Computer-Based Learning as a Variant of e-Learning and M-learning

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Abstract

In this study, discussion on how inconsistency in the definitions of e-Learning, distance learning and online learning has negatively impacted the use of Computer-Based Learning (CBL) is presented. Secondary school students were taught mathematics using CBL approach in four lessons. The CBL approach, as a variety of e-Learning and distance learning was deployed offline. A questionnaire was used to collect students' views on preferability and effectiveness of CBL in learning mathematics. Further, statistical methods were employed to calculate cognitive impact that the method had on the students. Finally, teachers' attitudes towards CBL and the viability of deploying digital content offline to students without basic computer knowledge are discussed. The study confirms that inconsistency in defining e-Learning, distance learning and online learning has negatively impacted the way CBL can be deployed offline. Information from the questionnaire revealed that overall; CBL approach was preferred as a complement to the face-to-face method. While cognitive improvement was not statistically significant, the main challenge to digital approach seems to be the alignment of CBL with face-to-face approach. It was further found that some teachers see CBL as a rival rather than a useful assistant. The study found that basic computer knowledge is not necessary for successful deployment of CBL.

1. Introduction

In recent years, there has been a groundswell of interest in how computers and the Internet can best be harnessed to improve the efficiency and effectiveness of provision of education at all levels in both formal and non-formal settings [1]. Real-time interactive virtual classroom with tele-education experience is an important approach in distance learning [2]. However, the use of digital technology in education has not been fully exploited (particularly in poor countries) partly due to the inconsistency in the definition and the understanding of e-Learning, distance learning and online learning. Although it is obvious that offline CBL is the viable alternative to web learning, in places where internet connectivity is nonexistent, the use of offline CBL is not wide spread. As the world is fast moving towards e-Learning and M-learning, the soft issues such as contextual implementation of e-Learning both offline and online, the role of instructor(s), students' general attitudes towards digital content, the role of basic computer driving skills, the combination of face-to-face approach with digital content and the viability of using offline CBL have not received the attention they deserve.

2. Inconsistency in terminologies

In poor countries such as Tanzania, the pace of employment of computers for teaching and learning has not matched the necessity and the potential. According to Moore et al. [3] one reason can be the lack of consistency in defining e-learning, distance learning and online learning.

Moore et al. [3] confirm that there is a general lack of consistency in terminology concerning e-learning, distance learning and online learning which inevitably affects not only the researchers who would like to build upon the findings, but also designers who are creating digital learning environments.

Terminology also poses a problem when the specific context of the learning environment is not described in sufficient details. This not only impacts the evaluation of such learning experiences but also the future of distance learning events. There is great difference not only in the meaning of foundational terms that are used in the field, but also in implications for the referencing, sharing, and the collaboration of results detailed in varying research studies [3].

Unfortunately, this inconsistency includes all types of CBL due to the fact that computers are an integral part of the technology used to facilitate learning and teaching, be it face-to-face or at distance. As such, due to this inconsistency, the pace of deployment of the technology in places where internet connectivity is not available or suboptimal has been slowed down and its benefits have been denied to the people who mostly would need it [4].

2.1. CBL, e-Learning and M-learning

It is generally accepted that CBL is an integral part of M-learning and e-Learning [5]. According to Cheng et al [2], CBL is in the inner cycle of the taxonomy of M-learning and e-Learning. Following this logic, one would expect a fair share of research and investments on offline CBL as an integral part of e-Learning. In reality, this is not the case. As regards to e-Learning and its benefits, there seems to be too much focus on web learning and M-learning at the expense of offline CBL.

Technology in the classroom is widely believed to help teachers promote a constructive classroom environment, and it is viewed by many researchers as having an influential effect on the teaching and learning process [6]. Having excellent computer facilities, such as good software with good internet connection does not ensure provision of complete benefits and opportunities of CBL to students. This is because a computer in itself does not provide adequate instructional value if not given meaningful activities. Means [7] argues that in order to provide students with beneficial computer-based activities, it is important to plan instructions for activities that are supported by computers. In order to set up an effective CBL environment, issues such as how much connectivity is adequate for sufficient CBL deployment and how face-to-face approach can be combined with digital content to improve learning in an environment where connectivity is absent are worth investigating.

Obviously, most of what applies to offline CBL will equally apply to M-learning due to the fact that CBL constitutes the initial stage towards M-learning. It can therefore be inferred that, proper grounding on CBL is the precursor to a well planned rollout to M-learning. In order to have a clear direction for M-learning, issues such as the role played by prior computer knowledge amongst students and students' attitudes towards CBL in relation to face-to-face method are some of the variables that need to be investigated.

Computers, just like any other teaching tool, would not promise to bring any benefit to students, unless their practical use, in a particular context, is explored in detail and implemented accordingly. Warschauer [8] posits that the activities in the CBL classroom were found successful when students understood the purpose of doing them and when they found the activities culturally and socially relevant. World Bank [9] reports that many ICT projects in developing countries that were dubbed as successful cases have eventually failed to make the desired impact due to lack of thorough knowledge of social technical aspects associated with them. This failure can partly be attributed to some fallacies which seem to guide the trend of investment and research towards CBL and ultimately towards web learning and M-learning in Tanzania and Africa in general. Some of these fallacies include:

i. CBL, internet connection and web learning have a one-to-one relationship. It is inferred, therefore, that, for CBL to succeed there must be fulltime internet connectivity and a well managed web-based content. Consequently, internet connection has been considered as a necessary condition towards e-Learning. For this matter internet connection has received all attention and investment, while simple but important issues such as the viability of use of digital content offline is completely ignored;
ii. Once there is internet connectivity and the content, CBL will enjoy an automatic rollout. As a consequence, no sufficient investigation has been done on models, viability and benefits of deploying digital content offline in poor countries such as Tanzania;
iii. Basic computer driving skills are a pre-requisite to a successful CBL rollout. Consequently, no systematic effort is being directed on the use of digital content to teach students who do not have basic computer knowledge in countries like Tanzania where resources are scarce.

These fallacies which, in most aspects are caused by the inconsistencies in the definition of terms, have led to a wave of popular digital educational projects such as "One laptop per child in Nigeria, Rwanda and Cameroon, and "Mkongo wa Taifa" in Tanzania, just to mention a few. These projects are examples of an inflated and exclusive drive towards connectivity and web content at the expense of other variables such as the optimal level of technology required under every context, the synchronization of CBL approach with face-to-face method, language issues and resource optimization, among others. These projects are, to a large extent, incommensurate with the problems at hand.

It has been widely recognized that harnessing the power of modern technologies for learning purposes requires that appropriate learning strategies be developed that harmonize effectiveness in learning with the technology role [10].

In general, there is a great demand for some effort to contextualize digitization of learning materials in all levels. In the case of underdeveloped societies such as Tanzania, connectivity will definitely arrive late. Somehow this aspect seems to receive more attention than it deserves. If context is taken into account, offline delivery of digital content and research on its viability in Tanzanian context is more vital than internet connectivity and web learning.

ICTs do not have to privilege one culture over another. Educators almost universally use the book as a tool, adapting it to the needs of particular cultures. We need also to use ICTs universally in education, without adopting the economic and

cultural assumptions that have driven its rapid globalization. Regarding the use of ICTs in education, there are several levels on which ICTs can push the cognition boundaries. New media allow us to represent in rich and diverse ways. This is not simply a matter of learning styles although diverse learning styles can be supported by ICT.

New media enable us to traverse the boundaries of art, science language and senses. They allow us to represent and simulate experience. ICT allows us to accelerate or decelerate processes for purposes of understanding. Just as an experiment allows us to reproduce, represent or test a pattern of activity in the physical world, multimedia allows us to represent and experiment in a 'virtual' world – transferring control and concept to the learner in new ways. We can improve safety, for example, using technology so that the concepts are transferred, confidence is built through simulated experience and skills are developed, long before the risk has to be taken [11]. Similarly, education can be improved by using the technology as it is demanded and available in a specific society.

3. Problem definition

The benefits of e-Learning and distance learning in places like Tanzania where internet connectivity is still at its rudimental stage, power supply uncertain, costs of internet connectivity still prohibitive and web content creation and management extremely expensive, will take long to become a reality. Despite these woes, the official position about CBL seems to be guided by overemphasis on web learning, online leaning/education and online delivery. There is no evidence of sufficient effort being directed towards the use of technology as the context demands. Due to overemphasis on online web based education, more resources and efforts have been disproportionately directed to optimization of connectivity first, at the expense of deployment, access and quality. Swarts and Wachira [1] report that the extent of application of CBL approach is negligible in Tanzanian secondary schools. In a country where shortage of mathematics books is above 46.5% [12], one would expect offline CBL to be the primary approach for content delivery, especially in subjects such as mathematics which have few teachers and few books.

Most people just don't like mathematics. One reason might be that some students are not visual learners and there are fewer ways to teach mathematics other than visually. Other reasons might include bad teaching and uninteresting teachers. In Tanzanian secondary schools the failure rate in mathematics has been consistently above 76% for the past 8 years [13]. This is a critical situation which provides for a fresh ground for experimentation with alternative methods, particularly CBL and M-learning. Another reason for poor performance in mathematics is that teaching mathematics is in itself a difficult endeavor and not all mathematicians know how to teach mathematics.

Primary data shows that the failure rate in mathematics at Saint Benedict Secondary School in Songea is 87% which is above the national mean of 76%. This situation cannot solely be attributed to the difficult nature of mathematics. Such a situation has the hallmark of dislike of the subject and lack of competent teachers coupled with insufficient facilities. To add to the dislike, the school has a book-pupil ratio of 1:12 and a teacher-pupil ratio of 1:130. These ratios are much better than the national ratios, though far below the international norm.

In this research, offline CBL as a variant of e-Learning and M-Learning is used to provide an opportunity to teach mathematics to remote areas in Tanzania. Currently, in Tanzania there are three universities offering courses in e-Learning [1]. There is a huge push towards connectivity to the Internet. These efforts are, however, not accompanied with sufficient studies about the varieties, viability and effectiveness of CBL, M-learning and e-Learning. The level of readiness towards the technology is not known. Besides training in basic ICT skills and some limited use of e-Learning at the three universities, the real integration and exploitation of ICT to address issues of access and quality have not been sufficiently investigated.

Online or offline digital content allows the learner to access the lecturer anytime within 24 hours. To the learner, while paper content is silent, static and whole in nature, digital content by contrast can be put in motion by the learner himself by re-enacting the lecture. A lecture that is mapped on paper is rigid, and can only be re-enacted by the effort of the learner's thought. By contrast, a digital lecture is re-enacted by replaying the lecture. With minimum effort of thought, the learner using digital content, can appreciate the origin of the case in presentation, while experiencing the way the case is systematically being developed by the lecturer from the beginning to its conclusion.

In those cases where teachers are scarce, digital content can be used to put students in contact with an expert who assists them to grasp the basic skills pertinent to a given theme. Since the level of expertise and mastery of subject matter differs from one teacher to another and even from one country to another, offline video content can be used to expand the audience of a subject expert. In this research for example, a mathematics professor from Victor Valley College in the United States of America [14] is made available to secondary school students in southern Tanzania where internet connectivity is nonexistent.

On the economic side, in comparison to paper content, digital content is more mobile, interactive,

cheaper and easily customizable. Additionally, revisions on digital content can be made quickly and new editions can be released immediately than it can be done on paper format.

As regards to connectivity, the big disadvantage that offline digital content has in comparison to interactive sessions is that students do not have the opportunity to ask questions and receive instant feedback. This is an acknowledged drawback. However, this drawback does not justify the current underutilization of CBL especially on subjects that demand rare expertise like mathematics.

In essence, the current emphasis on associating digital learning with the Internet has increased the adverse effect of digital divide. This state of affair is not justified because; research has shown that the component of interaction in classrooms is negligible particularly in Tanzanian schools. Mselle and Kondo [4] report that students in Saint Benedict Secondary school seldom asked questions during four class sessions conducted through offline CBL approach. With this data it can be concluded that the effort that is directed in making digital content interactive is not proportional to the demand. On the other hand, opportunities that are associated with offline digital content are being wasted.

In this study, an attempt was made to conduct secondary school mathematics lessons using digital content in a place where internet connectivity is non-existent and few computers are available. The focus was, to investigate if the offline digital content could be used to mitigate the impact of insufficient books and teachers. More importantly, we wanted to know the impact of offline CBL method on students' cognition; the extent that offline CBL, as a complement to face-to-face, appealed to students and teachers and the amount of ICT skills needed by the students to smoothly sail into the new approaches such as e-Learning and M-learning.

4. Questions

This research attempts to answer the following questions:

i. Can offline digital mathematical content be adequately deployed to students, despite the suboptimal level of connectivity and lack of interactive web content?
ii. If secondary school students use offline CBL method to study mathematics, will they perform better than when the face-to-face approach is used?
iii. Are basic ICT skills necessary for successful deployment of CBL?
iv. Will secondary school mathematics students find digital approach more comprehensible and more preferable than the traditional face-to-face approach?
v. What are the attitudes of Tanzanian mathematics teachers towards digital content?

5. Method

The goal of this study was twofold. Firstly was to reveal how opportunities are lost due to inconsistencies in definitions and understanding of the terms, and secondly to evaluate the viability of offline CBL approach in lessons; both as a replacement and a complement to the face-to-face method for teaching mathematics in an environment where technology is still at its rudimental level. The study focused on three possible kinds of benefits: cognitive, affective and technological while assessing the position of the face-to-face approach within offline CBL context, as a precursor to M-learning and e-Learning. The study also delved on establishing whether, with the lowest level of digital preparedness, students could still get sufficient benefits of digital content. In addition, the study aimed at establishing whether offline CBL content could be used instead of, or in conjunction with the face-to-face approach to bring about better results. The experiment was used to collect data pertinent to cognitive and technological benefits while the questionnaire was used to collect data about students' attitude towards CBL. Observation was used to determine teachers' attitudes towards offline CBL.

5.1. The School and the Students

The secondary school chosen for this study is in a relatively deprived area of Songea, in Southern Tanzania. One group (Form IV class) consisting of 63 students and another group (Form III class) consisting of 66 students constituted the sample for the study. The Form III students had basic computer driving skills while the Form IV students had no prior computer exposure. For both groups, it was their first experience to learn a subject using computers. The School Management and the mathematics teachers agreed to the proposal of introducing the use of mathematics digital videos to students for learning.

5.2. The Experiment

The students and their teachers were informed of the experiment and they all agreed to participate. The content was adopted from NECTA [13], Toner [14], TIE [15], Thompson [16] and MOEVT [17]. The Form III group was taught two topics; variation and cycles while the Form IV group was taught probabilities and linear programming. For the Form IV group, the choice of topics was random while for the Form III group; the topics selected were those

that had been deemed by the teacher as being very difficult. The cognitive impact of CBL is measured by comparing the test scores of students before and after the use of CBL using within-subject design.

Because there was no power guarantee, a laptop was used. Due to machine scarcity, the laptop was connected to a projector. Each topic was played for 40 minutes. Students were allowed to take notes without a chance to either ask questions or pose the video play. Later on, the students were instructed to do their individual studies on their own to prepare for a test that would follow after 2 days. The tests were prepared by their teachers. The tests consisted of 12 questions, thoroughly covering the material taught. Each test was administered for one hour. For the Form IV group, the post-test results were compared with the pre-test results. For the Form III group, post-test results were compared with results obtained from a previous weekly test.

5.3. The Questionnaire

Ten days after CBL had been introduced to them; students were requested to fill in a questionnaire that was intended to collect their views pertaining to comprehensibility of the subject, preferability of CBL and superiority of CBL in comparison with the face-to-face method. The translated version of the questionnaire is shown in Figure 1.

1 Learning mathematics by this method is:	Highly comprehensible	comprehensible	A bit comprehensible	Not comprehensible
2 How much would you prefer this method?	I prefer it very much	I prefer it	I prefer it a bit	I don't prefer it at all
3 Compared to face-to-face method, how would you rate this method?	It is better	It is good	They are equal	It is inferior
4 What, in your opinion, should be done to improve this method of teaching?				

Figure 1. The questionnaire (Translated from Kiswahili)

5.4. Observation

Teachers' attitudes towards digital content were observed during and after the deployment of the CBL. Soon after deployment of CBL, two mathematics teachers were provided with the digital content covering the entire syllabus with intention to make this available to students for their private studies.

6. Results

All Form IV students (n=63) were computer illiterate. This group was subjected to two revision classes. To them, pre-test and post-test examinations were administered. All of them filled the questionnaire. Statistical data on test results are summarized in Table 1.

All Form III students (n=66) were computer literate. This group was subjected to two revision classes. To them, pre-test and post-test examinations were administered. Only 63 students answered the Questionnaire. Statistical data on test results are summarized in Table 2.

Results from the questionnaire are reflected in figure 2 through 7. Figure 2 reflects that 7.94% of Form IV students found CBL highly comprehensible. It is further revealed that 60.32% of this group found CBL comprehensible. In total, 68.26% of Form IV students found CBL comprehensible and highly comprehensible. Figure 5 reveals that 19.67% of Form III students found CBL to be highly comprehensible. 47.54% of them found CBL comprehensible. In total, 67.21% of form III students found CBL comprehensible and highly comprehensible.

Regarding preferability, Figure 3 shows that 30.16% of Form IV students found CBL highly preferable and 49.21% found CBL preferable. In total, 79.37% of Form IV students found CBL preferable and highly preferable.

Figure 6 shows that 34.43% of Form III students had high preference for CBL and 34.43% just preferred it. In total, 68.86% of form III students found CBL preferable and highly preferable.

On ranking CBL against face-to-face, Figure 4 reveals that 19.05% of Form IV students found CBL to be better than face-to-face method and 61.90% found CBL to be good. In total, 80.95% of Form IV students ranked CBL as a good or better method than face-to- face.

Figure 7 indicates that 22.95% of Form III students ranked CBL as better and 57.38% ranked it as good. In total, 80.33% of Form III students ranked CBL as a good or better method than face-to- face.

It was also revealed that 12.8% of the respondents found CBL deficient due to lack of an interactive mode and parallel Kiswahili version which could have enabled students to ask questions and understand the lessons better. Furthermore, 17.6% recommended basic computer skills to be taught prior to deployment of CBL in classrooms.

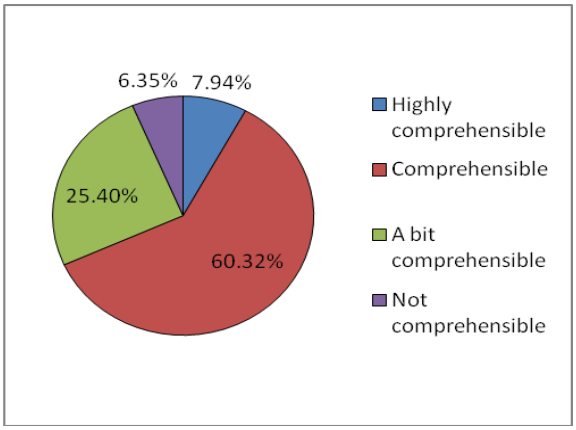

Figure 2. Comprehesibility of CBL among Form IV students

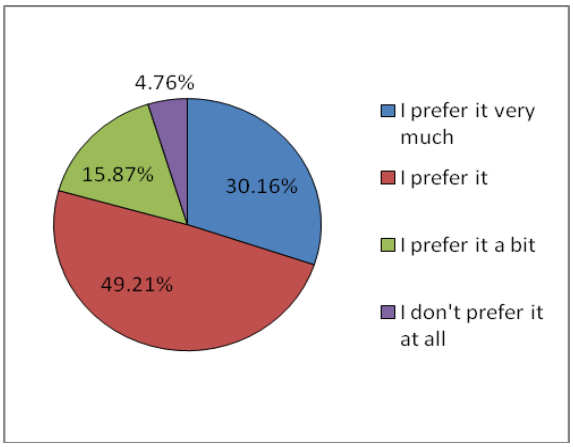

Figure 3. Preferability of CBL among Form IV students

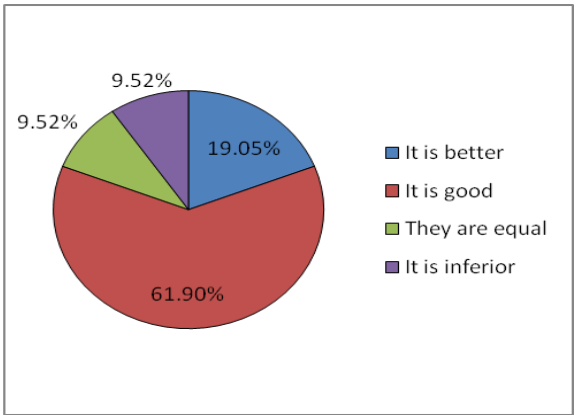

Figure 4. Ranking of CBL by Form IV Students

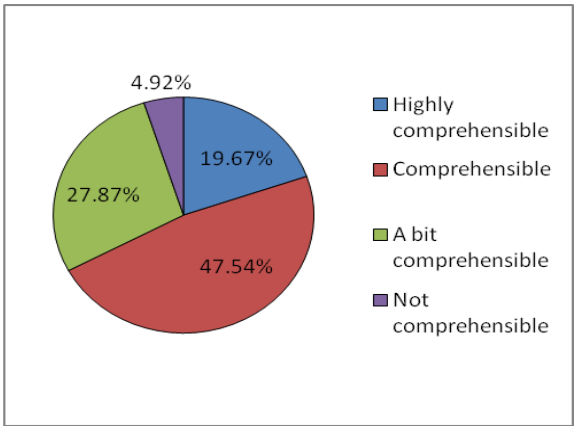

Figure 5. Comprehensibility of CBL among Form III students

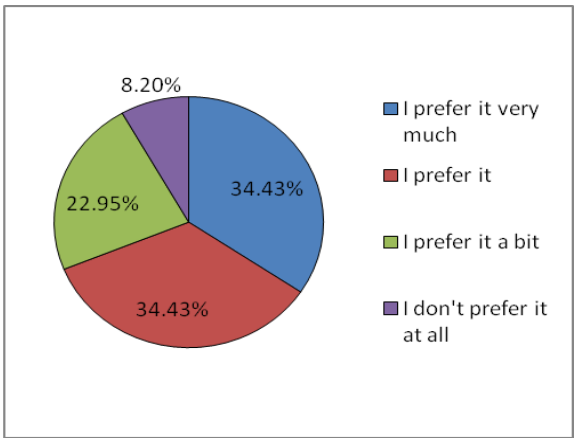

Figure 6. Preferability of CBL among Form III students

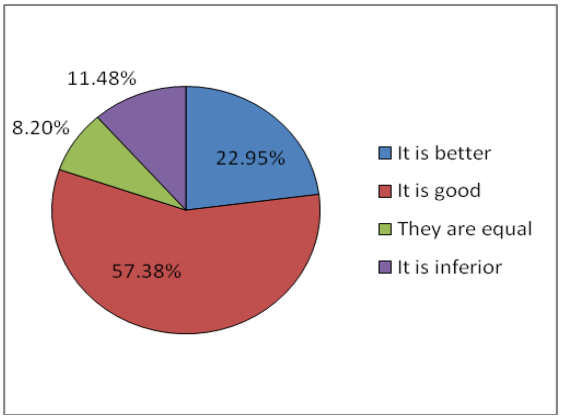

Figure 7. Ranking of CBL by Form III Students

From the class experiment, results for Form IV students (n=63) as summarized in Table 1 reveal that the mean score for the pre-test was 43.23% and that one for the post-test was 46.41%. Although this shows an improvement in performance, the difference is not statistically significant at the 95% confidence level (two tailed z-test, $|z| = 1.117$).

Regarding Form III students (n=66), statistical data as summarized in Table 2 show that the mean score for the previous weekly test was 23.31% and that of post-test were 18.02%. These results show that the performance in post-test was poorer than the previous weekly test. However, the difference in performance is not statistically significant at the 95% confidence level (two tailed z-test, |z| = 1.729).

Table 1. Summary of Form IV results

Tests	N	Total scores	Mean	STD	Z
Pre-test	63	2724	43.23	14.375	-1.117
Post-test	63	2924	46.41	17.373	

Table 2. Summary of Form III results

Tests	N	Total scores	Mean	STD	Z
Previous weekly-test	66	1539	23.31	14.665	1.729
Post-test	66	1189	18.02	20.140	

6. Discussion

Students' performance, students' attitudes towards CBL, teachers' attitudes towards CBL, the role of computer literacy and combination of CBL with face-to-face approach were examined in this study.

6.1. Students' performance

With regards to students' performance, the results did not show significant statistical difference. This could be attributed to the short time that the students were exposed to the method. It was evident that CBL could be used to mitigate the shortages of teachers and books in places where this content could be deployed offline. Currently, there is a huge investment in books and internet connectivity. These results suggest that more benefits could be obtained if offline CBL was considered as an alternative or a complement to books. CBL seemed to be accepted as highly comprehensible and preferable. Nevertheless, students proposed its use as a complementary approach to the face-to-face method, rather than a substitute. This could mainly be due to the lack of direct interaction with the digital teachers and the fact that English which was the language used in videos, is a second language for the Tanzanian students. It must be made clear that the percentage that demanded direct interaction is 12.8%. Though notable, this number is still small when compared to the percentage that did not find the method inadequate even without direct interaction.

6.2. Students' attitudes towards CBL

From the questionnaire most students were positive on CBL. Majority of students found CBL to be more comprehensible when compared to face-to-face. Similarly, the majority of students preferred and ranked CBL approach higher than face-to-face. These results may have been influenced by the novel nature of the approach. However, the competence of digital lecturer in delivering the content might have contributed.

6.3. Teachers' Attitudes towards CBL

It was observed that teachers liked to use digital content as a complement to the books and as an aid to preparations before class presentations. However, teachers were reluctant to engage CBL method as a possible alternative to their class sessions. Of the two teachers who were involved in the experiment, no one reported to have arranged students to use CBL as an alternative to his lectures. Moreover, no one reported to have encouraged students to use video content as a means for self study. The possible explanation could be that teachers considered the CBL lecturer, left alone with students, to be a rival rather than an assistant.

6.4. Basic Computer Skills

It is obvious that elementary computer skills constitute an added advantage for CBL users. However, the study showed that basic computer knowledge is not a necessary condition for effective deployment of CBL. Students who had prior computer knowledge did not demonstrate any extra enthusiasm towards CBL when compared with those who had no prior exposure. This is a very serious issue to be noted because more investment is being directed towards basic computer skills instead of investing on the immediate use of computers for delivery of the digital content.

As a precursor to web learning and M-learning, offline CBL proved to be an acceptable method to the majority of the students. If it is sufficiently utilized, there is a possibility that even the students who had no interest in it will get used to it.

7. Conclusions and recommendations

Online or offline CBL mode is about addressing diversity. It is about adopting educational practices to accommodate dispersed populations, differences in circumstances, and educational needs that do not conform neatly to same-type same-place approach. The lack of consistency in the meaning attached to the basic terminology pertinent to educational technology has affected research, design, deployment

and utilization of the technology in education. The adverse effect has been the underutilization of the technology especially in underdeveloped countries such as Tanzania.

In this research, emphasis on using offline CBL as a means for distance learning is made. This can be achieved through various means; flash disks, compact disks, DVDs, etc. Furthermore, it is concurred with Hall [18] that e-Leaning is one way of delivering and acquiring education a distant. Internet connectivity is linked with online learning and web learning but it is not a necessary condition for deployment of CBL or e-Learning or distance learning.

Offline CBL is a method which is already well developed and can effectively be deployed in places where internet connectivity does not exist. It was found that combining offline CBL with face-to-face is more effective than deploying CBL alone. The claim that using Kiswahili (local language) in tandem with CBL as an instruction language could improve the level of understanding was echoed. The main emphasis, in future, should be producing parallel Kiswahili translations for all English videos in order to provide students with two alternatives.

Web learning will require optimal power supply, permanent internet connectivity and proper network management. To surmount these hurdles in the current Tanzanian context, enormous resources will be required, which is next to impossible. Since less than 15% of the students demanded an interactive component to the lectures -which is an indication that offline mode is a possible alternative for deploying digital content- full connectivity will lead to loss of the opportunities offered by offline CBL. While efforts towards internet connectivity must continue, more focus should be on deployment of CBL offline instead of basic computer knowledge and interactive classes. In the long run, M-learning would be an easier and more effective alternative because it relies less on optimal power and local network management. There is evidence that if emphasis is directed in deploying CBL offline, benefits will be quick and enormous.

Future works will focus on blending the current content with parallel Kiswahili translations, preparing adequate digital content which is commensurate with Tanzanian syllabus and deploying digital content using domestic televisions as means for mitigating the impact of insufficient books and teachers. Possibility to design and develop small devices for deployment of digital content must be explored.

8. Acknowledgments

We would like to express our appreciation to the Management of Saint Benedict Secondary School of Hanga in Songea, and the Mathematics teachers, Mr. N. Sanga and Mr. J. Luvunzu, from the same school, for their cooperation during the experiment and data collection.

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