The effects of class size on the delivery of quality mathematics learning in secondary schools.

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Abstract

The Education For All (EFA) agenda at independence in Zimbabwe led to a massive expansion of education in order to avail educational opportunities to marginalized black children. This has not been coupled with the adequate provision of teaching and learning resources, consequently this has led to overcrowded classrooms. The purpose of this study is to examine the effects of overcrowded classrooms on mathematics learning and how these challenges can be overcome. Interviews observation, and analysis of learner exercise books and examination results were used in the qualitative approach. The study revealed that, secondary schools are overcrowded to levels where teachers are failing to provide quality in teaching and learning of mathematics. It was also found that this problem is exacerbated by lack of resources such as mathematics teachers, textbooks, classrooms and furniture among others. For policy and decision-making processes, the study recommends the government gather relevant and reliable data about the learning conditions in secondary schools. There is also need for effective collaboration among all the relevant stake holders who have the responsibility to provide resources to schools. It is further recommended that digital and e-learning technologies should be incorporated as alternative ways to manage large classes.

Keywords: Class size; Quality mathematics learning; Students' performance; Economic constraints.

1. Introduction

Developing countries have faced significant challenges in the delivery of quality mathematics learning in secondary schools, as represented by low pass-rates in mathematics examinations. Public examinations tell a story about performance because they play an important role in defining and monitoring educational standards (Kellaghan & Greaney, 2019). According to Akrofi, Janisch, Lesley, Griffith and Liu (2007), school success is determined by high passing scores in examinations. Evidence from the Zimbabwe national examination results reveal that performance in mathematics has never exceeded 23% during the past five years for 'O' level mathematics results (Zimbabwe School Examinations Council, 2020). This problem of low mathematics performance is attributed to a wide range of factors which include, among others, the problems which mathematics teachers face in handling large classes.

After independence in 1980 the government embarked on mass education to avert the ills of the colonial epoch, which had denied educational opportunities to black children. This led to a dramatic increase in enrolments and

secondary schools increased from 189 to 2980 secondary schools in 2020 (Zimbabwe National Statistics Agency 2020; Zvobgo, 1986). The Education for All (EFA) agenda is what triggered this massive expansion in education which has subsequently led to overcrowded classrooms.

It is government policy that all learners after completing their primary education must automatically be promoted to secondary education despite their academic performance. (Ministry of Primary and Secondary Education,2019). The rapid expansion in education is not necessarily the problem because the aim is to avail educational opportunities to all school going children since education is a universal human right. This quest for education has not been accompanied by adequate teaching and learning resources such as mathematics teachers, textbooks, classrooms and other essential learning materials (Nyagura, 1993). Consequently, this has led to a crisis in the delivery of quality in mathematics education and in turn provision of education especially in mathematics learning has become commercialized with the sprouting of private colleges and extra mathematics lessons in and around the local communities (Munikwa & Mutungwe, 2011).

We pursue this study by exploring the concept of class sizes, we find that as we read the available literature, there are diverse perspectives and we deliberate on these assumptions as key issues in this study. In brief some researchers (such as Nizamettin & Bekir, 2014 and Kadri & Souad, 2015) assume that large classes are less productive in relation to student performance. Several studies have refuted this claim, for example Torberg, Astrid & Bjarne (2015) did not find any significant average effect on long run outcomes of reduced class size. We grapple with these issues and more in this study with specific consideration of our particular context. The issues of context are fundamental because there is need to collect relevant and reliable data to draw authentic conclusions upon which recommendations can be made. We need to strongly bear in mind that mathematics is essential for nurturing skills and competencies that are relevant for socio-economic development (Valero, 2017).

1.1 Purpose of the study

School overcrowding is linked to factors which hinder the effective delivery of quality education. The purpose of this study is to essentially examine the effects of overcrowded classrooms on mathematics learning and how these challenges can be overcome. In view of this, the research addressed three questions:

a) What are the factors behind school overcrowding in secondary schools in Glenview-Mufakose district in Harare Metropolitan province?

b) What are the effects of class size on students' and teachers' performance in mathematics learning in the classroom?

c) What are the benefits of small class sizes on mathematics learning?

1.3 Review of related literature

In general, a school is said to be overcrowded if the number of enrolled students exceeds the number of students that the school is able to handle given the available teaching and learning resources, as well as when the student

teacher ratio exceeds the recommendations of a countries' education policy (Kadri & Souad, 2022). However, discussions about how big or small a class should be have continued to be made in different parts of the world. As such, some researchers have recommended the provision of small class sizes because of several marked advantages. Smaller class sizes can provide favorable conditions for teaching and learning (Nizamettin & Bekir, 2015). In smaller class sizes teachers have the opportunity to provide individualized support to every child so as to satisfy the learners' psycho-social needs (Johnson, 2011). In this regard teachers are able to employ learner centered learning such as group work, simulations and case studies (Wright, Bergon & Bartholomew, 2019).

Causes of overcrowding and the effect of class size

Causes of overcrowding in schools include transfer of construction of new schools to local governments where resources are limited due to a rapid increase in the school age going population, lack of infrastructure, lack of accountability, teachers and school managers increasing enrolments to improve their salaries, budgetary constraints, policies on free and compulsory basic education, political problems and government strategies (Kadri & Souad, 2022). Overcrowding hinders the effective management of time and tasks by teachers and it also causes school violence, spread of contagious diseases and school wastage (Kadri & Souad, 2022). Several research findings relating to class size studies have concluded that large class sizes are associated with significant challenges such as lack of effective classroom management and control, inability of teachers to carry out effective continuous assessment activities (Barde, Ahmed, Mohammed, Bizi, Ibrahim & Uzoma, 2021).

Some researchers like Mueller (2013) claim that small class sizes are only productive with high quality and experienced teachers. The extent to which class size is productive may vary from subject to subject as alluded to by Blatchford, (2003) who says that class size affects the academic achievement of learners in mathematics and literacy. Barnett, Schulman and Shoe (2004) found that small class sizes and better staff-child ratios offer health and safety benefits. Small class sizes may help to reduce crowding effects such as noise, disorder and disruptions hence teachers may be able to spend more time on each student. Spending more time on each student enables teachers to increase students' motivation levels which researchers like Halawah (2011) found to be significant in students' learning. Zaccone and Pedrini (2019) states that students motivated intrinsically show good academic performance and achievements as compare to those motivated extrinsically through external factors like good grades and other attractive prizes. In cases of large classes, it is difficult for teachers to understand the individual needs of students and hence, they may not be able to motivate the students properly for learning. In case of small-sized classes, teachers are able to easily know the needs of students such as the nature and intellectual levels of learners (Aamir, Ullah & Kaleem, 2021).

In motivated instructional settings, moral and enthusiasm of teachers is high than in tense instructional situations where teaching becomes ineffective (Aamir, Ullah &Kaleem, 2021). Shah & Inamullah, (2012) found that noisy

environments affect listening, reading and instruction from teachers. However smaller classes cost more, while the costs are easy to measure the benefits may be difficult to see and measure without rigorous research (Barnett, Schulman & Shoe, 2004). It was found that small class sizes are linked to high rates of graduation and lower levels of delinquency (Barnett, Schulman & Shoe, 2004). On the other hand, large classes could benefit learners if being in a large class affords a student the chance of finding another student whom they can interact with such as students with the same academic abilities. Asqalan, Hijazi & Al Natour, (2016) found that teaching large classes is problematic, but they recommend conducting further research in class size context. Studies by Chang & Taxer, (2020) revealed that students' misbehavior disrupts the learning environment. Torberge, Astrid & Bjarne, (2015) argue that reduced class size does not have any significant effect on students' performance, extra resources and reduced class sizes are effective tools in some contexts while ineffective in other contexts. This is because some of the researchers have based their arguments on test scores which may be highly subjective. In this context other researchers claim that test scores measure cognitive skills while class sizes may affect non cognitive skills which are difficult to measure (Torberge, Astrid & Bjarne, 2015). Empirical data based on test scores may be biased in situations where teachers can manipulate test scores for personal goals (Torberge, Astrid & Bjarne, 2015). Based on the view that small class sizes can enhance productive learning in the classroom, several countries in Europe, China and Japan have made significant efforts to reduce their class sizes (Blatchford & Lai, 2012). For the OECD countries the largest class size at lower secondary school is 23 (Nizamettin & Bekir, 2015). Finland, Iceland and UK have class sizes of 19 or lower, Turkey, Korea and China have class sizes of 28, 34 and 54 (OECD, 2012). Kadri & Souad, (2022) found that according to UNESCO the teacher student ratio is 1 to 25. This is to ensure quality education for everyone. This implies that public schools in the world suffer from overcrowding.

Hiring more teachers is one of the ways to reduce a high student teacher ratio although it may be expensive. This could decrease teachers' workloads and make them to be more enthusiastic about their teaching and love their jobs (Nizamettin & Bekir, 2015). By nature, more inputs such as hiring more teachers could imply more production. This is not easy to ascertain because in a typical education production function, how can one measure productivity? If measurement is based on test scores, then what about non cognitive skills which may not be easily measured by test scores? On the other hand, if students' performance does not have any serious effects on decision making in an educational setting, then reducing class size may not be effective. Teachers and school principals might exploit resources for their personal gain.

Wang & Calvano, (2022) have noted that the debate about class size has continued to be contested and research on its impact on performance is inconclusive, mainly focusing on academic performance outcomes such as test scores but not addressing classroom dynamics, such as subjective educational outcomes such as student learning outcomes and satisfaction. Organisation for Economic Co-operation (OECD), (2012) has refuted the claims that large class sizes significantly affect students' learning in the classroom. Argues that though there is no empirical

evidence at hand to support this claim, class size is one of the tacit factors which affect learning in the classroom. A number of other studies have been conducted in the different contexts, in which the ratio between the students and the teacher has often been seen as an element that impacts the instruction. In general, it can be noted that with particular reference to cultural, social and economic fundamentals, a classroom setting reveals a broader picture of the inability to provide more classrooms, more teachers and more facilities. In support of this assumption other studies have alleged that small class size is an indicator of quality provision of educational facilities (Wright, Bergon & Bartholomew, 2019).

However, it is unclear whether improving the ratio between the students and the teacher is an important factor for the government to consider. Taking this into account, the current study is an attempt to determine whether bringing improvement in the students-teacher ratio positively influences the classroom instruction through the lens of motivation. It should also be noted that each study has targeted a particular culture and a specific context. That is why these generalizations may not suit the context of Zimbabwe. Hence, this study focused exclusively on the context of Zimbabwe more especially secondary schools in Glenview-Mufakose District.

2. Materials and methods

With particular reference to the purpose and objectives of this study, the need to gain a deeper understanding of the causes of large class sizes and the benefits of small class sizes most likely required the active participation of local communities, teachers and government officials during single and multiple participant interviews. This enabled these participants to freely express their views and feelings. Further, the need to examine the effects of class size on students' and teachers' performance in mathematics learning in the classroom, was achieved by collecting and analyzing data about specific quantities of students' written work. Analysis of documents i.e written exercises, local school and national examinations results in mathematics were used. This was also coupled with observation of mathematics lessons. Therefore, qualitative tools were used to collect and analyse data as recommended by several researchers who have carried out similar studies (For example, Merriam, 2009; Patton, 2002; Chirume, 2016; Mills & Gay, 2019; Aamir, Ullah & Kaleem, 2021). The researchers also used interview guides with open-ended questions to allow participants to express their views freely.

Meanwhile, for this study all 12 secondary schools in the district were sampled. From each class 10 exercise books for written work and tests were randomly selected from each class and at each level to determine the amount of work. Non-participant observation of mathematics lessons was carried out in order to understand how teachers and learners participated in learning. A total of 10 mathematics teachers, 7 school heads and 20 learners were interviewed.

3 Results and findings

The data that was collected from the various data collection strategies mentioned above is presented below:

Observation of learners' and teachers' activities during lesson time

I. Mathematics teachers come late for some lessons

Some teachers were observed marking huge piles of books up until lesson time. One teacher bemoaned her loss of lesson time saying:

> *I have so many books to mark before a lesson, as you know we give daily work in mathematics, the students are so many I go to some lessons late. Marking daily is even more difficult because some of the students use only one maths daily exercise book due to financial constraints*

II. A high level of students' absenteeism from mathematics lessons.

Evidence of learners not attending lessons were observed from learners who could be seen loitering around the school premises during lesson time. In many cases teachers were observed passing by and not taking any significant measures to maintain order.

III. Most of the classrooms were noisy and overcrowded.

In some cases, learners could be seen standing or sitting on the floor. In other cases, learners could be seen moving around in search for furniture during lessons.

IV. High levels of indiscipline

Indiscipline such as bullying, drug and alcohol abuse, sexual abuse and truancy, were observed during lesson time. In many instances numerous cases of drug and alcohol abuse where students were caught red handed and in possession of dangerous drugs were observed. In addition, serious cases of sexual indulgence in the classrooms and playing fields were observed. In the majority of these cases students were not ashamed of such behavior, it seemed normal to them because they did not show any remorse.

Naturally any observer would raise eyebrows and ask questions like, is there any learning taking place? These are key observations which reveal systemic overtones that contribute to the simulation of ideas, that there is very little or no order in these schools and that the school environment is to a lesser extent conducive for learning. Hence from the observer's perspective it should be noted that very little or no learning could be taking place in these schools. The reader may be tempted to think that this is an abrupt conclusion, hence there is need to examine other sources of data in order to draw authentic conclusions.

Analysis of students' exercise book and examination results

From the data gathered from the analysis of students' exercise books the following themes were deduced namely rrequirements, quality, feedback, low performance

a. Requirements

The quantity of work with reference to the number of exercises did not meet the requirements with respect to the expected amount of written work and tests. From the data collected, the number of exercises range from 0 to 15 exercises, while the number of tests is between 0 and 2 in all cases. According to the requirements in mathematics, learners are expected to write 5 exercises every week and a test every month. The expected number of exercises during a normal school term is 50 while 3 tests are expected to have been written. Therefore, the quantity of work falls far below the expectations according to the Ministry of Primary and Secondary Education (MOPSE) policy on mathematics learning (Circular No. 36 of 2006). It should be noted that, it is not clear if these number of exercises and tests could be based on some empirical data. What about the varying levels of cognitive and academic abilities? In essence how many questions and exercises should be given to cater for each category? Further studies are required to provide meaningful answers.

b. Quality

The exercise books did not present compelling evidence of connection or systematic progression between subtopics or topics. The exercises represented disjointed elements which seemed to show that mathematics teachers did not make deliberate efforts to sequence their topics. For example, some exercises showed that only 3 exercises were given on 3 topics i.e. ratio and proportion, fractions and equations. This implies that the teacher did not regard these topics as being multifaceted i.e. subtopics that would need to be covered and also the taxonomies (e.g. knowledge comprehension, application, analysis, evaluation) before the learners could graduate from a particular topic. This disjointed format tends to make it difficult for learners to understand mathematics. The learning process is even more complicated because learners do not have adequate textbooks to provide a hand-on experience. Based on the researchers' experience as mathematics teachers, the majority of learners who possess mathematics textbooks have difficulties conducting self-regulated study.

c. Feedback

Corrective marking was not observed in most of the learners' exercise books and there was also was little evidence of feedback. The researcher discovered that there were 9 visually impaired learners among the students. Two of the learners had a few braille sheets which were not marked. Three said they were not given work to do and four said they were not doing mathematics. While it seemed problematic for learners to get meaningful feedback in their learning the situation was worse for learners with visual impairment. The fact that the quantity and quality of work which the learners produced was less satisfactory seems to be an indicator of other weaknesses in the teaching and learning process such as lack of supervision, lack of motivation of both teachers and learners and shortage of human and material resources to manage large classes.

d. Low performance

There was very little evidence of formative testing in the students' exercise books. The results of these tests are usually averaged and written on students end of school term reports. Many students were observed complaining about their marks. For example, one of the students said:

.. I feel I could have got a better grade in maths If we had written more tests ..

Individual school results for national mathematics examinations for ten secondary schools reflect very low performance of below 23% while 3 secondary schools have their results up to 39% as represented in Table 1. For these 3 schools it may be due to their strict enrolment policy. At national level a similar declining trend of results in mathematics is evident as represented in Table 2. During the last 5 years the pass rate at national level has never exceeded 23%, which is a low pass-rate than anticipated with the introduction of continuous assessment as part of the mathematics examination.

Year	A	B	C	D	E	F	G	H	I	J
2017	20	22.1	16,5	9.3	19.4	36.9	4.9	23.9	9.2	10.8
2018	16.9	20.1	10.5	8.1	21.3	37.2	5.4	24.3	9.4	10.3
2019	22.9	33.9	10.7	9.7	22.4	31.3	6.3	20.1	10.1	10.9
2020	21.9	28.3	1	4.8	23.9	30.5	6.5	22.3	8.3	9.4
2021	22.4	29	9.7	5.3	20.8	32.2	5.9	19.5	8.4	9.8

Table 1: 'O' level mathematics pass-rates for some individual schools (Source: Ten schools in the District)

Year	Public Schools	Private Schools
2017	22.2	30.8
2018	20.4	20.4
2019	19.2	15.9
2020	18.2	19.4
2021	18.8	32.1

Table 2: National 'O' Level mathematics results (Source: ZIMSEC)

A total of 20 mathematics learners were interviewed, they pointed out several challenges that are directly linked to large classes. For example, one of the learners said:

> *the teacher moves with learners who understand and since we are too many in our class, I don't get much time to ask for explanations ..*

Another student also said:

.. we didn't have a mathematics teacher since last term, a student teacher came at the end of the term, all the while I had to take up extra lessons for maths

There is a shortage of textbooks, furniture, classrooms and mathematics teachers. The classrooms are overcrowded. One of the participants said:

...we don't have textbooks some of the students who have textbooks don't want to share with others we have no idea about what we are doing in mathematics...

Challenges associated with large classes

A total of 10 mathematics teachers were also interviewed with open ended questions, they said that the classes were too large and difficult to manage. They cited several challenges that are associated with large classes which include the following:

a. Poor student-teacher interaction

Large classes hampered opportunities for the growth of positive potential psycho-social relationships between the teacher and the learner. Participants believed that the teacher and the learner needed to better understand each other so as to enhance the teaching and learning process.

For example, one of the teachers said:

teaching these learners is not just going into the classroom one needs to understand these students especially their home background because how can you help someone whom you don't know

Another teacher also said:

I don't even know the names of these learners except for two groups the gifted learners and the naughty one.

Commenting on the issue of inclusion of learners with special disabilities such as hearing and visual impairment one teacher said:

You know, sometimes it is difficult to identify learners who have some disabilities especially when dealing with large classes, it happened to me I was partially sighted since birth and I didn't know it I thought it was normal teachers never bothered to find out about my condition so I struggled through my schooling.

b. Inadequate student class work and feedback initiatives

Large classes make it difficult to give adequate class work, homework and formative tests as alluded to by one of the teachers who said:

I teach in 5 classes with a total of 376 students, I am expected to give 5 exercises every week and a test every month, this adds to 1880 exercises every week. Is this practical?

Another teacher commented that:

> *With these large classes it practically difficult to tell who is submitting books for marking and those who are not you can spend the whole year with some learners not writing homework*

c. Inadequate teaching and learning resources

Large classes have contributed immensely to acute shortages of classrooms, furniture and teaching and learning resources such as mathematics textbooks. This has a huge impact on the students' learning process in the classrooms. For example, one of the teachers said:

> *We have a problem of inadequate furniture and classrooms hence we cannot accommodate all the learners at the same time however even when the other learners come in the afternoon session some waste lesson time looking for furniture from other classes.*

Another one also said:

> *The few textbooks that we have are not enough for these numbers sometimes you are forced to write everything on the writing board which is a lot of work.*

d. Failure to employ action-based research initiatives

Participants reported that with large classes teachers cannot implement action-based research a strategy that has recently been introduced with the new competence-based curriculum. It becomes difficult to craft teaching and learning strategies that relate to the learning needs of the learners in varying contexts. One of the teachers said:

> *it is near impossible to apply this strategy without adequate resources*

Despite the challenges posed by large classes some participants alluded that large groups of learners gathered in one place offered a good chance of conducting research, pilot studies and intervention strategies that relate to the learners. One teacher said:

> *..large groups of learners provide excellent opportunities to market constructive ideas such as the introduction of digital technology.*

Interviews with school managers

The researcher wanted to gain understanding of the causes of overcrowding in secondary schools which included the following:

I. Rural to urban migration

Participants said that there was a significant rural to urban migration, where people were seeking for better services, facilities, economic opportunities and jobs. Commenting on the causes of rural to urban migration one of the participants said:

> *These people who come to town think that they will get jobs and money, so they move with their families and putting pressure on the existing secondary schools.*

II. Policy on access and inclusion in education

It is government policy that all school age going children must be enrolled in school despite their financial status or performance. Commenting on this issue one of the participants said:

> *We are in trouble you are forced to enroll and you have to because this is government policy, I was a geography teacher and the school enrolled a child who could not write his name but he dropped out after a while.*

III. Economic constraints

The prevailing economic conditions make it difficult for government to finance the construction of new schools. Local communities are struggling financially and they cannot pay enough levies to build schools or expand the existing ones. After independence the government built more schools in the rural areas than in urban areas. Asked to comment on the successes of this policy after independence, one participant said:

> *It was better during the first 10 years after independence schools produced individuals with quintessential skills i.e. genuine skills, now we have a crisis since the population will continue to expand.*

Public schools remain crowded because private schools are out of reach for the greater percentage of the population. One of the participants said:

> *Since independence many private schools have been constructed around the country by however, these private schools are out of reach for many*

4. Discussion

This study has investigated through the collection of data, analysis and interpretation of data from students, teachers, school managers and education officials on the perceptions and opinions concerning the effects of overcrowding in mathematics learning in secondary schools. These are summarized in this section.

Class sizes and enrolments

The study's findings indicate that Secondary school enrolment has continued to rise despite the adverse economic conditions and the effects of the COVID 19 pandemic. For example, class sizes in Glenview range between 50 to 92 in each class, with the student teacher ratio standing at an average of 1 to 70. Chirume (2016) found similar results were in the Midlands Province the student teacher ratio was between 1 to 69 and 1 to 80. In 2010 the student teacher ratio for the whole country was 1 to 22 (ZIMSTAT, 2013) which may be an indicator of a sharp increase in student enrolment. Moreover, the actual number of public secondary schools has not increased, no new schools have been built and no new buildings have been constructed even within the existing premises to ease congestion in the area under study.

Economic conditions

Participants have attributed the lack of construction of new secondary schools to the serious economic constraints that has crippled government's and local communities' capacity to construct new schools and improve the existing ones. Ndakala, Dengeinge, Dzinoreva and Mutiwanyuka (2019) have reported that Zimbabwe has continued to face stiff economic challenges and the wider economic context remains constrained with poverty prevalence rate standing at 56 per District out of 60. Government has not been able to avail adequate financial resources to construct new schools or improve the existing ones. Local communities are struggling to pay tuition fees and levies and the little that is raised is not enough to meet the financial requirements of the secondary schools. Despite these challenges school enrolments continue to rise. The problem is exacerbated by the policy of automatic promotion from one Grade/Form to another (Tshabalala & Ncube, 2013). In this regard some participants said that there was a controversy between inclusion and the provision of quality education in secondary schools and this needed serious consideration., because this wide spread increase in enrolments had negative consequences for the teaching and learning process in the classroom.

Class sizes versus teacher learner activities

This study has revealed that large class sizes have more negative effects than positive effects on mathematics learning in the teaching and learning process in the classroom. Teachers carry heavy loads, they fail to give adequate homework, tests, mark and provide immediate feedback. They are not able to provide individualized attention or implement learner centred approaches like group activities. In general, the environment is not conducive for learning because of too much noise and disruption which also leads to poor communication, poor student interaction and lack of supervision of students' behavior and performance. Several studies on the effects of class size on student performance have concluded that small class sizes are more conducive to the learning process. For example, Blatchford and Russell, (2020) found a link between student learning and class size, students get more attention than in large classes, which enhances their participation.

The effects of class size on teachers and students may be viewed from various perspectives. This may vary according to subjects as alluded by Aamir, Ullah & Kaleem, (2020) who reported that different subjects require diverse class sizes. Some studies on the effects of class size on student performance have typically revealed that students from low-income families benefit more than others because high income families can be able to provide private tuition (Fredriksson, Ockert & Oosterbeek, 2013). Other studies, for example Wang & Calvano, (2022) have noted that the effect of class size reduction on students' academic performance are statistical and/or economically insignificant. In the light of this discussion and literature, it must be said that the question of "relevance" is subjective, hence systemic validation of the effectiveness of class size on student performance must be weighed within varying contexts. On the other hand, reducing class size can be expensive because of its implications for more resources such as increasing the number of teachers and providing more classrooms. However, we need to bear in mind the issues of education production function, in essence, is there a match between the inputs and outputs in education in secondary schools?

Education production function in mathematics learning

In a typical education production framework, more inputs could lead to increased production. Measuring productivity in education is probably a complex task because students' performance is usually based on test scores which do not measure non cognitive skills. However, one can assume that students' performance is in part represented by their performance in national examinations. This is a reflection "in part" of what is taking place in the classroom. In this regard performance in mathematics, is very low (see Table 2). A comparison with national performance in mathematics from 2017 to 2021 also reflects the same trend. A broader perspective of examining this problem shows that the nation could be in a more serious predicament. For example, the 2012 population census revealed that 1.2 million orphans and vulnerable children dropped out of school of which half were girls (ZIMSTAT, 2012). It may be necessary to consider dropouts as part of the agenda for the wider macro socioeconomic transformation.

In the light of this observation, for example, based on Inter-Censal Demographic Survey, (2017) the projected number of school candidates who could be registered for GCE 'O' level examinations in 2019, was 350000 assuming that every child had equal access to educational opportunities. Of this figure only 170000 candidates were registered for the November 2019 mathematics examinations which is less than half of the number of potential candidates. Several factors accounted for this discrepancy which include expulsion from school, child marriages, child pregnancies, child labour, financial incapacity, cultural and religious beliefs among others(ICDS, 2020). According to ZIMSEC, (2020) 26981 candidates passed mathematics with a Grade C or better which translates to 7.7% of the potential number of candidates. If then this is the case, can we hope for any significant improvement in the near future?

Prospective extrapolation of attaining future goals

ICDS, (2017) has reported that 40% of the population of Zimbabwe is below the age of 15 years. This is the target group for educational programmes (e.g. STEM), that can enhance the achievement of macro socioeconomic blueprints (e.g. Vision 2030, African Union's Second Decade of Education for Africa Plan of Action (2006-2015), the Sustainable Developmental Goal no. 4 (SDG 4) and the African Agenda 2063) (Ndakala, Dengeinge, Dzinoreva & Mutiwanyuka, 2019).

5. Conclusions

Based on the objective of this study, analysis and interpretation of data and the discussion of the findings the following conclusions are made:

The challenges that are being experienced by teachers and learners due to large classes are largely attributed to the problems of the current economic constraints which Zimbabwe is going through. These economic constraints have crippled institutional, organizational, human, technical, material and financial capability to develop, such as constructing new schools, expanding existing ones, increasing the number of teachers, providing better salaries

and conditions of service for teachers, providing adequate teaching and learning resources, etc. Lack of these essential requirements has negatively affected the teaching and learning process, by teachers finding it difficult to provide appropriate teaching strategies, individual interaction and attention, audio visual aids, management of classroom activities and students behavior which has also contributed to lack of motivation among students due to large classes. Students with visual impairment/blindness are widely being neglected, the majority of these students either drop out of school or never register for mathematics examinations. For those who register for mathematics examinations very few pass with a Grade C or better. Hence this group of learners is excluded from STEM learning programmes at all levels.

National GCE 'O' level mathematics results have decreased from 22.2% for November 2017 to 18.76% for November 2021, but national production in mathematics at GCE 'O' level falls below 10% when taking into account all eligible candidates. Dropout rates are very high, above 50% of potential examination candidates are not accounted for, whereas 40% of the Zimbabwe's population is below the age of 15 years, which represents the most targeted section of the population in relation to educational provision. Effective educational provision has been largely crippled because of lack of a conducive learning environment, hence it is difficult to predict any meaningful positive improvement in mathematics learning in the short term. Therefore, given these circumstances the attainment of macro socioeconomic goals seems essentially problematic.

6. Recommendations

With reference to the conclusions of this study we note that there is urgent need to consider serious steps to restore order in secondary schools and make them to be more conducive and convenient for effective mathematics learning. Therefore, the following recommendations are proffered:

For government

There is an evident need for more schools hence with planning in conjunction with the relevant stake holders more schools can be the constructed. There is also need to recognize the significance of comprehensive, reliable and updated education information, that is born from active research and primary data, that is relevant and useful for decision making processes. Local universities, educational institutions and non-governmental organisations can be useful as "think tanks" or "hubs" to produce knowledge and endogenous resources such as textbooks, furniture, software, hardware, digital technologies, etc, that can transform secondary schools into vibrant and conducive learning environment within the prevailing contextual variables.

For school managers

There is need to make deliberate efforts to focus on instructional goals which put more emphasis on the teaching and learning activities, this is in addition to their managerial and administrative duties. By virtue of their position and responsibilities school managers can transform the school environment through putting in place instructional

goals that can influence instructional practices in the classroom in the face of the challenges of large classes. School managers must be accountable for the success or failure of education programmes in the school. Mestry, (2017) found that one of the primary reasons for the poor academic performance of learners in public schools is the ineffective instructional roles of school managers.

They need to collaborate ideas with relevant stakeholders such as local communities, non-governmental organisations and teachers to find lasting solutions such as providing adequate teaching and learning resources to solve the challenges of overcrowding in classrooms. Some of the strategies could include:

Increasing the number of teachers and classrooms

This could reduce the number of students per teacher by creating small class sizes. Several studies such as Nizamettin & Bekir, (2014) have supported this idea. Participants have said that this is difficult because government does not have adequate funding. Some schools have employed more teachers who are paid from the school finance. For example, one of the secondary schools employed 12 teachers but participants said these were not enough it was like a waste of resources.

However, reducing class size by increasing the number of teachers is costly but promoting this solution and implementing it could have appositive impact on students' performance and also reducing teachers' work load. Therefore, there is need to consider ethnocentric approaches whereby all stakeholders come together to collaborate ideas about what can be done. From the researcher's perspective it seems there is poor coordination between the stakeholders and policy makers. Similar studies carried out by Kadri & Souad, (2022) have also revealed the same problem.

For mathematics teachers

In the face of the current economic hardships, teachers need to strive to produce the best they can under the circumstances. This study emphasizes the need for teachers to be more proficient and professional in their jobs. They need to conduct active research in order to find ways and strategies to deliver their lessons even in large classes. As they do this, they not only contribute to the well-being of the communities but also develop their own personal skills and competencies in dealing with complex situations. In this they become more proficient and marketable for future projects and opportunities. Mathematics teachers need to think about the use of digital technologies and e-learning initiatives that can help to manage large classes.

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