. First, the study considered learning instruction that was learner-centred; hence the findings will give them an opportunity to learn from these examples. Second, the study included authentic and open-ended activities relevant to their classroom situation. Third, the study used the performance assessment process to assess learners' performance in computer application skills, providing added value to the teachers.

Method

The study was conducted in four secondary schools in Tanzania. The purposive sampling strategy was used to select the four schools and the learners who participated in the study (Tashakkori and Teddlie, 2003). The criteria used for the selection of the schools and the learners were that the participating schools should have computers and the learners should be undertaking a computer course during their studies.

At the time of the study, nine to 11 learners were enrolled in the computer course (they had to pay for the course) in the different schools and these were the learners who voluntarily participated in the study. In all, 40 learners from the four schools took part in the study: 20 were in Grade 9 and the other 20 in Grade 10. Of these students 23 were females and 17 were males. The age distribution of the learners ranged from 13 to 19.

Four teachers where involved in the study, as co-observers, one teacher from each school. These teachers participated in this study as co-observers when the learners worked on their open-ended digital learning tasks and during the presentation sessions. These teachers also participated in the reflection sessions with the researcher to discuss the events observed during the process and any matters arising from these observations needing to be addressed. The co-observers and the researcher then wrote up on what had been observed while the events were still fresh in their minds. Finally, all this information was compiled and presented in one report.

Data collection procedure

Data was collected in two main stages. The first stage aimed at determining the learners' intelligence profiles using a multiple intelligence survey questionnaire, and school progress reports. The instrument was adapted from McKenzie's (1999) inventory questionnaire that was used to identify the learners' strongest and weakest intelligences from the learners' own assessment. The progress reports showed subject annual scores and indicated the current level of academic attainment of a learner in each subject. The school progress report was used to validate the results obtained from the multiple-intelligence survey questionnaire.

The second stage involved the execution of three open-ended digital learning tasks, observing the learners as they worked on these tasks, and then assessing all the open-ended digital learning task documents and presentations using holistic-type rubrics. All the learners' documents were saved on floppy disks, printed out, and the hard copies compiled. Altogether, there were 112 documents, comprising 56 open-ended digital learning tasks using *Microsoft Wor*d, and 56 presentations using *Microsoft Power Poi*nt.

A three-point checklist was used by the researcher and one of the school teachers (co-observer) to observe the learners while working on their open-ended digital learning tasks. There was a session beforehand, between the researcher and the teacher, to discuss how to use the checklist and what was to be observed. The checklist was then used to identify the learners' abilities as regards interpersonal intelligence. After each observation session, the researcher and the co-observer discussed the outcomes of each observation in a reflection section. A write-up was then prepared.

A holistic scoring rubric was used to assess the performance of the learners in the tasks and presentations, which were saved on floppy disks by the learners. After all the tasks in the documents had been scored by the researcher and the teachers from each school, an overall average score was calculated from the three open-ended digital learning task and presentation documents for each individual learner. The average scores were then grouped into three performance categories: 3 points for above average (AA), 2 points for average (A), and 1 point for below average (BA). If a learner's average score was 2.5-3, his/her performance was categorised as above average, 1.5-2.4 as average, and 1.0-1.4 as below average. To avoid bias during the scoring of the learners' task and presentation documents, an inter-rater reliability coefficient was calculated from all the scores scored by the four teachers, plus the researcher. The average Kappa Coefficient of all the tasks was 0.78.

For the purpose of this study, attention focused only on four intelligences using the theory of MI: logic mathematical, verbal linguistic, visual spatial and interpersonal. The selection of the four intelligences was based on the performance assessment procedures used, that is from the preparation of the authentic tasks (the three open-ended digital learning tasks) that required the learners to complete the tasks using the available resources, that is, computers in the selected schools. The computers had no internet connection, no CD drives, and no educational software installed. The second criterion that was used in the selection of the four intelligences was the expertise of the researcher and the school teachers (Wiggins, 1993). For example, neither the researcher nor the teachers had been given any formal training in musical or kinaesthetic fields. Lastly, the assessment of the learners' performance abilities was based on the different strategies and skills used by the learners to complete the tasks and how these abilities were reflected in their strengths and weaknesses in verbal linguistic, logic mathematical, visual spatial and/or interpersonal abilities.

A descriptive analysis was used to describe the relationship between multiple intelligences and learners' performance in open-ended digital learning tasks using a contingency table (Patton, 1990; Creswell, 1998; Merriam, 1998). It was assumed in this study that the learners' performance abilities in the three open-ended digital learning tasks and presentations would be that most learners would perform according to their intelligence profiles, and some of the learners would perform using several intelligences for the same tasks. The following discussion on how these learners showed their varied performance abilities is based on the assessment of the three open-ended digital learning tasks and presentations, with reference to computer application skills. The next step was to determine whether there was any relationship between the learners' skills and ability to use computer applications and their intelligence profiles.

Using the contingency table, a significant relationship between learners' intelligence profile in logic mathematical, verbal linguistic, and visual spatial intelligences and their ability to apply computer skills was found. Interpersonal intelligence was not included in the holistic scoring rubrics of the tasks because performance abilities in this intelligence are more observable and, hence, were assessed during observation.

Results

The skills and ability to use computer applications were found to be average for most of the learners who participated in the study. These learners, as mentioned earlier, participated in the study because they were doing a computer course in their schools. These results, therefore, were not worth taking into account since these learners were also doing computer studies and thus were expected to do much better than the scores they obtained. However, their skills and ability to use computer applications in all three tasks showed great variations. There was a small group of learners whose skills and ability to use computer applications was above average in all three intelligences. These learners used the computer applications they already knew and also applied new computer skills taught during the study. These results are supported by results from a study by Kallenbach and Viens (2001), who also saw changes in students' preferences through choice-based activities, in that they became more assertive, slightly shifting the balance of power in the classroom. The creative use of these computer application skills provided the students with more points to categorise them as above average performers in this study. The other group, which constituted the majority of the learners, used very few computer application skills. The results of how the learners performed in the three tasks and presentations in relation to computer application skills are summarised in Table 1 below:

Table 1: *Learners' Skills and Ability to use apply Computer Applications in relation to the Three 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

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

The reason why the students applied very few computer skills, as illustrated by Table 1, could be attributed to this being the first time they were allowed to use computers to complete tasks and make their own choices of what they wanted to include in their tasks. Moreover it might be that they were not very conversant with some of the computer application skills and so decided to use whatever skills they had. Suess, (1996); Suess, Kersting and Oberauer, (1991) also confirm that research on intelligence tends to show that the ability to solve a specific problem relies on the amount of available pre-knowledge that can be applied in solving a particular problem. Hence, their performance ability was categorised as below average. On the whole, this shows that, despite doing a computer course, these students were unable to show their competence in using computers as their task documents and presentation slides revealed. These results indicate that that these learners need more open-ended activities that would allow them to have hands-on experience in using computers. The next section discusses the different computer application skills that were assessed, according to the concept of the theory of multiple intelligences, in the following categories: logic mathematical—recording and organising bits of information; visual spatial intelligence—using pictures, clip art, tables and graphs; and verbal linguistic—organisation of texts and use of paragraphs.

The main intelligence profiles identified from the study and the skills and ability to use computer applications

Recording, organising and using number information *(logic mathematical intelligence)*

The skills and ability of the learners to use different computer applications to record and organise number information and logically arrange their text document was generally below average. For example, ten learners' performance was above average. They were able to use two computer programs (*Microsoft Excel and Microsoft Word*) to draw graphs and tables to record and organise their number information. They also managed to use *Microsoft Word* effectively to arrange their text document in a logical way. They accurately used bolded subtitles and arranged the text in small logical paragraphs for better understanding. Furthermore, these learners frequently used different number information in their texts to emphasise a point and added some of this information in their presentation slides as well.

The performance of four learners was average, because they managed to use only one computer program, that is, either a table or a graph was used to record and organise their number information in their text document. Number information was sparingly used in both their texts and presentation slides. Twenty-six (26) learners' performance was below average, that is, they failed to use any computer applications, other than Microsoft Word, to help them record or organise the number information in the form of tables or graphs in either of their documents (Microsoft Word document and presentation slides). They managed to use Microsoft Word to type their text in one or two paragraphs, but without providing subtitles. Generally, these learners did not use any other computer application. In their Microsoft Power Point slides, they did not include tables or graphs.

Visual application skills – use of pictures, clip art, colours, tables and graphs, font sizes and style *(visual spatial intelligence)*

Information was visually presented by the learners using the different tools available in Microsoft Word and Microsoft Power Point. For example, eight learners' performance was above average in this category, as they managed to use pictures from clip art and photographs from the reading resources (to emphasise a point), they used Word art different font colours (for decoration), bolded fonts and lines to underline their titles and subtitles (for emphasis) and they also used tables and graphs (to organise number information) in their Microsoft Word documents. They also used animations in their power point presentations.

The computer application skills of nine other learners were average, because they managed to use only one computer application for visual presentation of the information in their texts and power point slides. These used pictures from clip art and from their reading resources only. Twenty-three learners' performance was below average, as they did not use any visual applications in their Microsoft Word documents or power point slides in all three tasks.

Organisation of ideas – into paragraphs, use of bullets, and columns (*verbal linguistic intelligence****)***

Most learners' performance in relation to verbal linguistic intelligence was either above average or average with 20 learners' performance being above average. This constitutes half the number of the learners who did very well in all three tasks. These learners managed to organise their ideas in their text documents by using paragraphs and bullets to produce a coherent document. One of the learners managed to format his document in columns and made a flyer using Microsoft Word. Most of the learners were comfortable with the use of paragraphs and bullets in organising their texts because this formatting is frequently used in their computer course in schools. These learners processed their documents in Microsoft Word, using paragraphs and the spell check tool, which showed up their spelling mistakes. They did not need extra help from the researcher when using with this program. Finally, the computer application skills of 12 learners were below average in this category. The Word documents they processed were less organised, with some of the learners having one big paragraph containing all the information in the text.

On the whole, most of the learners were comfortable using Microsoft Word for typing documents. This is mainly because in the process of learning basic computer skills in their computer classes, their teachers stressed the learning and using of Microsoft Word, following the computer syllabus recommended for secondary schools in Tanzania.

In other words, most of the learners had basic computer application skills that could be applied in completing their tasks. However, if these learners had been given more opportunities to work on open-ended tasks that had allowed them to have hands-on experience, they could have applied more skills to complete these tasks. Although they had good background knowledge of how to use Microsoft Word, they needed to be trained in the application of other basic computer programs such as Microsoft Excel and Microsoft Power Point, as well as the various formatting tools that are available.

The following is picture art used by one of the learners in Task 1: The picture shows a sick person being attended to. Therefore, if people do not have clean and safe water, they may contact cholera and end up in hospital, or they might even die.

Figure 1: A sick person being attended to.

The relationship between learners' intelligence profile and computer application skills using different intelligences

A contingency table was used to determine whether there was a significant relationship between the learners' intelligence profile (strengths and weaknesses) and their skills and ability to use computer applications. The contingency table (see Table 4) was drawn from: (i) the results of the final judgment of the intelligence profile of the learners recorded in table 3, and (ii) the assessment results of the learners' skills and ability to use computer applications in relation to different intelligences as recorded in Table 2.

Table 2: *Combined 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

Note: H – high, M – Medium, L - Low

The descriptive data analysis procedure was then used in this part of the study. This procedure was selected as it was appropriate due to the small sample size and the purposive sampling method deployed. These limitations tend to limit the use of a chi-square test. In fact, a chi-square test requires at least 80% of the cells of a contingency table to contain at least five cases of confidence level to be placed on the results (Cohen, Manion and Morrison, 2000). In this case, some of the cells in the contingency table contained less than five cases, or none as seen in Table 3:

Table 3: *Contingency Table Indicating the Relationship between Learners' Intelligence Profiles and Their skills and Ability to use Computer Applications*

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

Note: **H** – high, **M** – Medium, **L** – Low

The distribution pattern of the learners in the contingency Table 4 above suggests that the performance of learners with a medium intelligence profile, especially in logic mathematical and visual spatial was below average in computer application skills. In verbal linguistic intelligence, however, the performance of many of the learners who had a high intelligence profile was also above average in computer application skills. The overall performance of the learners and their intelligence profiles are discussed below.

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

The computer application skills of four learners who scored high in logic mathematical intelligence were above average in relation to the three tasks. These learners had planned their data properly, they had recorded and organised their number information in tables (using Microsoft Word) and had used graphs (from Microsoft Excel). These four learners had also made good use of numbers, because they always made reference in their text documents to the numbers in the graphs and tables. Conversely, the computer application skills of the five learners whose intelligence profile was low in logic mathematical intelligence were below average in relation to the three tasks. These learners did not use tables from Microsoft Word or graphs from

Microsoft Excel to record or organise their number information in planning their data in any of the tasks. Moreover, the content part of the tasks was not divided up into paragraphs, although they managed to compile their texts using local examples from their reading resources.

A group of four learners, who had minimum intelligence profile, scored average in computer application skills. They used neither tables nor graphs to organise number information in their texts. Some of them divided their information into paragraphs using Microsoft Word, with some examples of numbers in their texts.

The study also showed that a group of 27 learners had medium intelligence. This group represented the majority. Within this group, six learners scored above average in their computer application skills, while the remaining 21 learners scored below average.

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

Out of the four learners with high intelligence profile in visual spatial intelligence, the computer application skills of three were above average in the three tasks. These learners demonstrated their visual skills by using pictures from clip art, and photographs from the reading resources. In some of the tasks, tables and graphs were used from Microsoft Word and Microsoft Excel programs. Also the learners used colours to decorate the text fonts to emphasise a point and also used different font types, alongside Times New Roman, in processing the main body of the text. Other Word tools used in the texts included bolding and underlining headings and subheadings. These students also managed to use animations in their power point presentation.

Of the participants, nine learners had medium intelligence profile and their computer application skills were average. These learners used either a table or a graph and one tool for their pictures, that is, either clip art or photographs from their reading resources. They also used other tools such as underlining. Some even changed the font types in their texts. Some of these students also managed to include animations in their power point presentations.

One learner had a low visual spatial intelligence profile, whose computer application skills were below average. The learner did not show any visualised skills for completing his tasks. He did not use pictures from any of the programs like clip art, Word art or photographs from the reading resources provided, nor did he use tables or graphs, or colours for his fonts to emphasise a point. No animation was used in his power point presentation. This learner basically managed to type the document using Microsoft

Word and nothing else, without considering the use of underlining, bolding and changing font types.

From this group, five learners scored above average in their computer application skills in all three tasks, but had a medium intelligence profile. Moreover, 21 learners had a medium intelligence profile in visual spatial intelligence, but scored below average in their computer application skills.

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

Thirteen learners, who had high profiles in verbal linguistic intelligence, scored above average with respect to their computer application skills in relation to all three tasks. In general, these learners were able to use Microsoft Word to process their ideas. Their ideas were narrated in small themes and these themes were coherent. A pair of learners from School 'M', for example, used their verbal skills to invent a rhyme as a strategy for an awareness-raising drive to educate members of their community on Typhoid in Task 1. The topic was on diseases.

Poem for typhoid fever

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 occurs to the person
That has contracted with salmonella typhi,
What is that disease, the disease is typhoid fever.

The texts of the learners whose computer application skills were above average in were arranged in paragraphs. The computer application skills of six learners with a medium profile in verbal linguistic intelligence were average. . Most of them learners managed to process their document using Microsoft Word. They put their stories in narrative form, and used bullets to emphasise some of the points they had used from the reading resources. As there was no learner who had a low profile in verbal linguistic intelligence, naturally there was no-one whose performance was below average. For the other group of 18 learners with medium intelligence profile in verbal linguistic intelligence, the computer application skills of seven were above average and of 11 they were below average in relation to all three tasks.

Discussion

The results of this study indicate that the majority of learners had a medium intelligence profile in the four intelligences. A couple of learners had extreme intelligence profiles where they had high intelligence profiles in three to four of the intelligence markers. Their performance was also above average in using computer applications for all their tasks.

When the learners were given open-ended digital learning tasks, they had the opportunity to use various computer applications, as well as different Word tools. All the learners completed all three tasks, with the third task being performed much better than the first one. These learners also had an opportunity to choose which computer applications to use for the tasks they had to complete. Their choice could have been influenced by their strong intelligence abilities (cognitive abilities), which could be linked to the patterns of performance abilities reflected in how they made their selection regarding the use of different computer applications when carrying out the three tasks. For example, the learners who had high profiles in logic mathematical intelligence made use of graphs and tables and organised their number information in all three tasks. Those who had weak profiles in logic mathematical intelligence did not attempt to use graphs or tables in their task documents. However, they were comfortable with the choices they made.

These learners also had diverse intelligence profiles (strengths and weaknesses) apart from the four selected intelligences investigated in the study. This corresponds with the observations of previous research done by Gardner and Hatch, (1989); Krechevsky and Gardner, (1990); and Leutner, (2002). The different intelligences that were identified in each learner showed a relationship between the learners' intelligence profile and their performance abilities in the different open-ended digital learning tasks they were given. This finding implies that the learners' intelligence strength can be used to make good choices for carrying out the given tasks. In fact, this lends credence to the findings of Hoerr (2004), whose assessment of learners based on multiple intelligences provided an opportunity for learners to learn using a wide range of intelligence profiles. He discovered that the performance of learners with high profiles in verbal linguistic and interpersonal intelligence was above average in the different open-ended digital learning tasks relating to these intelligences, such as writing skills and organization of ideas. On the other hand, the performance of learners, who had low profiles in verbal linguistic and interpersonal intelligences, was below average in open-ended digital learning tasks requiring these intelligences. Therefore, it is important that learners' distinctiveness and uniqueness is addressed and taken into account as learners engage in and take responsibility for their own learning. In fact, learner-centred instruction may also provide learners with an opportunity to display their various skills, abilities, talents and preferences as they work on different tasks (Gardner, 1983; 1999). Doppelt and Barak (2002) and Doppelt (2003) also found out that when learners create their own products from open-ended tasks or projects, they tend to experience meaningful learning which enables them to exercise different ideas in their own projects.

On the whole, the results from the three tasks could provide evidence of the strengths and weaknesses of the learners' intelligences in relation to their intelligence profiles. These learners were able to use their skills and abilities to use computer applications on the basis of their strong and weak intelligences. In one of their studies, Lane, Stone, Ankenmann, and Liu (1992) asserted that a related pattern of results from learners' performance entails giving them a certain number of tasks to help identify this pattern. In other words, a single task given singly cannot be used to judge the performance abilities of the learners. Hence, it is important to have more than one task to help identify the learners' patterns of abilities and skills using the theory of multiple intelligences.

Conclusion

The results of this study have shown that a distinct pattern of performance abilities was exhibited by the learners as they worked on the open-ended digital learning tasks. Each learner managed to exhibit his or her strengths and weaknesses in different intelligences; thus there was no uniform level of ability. The contingency Table 3 indicates that there is a positive relationship between the learners' strong intelligence profile and their competence in using computer applications (as shaded in the contingency Table 3). The performance of a good number of the learners who had a high intelligence profile in this study was also above average. On the other hand, the performance of the learners whose intelligence profile was low in that intelligence category was also below average in relation to their use of computer applications for all three tasks. The performance of some of the learners, who had medium intelligence profiles, was also average. These findings indicate that there may be a relationship between learners' strong and weak intelligences and their ability to make good choices in carrying out different tasks.

The assessment results of the three tasks also showed that the learners' skills and ability to select and use computer applications was unique to individual learners. For example, learners who had a high intelligence profile in visual spatial intelligence used different pictures, images, drawings and clip art pictures to express their visual ability, despite the tasks being similar for all the learners. Moreover, two learners with a high visual spatial intelligence drew on manila sheets to complete some of the visual sketches they had in mind for their tasks. However, the learners with a low visual spatial intelligence used one or two pictures from clip art or did not use any at all. They did not even make use of the manila sheets, although they had been distributed to each learner for the students to use to draw diagrams or pictures for their tasks.

Thus, rather than just focusing on the skills that are useful in the school context, the results from this study showed that the open-ended digital learning tasks gave learners an opportunity to exploit their different learning preferences deemed relevant in achieving significant and rewarding outcomes in their tasks. For example, the learners used the computer applications they had learned to produce their task documents and presentation slides, namely, Microsoft Word, Excel and Power Point, as well as engaging in collaborative learning. These positive outcomes could not have been achieved had the learners only been given standardised tests and required to provide answers to the questions provided.

However easy or difficult it was for the learners to complete their tasks, some of them appreciated how difficult it could be to address complex social issues that occur in real-life situations. Nevertheless, the learners enjoyed their tasks, because they were drawn from their own localities, which were familiar to them. In fact, some of them came up with good ideas during the presentation sessions that prompted interesting class discussions. Many of the learners acquired communication skills that could be transferred to other courses and work situations. In this study, therefore, the selection of real-world activities ensured that the learners were able to apply their previously learned computer skills to complete the tasks at hand, while learning new meaningful skills in the process. Thus, learner-centred instruction should be used in schools, especially in Tanzania, as it can help learners acquire new computer application skills while deploying either their strong or weak performance abilities.

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Appendix 1: Scoring rubric for performance abilities in computer application skills

Intelligence	**Below average (1)**	**Average (2)**	**Above average (3)**
Logic mathematical	Did not use tables or graphs to show ability to record and organise number information. Did not use logic sequence to categorise events – did not use subtitle or paragraphs. Did not make use of numbers in text to emphasise 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 emphasise a point.	Used both tables and graphs to show ability in recording and organizing number information. Used logic sequence to categorise events –used subtitles and paragraphs. Frequent use of numbers in the text to emphasise a point.
Visual spatial (Excel programme)	Did not make use of charts or tables from MS Excel and MS Word.	Used chart or tables from MS Excel or MS Word.	Good use of both charts and tables from MS Excel and MS Word.

(Clipart) (word art/ auto shapes) (Colours) (Animations – power point) (Lines/ bolding & fonts)	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 emphasise a point. Did not use animations in presentation slides. Did not use bold/different fonts/ underline in the text.	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 emphasise a point. Used animations in presentation slides (simple animations). Used bold and or different fonts – comic sans, underlined headings.	Used more than one picture from clipart 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 emphasise 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, assemble points as selected from the readings and use bullets. A lot of spelling mistakes in the sentences and less accurate use of words. No thematic coherence to describe a procedure in their text, less use of paragraphs. Did not use language to prepare rhymes to describe a point in the task.	Was able to put a story into narrative form 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 prepare 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 prepare rhymes to describe a point in the task.