Challenges of Learning Mathematics by Distance a Case Study of Public and Private Universities in Zambia

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Abstract: ***Zambia has experienced an influx of institutions and Universities opening in every district. The tertiary education expanded from three public Universities and one private to over eight public Universities and over 100 private tertiary education in the last decade. The demand for tertiary educationin the last decade has grown so much that institutions are being opened in almost every district and all of them offer distance learning. The article explores students' perceptions of open and distance education in Zambian Universities. A total of 120 students (90 male and 30 female) represent the study sample. The results obtained indicated that respondents rated the quality of materials, feedback from instructors, periods for residential where all rated fair to poor with 48.3% to 51.7%, 41.7% to 58.3%, and 43.3% to 56.7% respectively. The p-values of the quality of the material were 0.897, feedback was 0.245, a period of residential school was 0.366, and all p- values indicated that the null hypotheses of no difference are retained. The categories of test results given between universities occurred with equal probabilities using one sample Chi-square test gave a p-value of 0.997, means to retain the null hypothesis of no difference in performance between Universities. The test results between full-time students and distance results gave a p-value of 0.000, means there is a significant difference in performance between full time and distance students.***

Keywords: distance learning, students' perceptions, ANOVA, ODL, feedback

1. Introduction

Distance education has emerged as an alternative education in nearly every corner of the world. Developed and developing countries use distance education as a potent tool for the development of human resources. Developed countries use technological advances which creates an opportunity to design innovative and influential environments to support a wide variety of learning based on constructivist learning theories. Online learning is growing exponentially in the U.S. with web-based programs, internal communication systems to ensure quality delivery of materials to learners [2]. Digital collaboration courses which include theory and practice in order to get quality teaching instructional design which supports learning from student input, student feedback and instructional intervention schemes to guarantee quality education [6]. The demand for the trained workforce is so high that the traditional institutions are failing to meet the demand distance learning become an alternative to cope up with the demand. However, in designing distance learning, cultural and linguistic issues needs to be put into considerations. Pedagogical methods, mode of learning, communication styles need to be addressed in the design in order to address potential obstacles to distance teach [4]. Technology in course design and instructor's actions are essential to successfully achieve set goals in online learning [5]. Perceptions of teacher training of distance learning were evaluated in Ethiopia, and the results indicated that that distance learning was rated from moderate to poor in material delivery and feedback to learners [7].Mobile technology is the next generation of distance learning which occurs at anytime and anywhere which can influence learning in a variety of contexts [8].Technological advances and especially in the use of Internet including video conferencing have developed such that new paradigm on education, teaching has gone beyond the solid walls of schools and characterized by mobility to enhance e-learning in mathematics by distance [1]. Distance learning is learning at a distance they are physically and temporally remote from one another and their instructors. It has the following advantages: Convenient to candidates, Easy access, no transport required to school, and one can learn from anywhere, Learn on schedule and manage time.

However there are also disadvantages such as classroom environment is missing, you may have no access to internet or equipment, you have access to questioning if a need arises, there is no real time participating in learning, there is no hand on training, the absence of feedback and no social atmosphere which may prohibit motivation.

In Zamia many tertiary institutes which offer distance learning depends on modules which are given to students at the time of registration, and there is a residential school of minimum two weeks and some maximum of four weeks. This period students are expected to cover the course material of 56 hours in 10 hours during their residential school. This is the general model used by all institutes which offer distance in any course including mathematics. The University of Zambia uses a program called ASTRIA which is used for instructors to upload learning materials to students, receives assignments and mark and return marked papers to students. Students download and uploads assignments, this model does not give interaction between instructors and students. The rest of the institutes even when University who indicate they use e-learning, the systems do not provide interactions between instructors and students other than uploading modules to students.

2. Research Focus

In this study, the perceptions of students learning mathematics by distance were analysed using variables such as quality of materials delivered, support from institutes, and feedback from instructors, communication with institutes, how students find mathematics doing it by distance and how students manage their time. These are the core components of learning which can help students build a conceptual understanding of mathematics.

3. Materials and Methods

The survey was conducted using aquestionnaire structured so that respondents are given a chance to give their personal opinion in the way distance learning is being organized. 60 students volunteered to answer the questionnaires from three Universities of which two where public Universities and on private University. There were 20 students from each University, and there were 41 males and 19 females who participated in the survey. The questionnaire had questions range from material delivery, clarity of materials, and feedback from instructors.

A test was conducted for all candidates on distance from three Universities, and the same test was conducted with full-time students at the University of Zambia. The responses and test results obtained were used for this analysis.

Descriptive statistics were used to find necessary statistics, perceptions of students were expressed as percentages and also tested for the null hypothesis (H_o) of no difference in opinions between covariates of interest were tested using; nonparametric methods and ANOVA between Universities and between locations.

4. Results and Analysis

In this study, 16.7% of respondents were from urban areas, 30.0% from Peri-urban areas and 53.3% from rural areas. In this study, 60 respondents participated in the study from two public Universities and one private University in which 41 were males and 19 females. The ANOVA (analysis of variance) table 1 on the Universities versus locations gave the F-value of 0.201 with two df for between groups, 57 df for within groups and a p-value of 0.818. This is interpreted as there is no difference in opinions between universities and locations, in the way students perceives mathematics is learning by distance.

Table 1: The ANOVA Table of the name of University versus location

			Sum of Squares	df	Mean Square	F	Sig.
name of the university * Location	Between Groups	(Combined)	.281	2	.140	.201	.818
	Within Groups		39.719	57	.697		
	Total		40.000	59			

Figure 1 below shows the distributions of respondents by locations from different Universities. It can be observed that the distributions of students in universities from different locations are not significantly different.

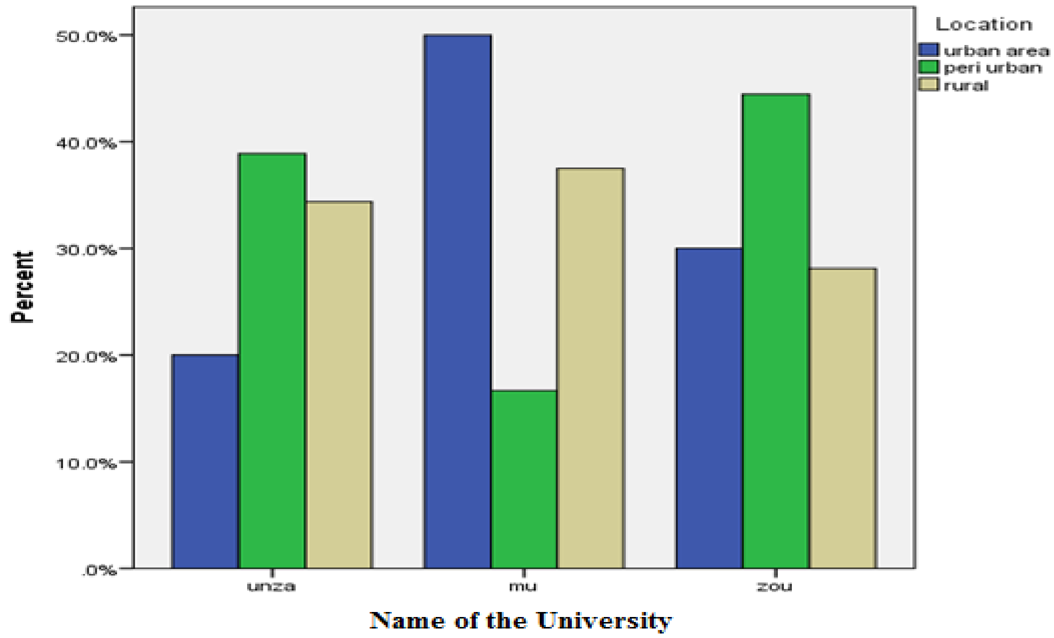


Figure 1: The distributions of students into universities by locations

4.1 Quality of Materials

The critical issue to be addressed in ODL (open and distance learning) is the extent and manner of support offered to learners. There are many factors which can be combined to influence the level of support which is appropriate. Learners need access to help guide through the sticky patches of learning. One of the main learner support is quality of materials given to students. The quality of materials where assessed and the following results were obtained.

The results on the quality of materials given to students by institutes indicated that the Universities and locations were rated on the quality of materials from fair to poor with 48.3% to 51.7% respectively on studying mathematics by distance.

The ANOVA table 2 on locations versus quality of materials with one df for between groups and 58 df for within groups give F-value of 0.306 and a p-value of 0.582. This is interpreted as the null hypothesis is retained. That is, there is no difference in the way students perceived the quality of materials given in mathematics by distance, as being of poor quality.

Table 2: The ANOVA Table for location versus the quality of materials given to students

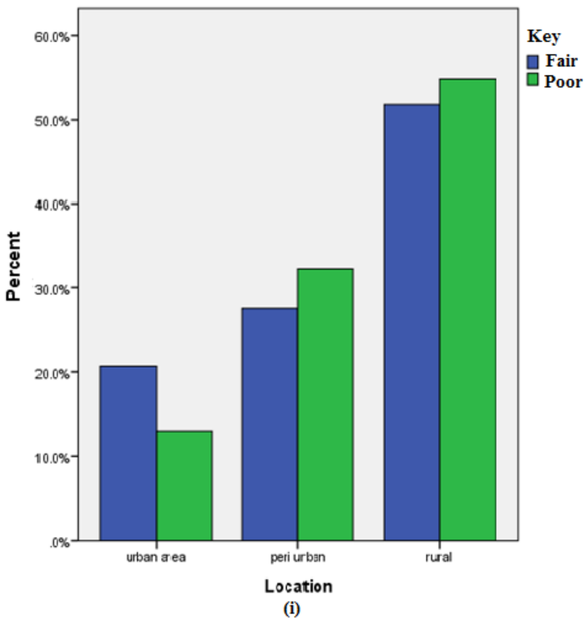
			Sum of Squares	df	Mean Square	F	Sig.
Location * Rate of quality of Material	Between Groups	(Combined)	.178	1	.178	.306	.582
	WithinGroups		33.755	58	.582		
	Total		33.933	59			

The ANOVA table 3 on Universities versus quality of materials with one df for between groups and 58 df for within groups gives F value of 0.097 and a p-value of 0.757.This is interpreted as retaining the null hypothesis. That is there is no significant difference in the way students perceive the quality of materials given in mathematics by distance, as being of poor quality.

Table 3: The ANOVA Table of the name of the University versus quality of materials given to students

			Sum of Squares	df	Mean Square	F	Sig.
name of the university * Rate of quality of Material	Between Groups	(Combined)	.067	1	.067	.097	.757
	Within Groups		39.933	58	.689		
	Total		40.000	59			

Figure 2 below shows the distributions of students rating on the quality of materials in mathematics studying by locations (i) and by Universities (ii). It can be observed from the histograms that there is no difference in the way students perceive the quality of material either between locations or between universities.



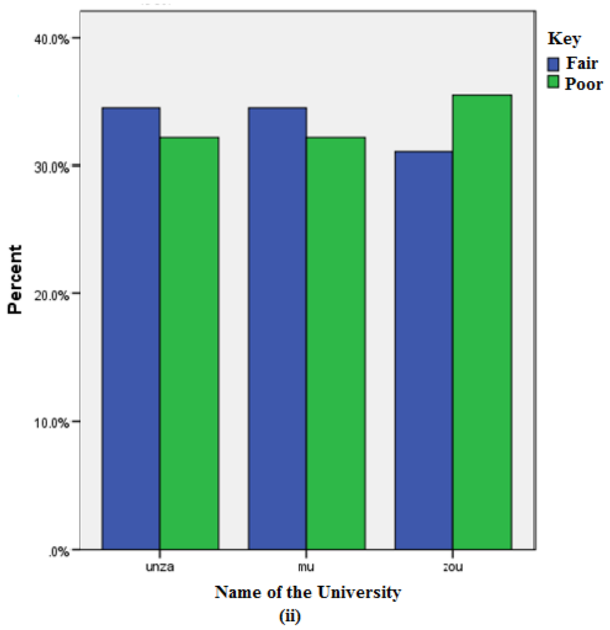


Figure 2: The distributions of students' responses to quality of materials by location (i) and by Universities (ii).

4.2 Feedback from instructors

Feedback is the essential component in education and training programmes. It helps learners to maximise their potential at different levels of training, identify their challenges and areas of improvement, and identify actions to be taken to improve performance. Students on distance learning may not know whether they are "on the right track" in their studies if feedback is not given to them. In this study feedback from instructors where assessed and the following results were obtained. Respondents rated feedback from instructors as fair to poor with 41.7% to 58.3% respectively.

The ANOVA table 4 on location versus feedback with one df for between groups and 58 df for within groups gave F value of 0.003 and a p-value of 0.955. Which is interpreted as retaining the null hypothesis. That is there is no difference in the ways students perceive feedback from their instructors as being poor.

Table 4: ANOVA Table of the perception of students rating of feedback by locations

			Sum of Squares	df	Mean Square	F	Sig.
Location * feedback from instructors	Between Groups	(Combined)	.002	1	.002	.003	.955
	WithinGroups		33.931	58	.585		
	Total		33.933	59			

Figure 3 shows the distributions of responses on how students rated the feedback by instructors from their respective Universities. It can be observed that students in rural areas are more affected than those in urban areas. The rating of feedback from rural areas on feedback is above 50 percent as poor while those in urban areas rated feedback below 20 percent. Generally, it can be observed that feedback was rated from fair to poor.

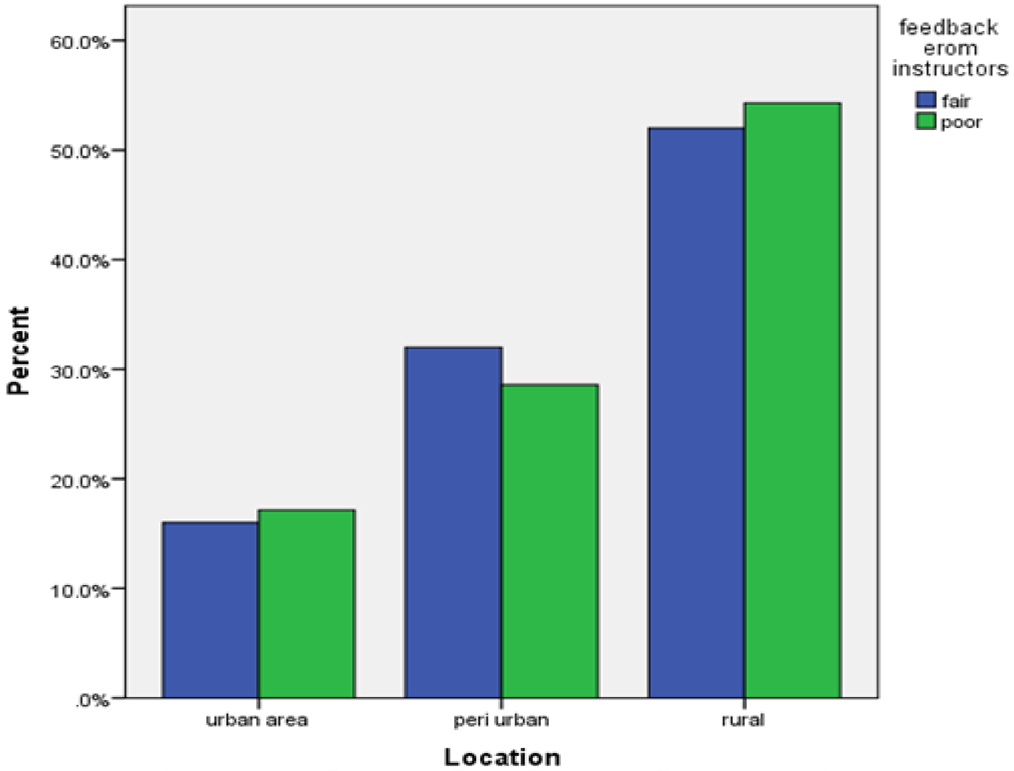


Figure 3: The bar chart of students' rating of feedback from instructors

4.3 Communications of students with the Institutes

Communication between the student and the institute is critical in distance learning. Students need a voice if they are to be fully engaged in a course, it does not matter whether traditional or online. This communication should not be one way if communication is to be effective. Students are more likely to become disengaged in ODL courses if there is no communication with their instructors and fellow students [3]. The success of the ODL courses depends on how the institute and students interact relating to the course material on online courses. However, institutes should construct communication opportunities that take different learning styles into consideration such as: Listen to what students say to each other and instructors and learn from each other and the institute should decide whether to use synchronous (everyone participating at the same time) or asynchronous (participants log at different times) communication taking into account of their objectives for students' interaction.

The results obtained on how students communicate with the institutes indicates that 25% of the students use post office to receive and submit assignments, 26.7% of the students travel to the institutes, 6.7% use phones to communicate with the institutes, 6.7% use internet for communication, and 35% indicated there were no communications with the institutes.

The ANOVA table 5 on location versus communication with institute with four df for between groups and 55 df for within groups gave F value of 1.721 and a p-value of 0.159. Which is interpreted as retaining the null hypothesis. That is there is no difference in perceptions of students from different locations about communication from institutions.

Table 5: ANOVA Table of the students' mode of communication with the institutes

			Sum of Squares	df	Mean Square	F	Sig.
Location * Communication with Institute	Between Groups	(Combined)	3.774	4	.944	1.721	.159
	WithinGroups		30.159	55	.548		
	Total		33.933	59			

The histograms in figure 4 illustrate different modes of how students communicate with the institutes. It can be observed that students in rural areas have no access to internet mode of communications and depends on post office with about 60% of them depends on the post office and above 50% indicated that there were no communications between students and the institutes. The students in urban areas indicated a high percentage of students using internet with about 50 %, while those in rural areas indicated the absence of internet connectivity.

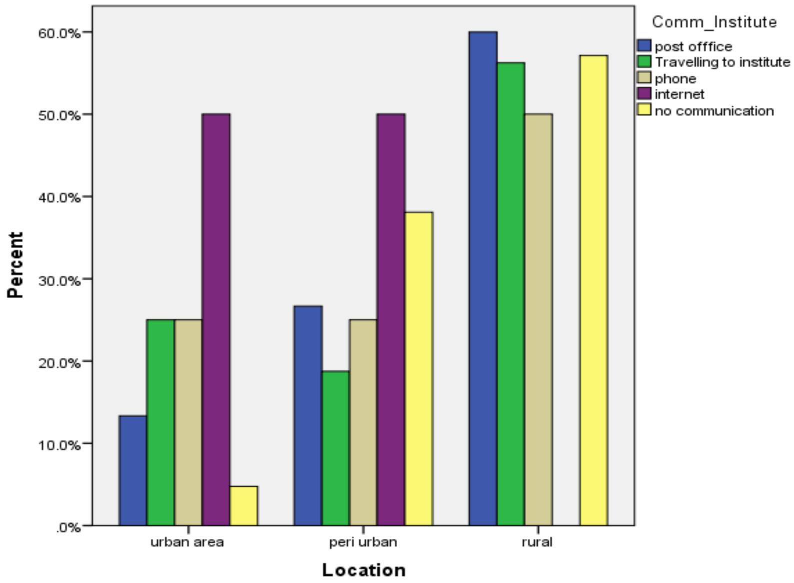


Figure 4: The bar chart of the distributions of how students communicate with the institutes

4.4 Rating of the residential school

The residential school is the only time students are given an opportunity to go to the Institute for four weeks or less to meet their instructors. This is the only time they meet their instructors before writing examinations in the courses they are studying by distance. It is expected that during this period instructors and students go through the course materials and help students understand areas of challenges they face while studying alone. Many Institutions at present run a two-week residential school instead of four-week.

In this study, the residential schools were assessed on whether it achieves its intended goals. Residential school was rated fair to poor with 43.3% to 56.7% respectively. The ANOVA table 6 on location versus a residential school with institute with one df for between groups and 58 df for within groups gives F value of 1.429 and a p-value of 0.237. Which is interpreted as retaining the null hypothesis. That is there is no difference in perceptions between students on how they rated the residential school as fair and poor.

Table 6: ANOVA Table of location versus residential school

			Sum of Squares	df	Mean Square	F	Sig.
Location * Rate residential School.	Between Groups	(Combined)	.816	1	.816	1.429	.237
	Within Groups		33.118	58	.571		
	Total		33.933	59			

Figure 5 below illustrates a histogram of the rating of residential schools by students. It can be observed that all students rated residential schools from fair to poor. That is students were not satisfied with the way institutions to organise their residential schools.

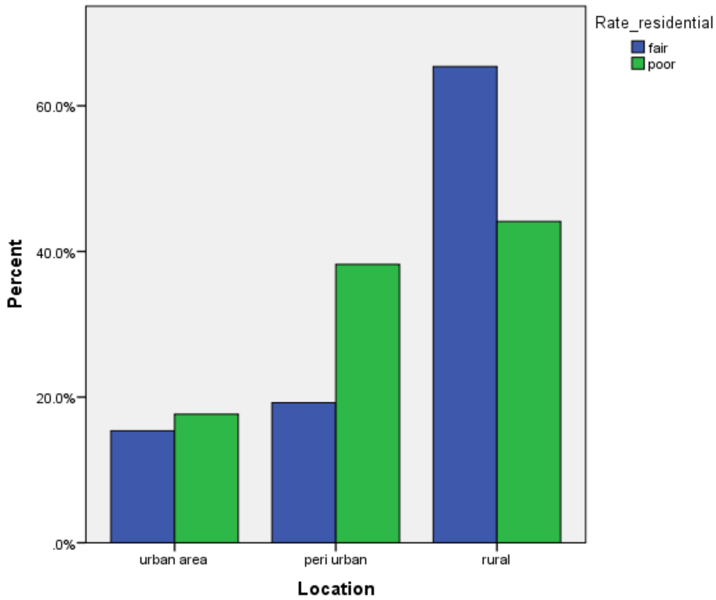


Figure 5: The bar chart of the rating of the residential schools

4.5 How students manage time

Time management is essential for distance students because of the flexible nature of the study. This is because distance learning has to fit into a busy life and the distance from class and other students who are there to help are far from each other. It is crucial that distance students must use their time wisely. Results obtained indicated that 6.7% of students study at night, 20.0% of students study during the day, 33.3% of students study during work, and 40.0% of students indicated they do not find time to study. The ANOVA in table 7 with three df for between groups and 56 df for within groups gave F value of 3.795 and a p-value of 0.015. This indicates that the null hypothesis was rejected. That means there was a difference between students on how students manage their time in studying mathematics at a distance.

Table 7: ANOVA Table on location versus how students manage their time

			Sum of Squares	df	Mean Square	F	Sig.
Location * how you manage time	Between Groups	(Combined)	5.733	3	1.911	3.795	.015
	WithinGroups		28.200	56	.504		
	Total		33.933	59			

The figure6 below shows the distributions of how students manage their study time from different locations. It can be observed that students differ in the way they manage their time when studying by distance. It can be seen that students in rural do not study at night as they only study during the day because most Zambian rural areas are not connected to the national electricity grid.

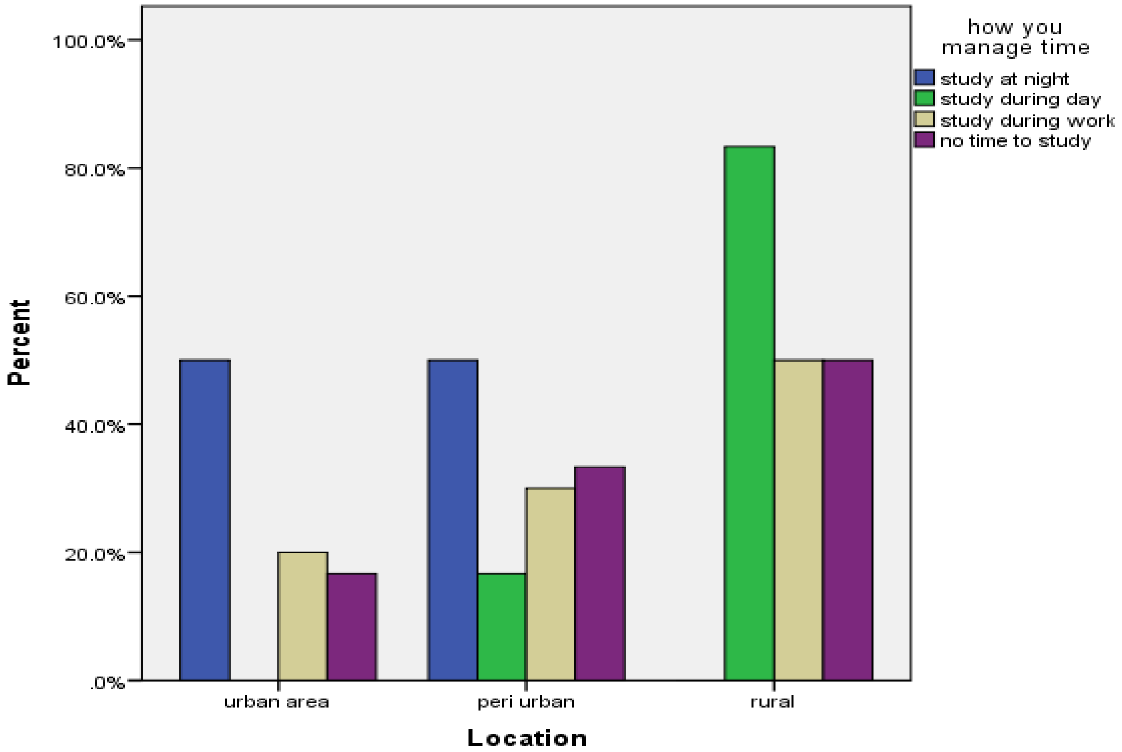


Figure 6: The bar chart of how students manage their study time

4.6 How do students find studying mathematics at a distance?

ANOVA in table 8 with two df for between groups and 57 df for within groups gave F value of 7.800and a p-value of 0.001 which means that reject the null hypothesis which states retain the null hypothesis and accept the alternative hypothesis. That is there is a significant difference between respondents in the way they perceive studying mathematics at a distance.

Table 8: ANOVA Table on how students find studying mathematics by distance

			Sum of Squares	df	Mean Square	F	Sig.
Location * How they find Studying Maths	Between Groups	(Combined)	7.291	2	3.646	7.800	.001
	WithinGroups		26.642	57	.467		
	Total		33.933	59			

Figure 7 below shows the histogram of the respondents on how they find studying mathematics at a distance. Students in rural areas where resources are limited rated studying mathematics at a distance as tricky as learning resources materials are not readily available. However, students in urban areas rated it as fair because they have access to resource materials such as libraries, internet connectivity and help from institutions available around.

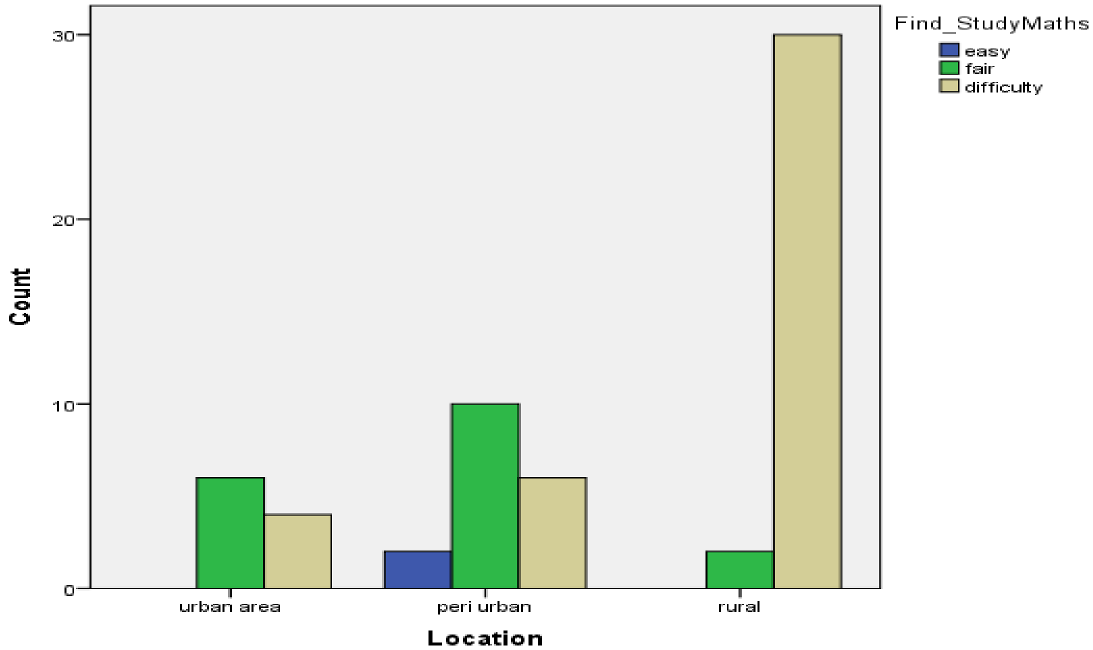


Figure 7: Bar chart of the distribution of how students find studying mathematics by distance

5. Discussion

Solving a mathematical problem or speed completing computational tasks or carrying out routine symbolic manipulations is not learning or teaching mathematics. Other people, still have a narrow definition of mathematics as computation and symbolic manipulations. However, the goals of learning mathematics are multidimensional and balanced, and students must develop a deep conceptual understanding (why), coupled with procedural fluency (how), they also need the ability to reason and apply mathematics (when), and develop a positive mathematics identity and high sense of agency. These goals are critical components of what it means to be mathematically literate in the 21st century[9]. Conceptual understanding is knowing more than isolated facts and methods. Students' understands mathematics ideas, able to transfer their knowledge into new situations and apply it to new contexts. Students need to be engaged actively so that they embrace their mathematics journeys and be empowered by mathematics in their lives. The learning principle states that: 'students must learn mathematics with understanding, actively involves in developing new concepts from experience and previous knowledge.' The results obtained, do not indicate that it is possible for students to learn with understanding, actively built new knowledge in such an environment. Institutes do not provide quality materials as these materials were rated fair (48.3%) to poor (51.7%). Support from institutes was rated fair (53.3%) to poor 40%). Feedback from instructors was rated from fair (41.7%) to the poor (58.3%). The educators would not even know whether students are learning with understanding as communication between students and institutes as respondents indicated that communication is through post office (25%), students travel to the institute (26.7%) and 35.0% indicated there is no communication with the institutes. The assessment principle states that 'Assessment should support the learning of important mathematics and furnish useful information to students.' It is not clear on the constraints put on assessment in such an environment. The issues which should be considered when developing valid assessment tools are not spelled out in these distance programmes. The Technology principle states that 'Technology is vital in teaching and learning mathematics; Technology used must be interactive so that it influences the mathematics that is taught and enhances student learning. Use of e-learning by sending material via the internet to students in which students downloaded and expected to read alone (which is the model used in Zambia) is not the way to go. The e-learning model used should be interactive such as video conferencing such as multipoint video conference, desktop video conference, immersive telepresence, online video conference, video conference etiquette, and home video conference. Video conference to everyone to meet at the same time regardless of time, location and no travel cost. Video conference saves time, and it is easier to have interactive comments from teacher to teacher, teacher to classroom or classroom to classroom with students in a different location across the globe. It is so challenging to develop mathematics knowledge if there is no interaction with an instructor. In mathematics, there is a lot of symbols and notations which need to be explained during the study. Three scenarios are presented here:

Scenario 1: Take for example pi (π) this is learned as equal to $\frac{22}{7}$ in elementary mathematics, later it is taught that π is an irrational number hence it cannot be written as $\frac{a}{b}$, where $a, b \in Z$ and $b \neq 0$ if expressed as decimal the decimals do not terminate or repeats. So this looks like a contradiction from a previously learned concept. The same π can be used in different contexts, such as $\pi(x)$ in which $\pi(x)$ is considered as a function of x where in here calculus is interested in studying the behaviour of this function where the domain, range, stationary points, increasing and decreasing interval are of interest. If the notation changes to

$\pi(\vartheta)$ in this context, pi theta is now a probability distribution in statistics/Bayesian statistics and probability theory. This is entirely different from the interpretation of the same in calculus. The question is how students studying alone would manage to make the distinction between all these different contexts in which pi is being used.

Scenario 2: During the study of Binomial expansion, the coefficients are calculated as $\binom{n}{r} = \frac{n!}{(n-r)!r!}$ the same formula is used in probability under counting procedures when counting some ways n objects can be rearranged taking r at a time where the order is not essential. The formula used to find some ways an event can occur is $\binom{n}{r} = \frac{n!}{(n-r)!r!}$. The formula is the same but interpreted differently depending on the context it is being used. Students may not see the difference between the two distinction use of notation and symbolism here,

Scenario 3: Take an expression $\binom{n}{r-1} = \frac{n!}{(n-r+1)!(r-1)!} = \frac{n!r}{(n-r+1)!r!}$ to understand that the last two expressions are equal may not be easy for a student to pick it asthis is the application of the factorial definition. The logic requires a good understanding of the definition of factorial.

Scenario 4: The expression $\frac{1}{x+1} = 1 - x + x^2 - x^3 + ...$ for students to understand how the given rational expression becomesan infinity series may not be straightforward if there is no interaction between the Instructor and the learner. To understand the concepts required, the knowledge of indices, knowledge of factorial definition, binomial expansion for rational/negative powers are required.

Scenario 5: Take for examples on some concepts of general mathematics; $\frac{0}{0} = ?$ $\frac{1}{0} = ?$ $\sqrt{-4}$ 5^0 0^0 and the distinction between 0 as an integer and o as a letter in the English alphabet, symbols such as ε $\delta, \chi, \eta, \varpi, \xi, \tau, \zeta$ these are standard symbols used in mathematics. Whether students would make sense of these symbols alone, an educator may not be sure because these symbols are used in different contexts and different fields of mathematics.

Scenario 6: If a student is asked to evaluate $\sqrt{4}$, different answers may come up because of the understanding that the signs on a square root do not come from inside of the square root sign but from outside. That needs an interactive mode of communication.

These concepts given above cannot be understood by reading mathematics alone, and as a practical subject, practice becomes easy if a student is guided. Many of these institutes offering distance learning have no mode of delivery in place which is interactive, and regulators such as Teaching Council of Zambia, TEVETA and Higher Education Authority approves such programme even when there is nothing in place for distance learning.

6. Conclusion

The teaching of mathematics by distance poses a significant challenge anywhere in the world if the mode of delivery of learning materials is not interactive with the learners. Video conferencing of any form gives learners a chance to interact with instructors, and this gives the student a conceptual understanding of mathematics which cannot be achieved by using any mode of delivery. The only mode which can be used in teaching mathematics by distance is by the using an interactive e-learning mode which involves any form of video conferencing. Any other mode used may not achieve the desired goals of teaching mathematics by distance.

7. Recommendations

It is recommended that the regulatory bodies in Zambia (Higher Education Authority, TRVETA, Teaching Council of Zambia, and Qualifications Authority) must ensure that all colleges and Universities who intends to offer mathematics by distance must use interactive mode of material deliveries.

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