Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.13, No.28, 2022

Does Class Size Matter on Learning Output? A Case in Science and Mathematics Subjects in Public Secondary Schools in Siaya County, Kenya

Lucy Akinyi Eunice[1] Prof. John Aluko Orodho[2] and Dr. Thaddaeus Ogola Rugar[3]
1. Doctorate Student in the Department of Educational Management, Policy and Curriculum Studies, School of Education, Kenyatta University, Kenya. E-mail: lusiakinyi@gmail.com
2. Associate Professor Specialized in Educational Research and Statistics, Department of Educational Management, Policy and Curriculum Studies, School of Education, Kenyatta University, Kenya
E-mail: Orodhojohn@gmail.com
3. A Lecturer Specialized in Planning and Economics of Education, Department of Educational Management, Policy and Curriculum Studies, School of Education, Kenyatta University, Kenya

Abstract
Class size is a key determinant for effective handling of learners if desirable results are to be realized. The policy standard requirement on class size is availed by the Ministry of Education to all learning institutions. However, the government has continuously given directives that schools should admit all students who seek admissions in their schools so as to enable 100% transition to secondary education, disregarding the policy standard on class size, forcing many schools to realize beyond policy class sizes. The purpose of this study was to determine the influence of class size on students learning output in science and mathematics subjects in public secondary schools in Siaya County, Kenya. The study was underpinned on the Education Production Functions Model by Hanushek (2008). The study employed convergent parallel mixed methods design. The target population was 6175, comprising 247 principals, 988 teachers and 4940 students, drawn from the 247 public secondary schools. Slovene's formula was utilized to draw a sample size of 376 respondents from 15 sampled schools. The average termly class mean scores were used to measure the students' learning output in the schools. Questionnaires, interview guides and document analysis guide were used to collect data. Test re-test method was used to determine reliability of the quantitative research instruments. While the quantitative data was analysed using descriptive and inferential statistics and presented in tables and graphical format, the qualitative data was analysed thematically and presented in quoted texts. The study found a positive linear relationship between class size and learning output. The coefficient of determination R^2 was established at 12% for class size and learning output. It was concluded that class size influenced learning output though there was no clear pattern that big or small class sizes influenced learning output in definite direction. Further, it was evident that although nearly all the schools fell short of the policy standard requirement on class size, teachers' lauded smaller class sizes that they can be effectively managed. The study recommended that the Teachers Service Commission should consider rationalizing student class size for effective teaching and learning.
Keywords: Small and Big Class Sizes, Beyond Policy Class Size Learning Output, Secondary Schools, Siaya County, Kenya.
DOI: 10.7176/JEP/13-28-05
Publication date: October 31st 2022

1.0 INTRODUCTION

1.1. Background to the Study

Student class size as a quality measure is determined through policy legislations. Considering the global goal of universal completion of secondary education by 2030, countries are implementing 100% transition to secondary schools which comes with additional expenditure per student. The WHO (2019) counsels that countries are rethinking the class size policy because an admission of one student beyond the policy standard would mean additional classroom, human resource, text books and other learning equipment which has become costly to maintain considering the fiscal environment in the world as other sectors of the economy such as health are demanding larger share of Gross Domestic Product (GDP).

A study by Grover and Chingos (2011), writing on class size and policy in the United States of America indicate that class sizes at secondary school level, averages at 24 students per class. Though the class sizes vary with grade, the variation has an implication on teacher's salary and infrastructure. Grover and Chingos (2011) opine that an increase in class size by one student would increase the teacher's salary and infrastructural cost by 225000 dollars or more considering the additional expenditure the additional students come with, while one student decrease per class would save 12 billion dollars to the state. Should class size be increased without appropriate infrastructural and instructional compensation, how would learning be affected, would seating arrangement and level of teacher student interaction be affected?

The OECD (2014a) indicate an average class size of 24 students and this may go down to 17 students in some countries like Greece, Estonia and Luxembourg. Furthermore, OECD countries realize higher completion rates averaging at 84 percent. Similarly, UNESCO (2018b,c) through a survey notes an average class size of 1:55 and beyond in Sub- Sahara Africa, but few teachers are employed to cater for the increased enrolment and no compensation is given to teachers when taking up more lessons coupled with inadequate learning facilities at school. Large or smaller class sizes effectiveness depends on quality resource availability and usage for value addition in the teaching and learning process.

In the Kenyan context, a report by Word Bank (2019) indicates that Kenya is keen on attracting huge student numbers to schools and on delivery of curriculum as well as completion of the syllabus. On the other hand, the report directs that much effort needs to be put in developing learners' skills. The government of Kenya allows admission to schools beyond the policy on class size of 45 students (UNESCO, 2019d; Republic of Kenya, 2019). The influx into the classrooms is to enable accommodation of all students transitioning from primary schools to meet the 100 percent transition policy to secondary schools. This though poses inconsistency with the policy requirement on class size. If a class has more students beyond the policy recommended capacity, then the recommended arrangement and spacing cannot be adhered to, and failure to adhere to policy requirements may have implication in the teaching and learning process. How then does this impact on the learning output? This study unravelled how learning is conducted in these classes; whether big or small class sizes, in order to establish the influence on learning output? Siaya County class size averagely stood at 47 students though the class sizes were noted to increase annually (UNICEF, 2014).

With regards to learning output, results from the Kenya National Examinations Council (KNEC) has shown that on average, 80 percent of the candidates have consistently performed below national average, scored between grade C- and E in mathematics. In the year 2014, 80 percent of the candidates scored between grade C- and E, in the year 2015, 86 percent scored between grade C and E, year 2016, 90 percent scored between grade C and E, year 2017, 87 percent scored between grade C and E, year 2018 and 2019 equally had a mean grade of D. The science subjects; Biology, physics and chemistry have had 50 percent of the candidates persistently scoring between grade D and E for nearly a decade. The low learning output that have persistently been realised in science and mathematics subjects. It is against this backdrop that this study which assessed if class size could have an influence on students learning output was premised.

2.0. STATE OF THE ART REVIEW

2.1. Class Size at Policy Value and Learning Output

Planned classroom activities are guided by the class size and entail teacher guiding the learner through the learning process. This is facilitated through regular teacher student interaction with the learning content to enable effective learning. A classroom environment determines if such interactions would support thinking, address individual learner needs, safe, helps in developing a thriving learning culture which surmount to meaningful learning. Additionally, an appropriate learning environment is the one where learners feel involved and comfortable enough to fully participate in group and individual activities (Movchan, 2018). Does class size affect the learning environment and influence learning output? The gist of this study was to determine the influence of class size on learners' scores.

The ambience of the classroom, the teaching approach and the setting and classroom arrangement, all relate to class size and have a direct and indirect influence on the achievement of learning outcomes. Classroom management is an important part in the teaching and learning process. The actions of the teachers to create an environment that is supportive to learning is a crucial part of the process (Martin, Schafer, Mcclowry & Emmer, 2016). The ambience of the classroom includes things such as the lighting, ventilations, acoustics and the general mood of the class. Research has demonstrated that the setting of classrooms enhances the quality of learning. Students can easily read what they see as better lighting improves the visibility even for those with visual challenges. Scientists have also proven that lighting influences the endocrine system which stimulates the production of endorphin which is the hormone associated with feelings of happiness. Effective learning takes place when students are happy and are in well-lit classrooms. Research has established that classrooms are important because they enable learners to get have a conditioned learning environment for enhanced concentration. However, there is limited research and literature on learner classroom concentration and test scores in institutions of learning (Alicea, Suárez-Orozco, Singh, Darbes ; Abrica, 2016). This study sought to establish the kind of learning engagements between the teacher and learners with different class sizes at below policy requirement, at policy requirement of a class size and beyond policy requirement of a class size.

The classroom processes have an impact on student engagement. Learning takes place more effectively when there is student engagement. These engagements happen between the teacher and students and amongst the students themselves. Research has proven that well-performing students tend to be high on student engagement. This takes place in the form of student support, instructional quality and organisation; which are all related to learning. Further, it has also been established that classroom interactions are linked to positive motivation.

Engagement of students can be viewed in terms of several dimensions. Alicea, et al., (2016) envisage engagement in terms of the following dimensions; academic, relational and cognitive engagement. These dimensions fall into a continuum where the student is on one end and teacher on the other and this could be practicable with a manageable class size (Hong & Sullivan, 2013; & Doolaard, 2016).

Hong and Sullivan (2013) aver that academic engagement involves the intentional activities to involvement in course-related activities. They include: attending classes, participation in class, reading assignments, studying for examinations and submitting assignments on time. Students who are academically involved in their work will naturally demonstrate high academic achievements. Relational engagement is the extent by which learners feel supported by and connected to their colleagues, teachers and their institutional workers. The connections serve to boost confidence and stimulate efforts when their levels of hard work drive go down. This approach emphasises the social emotional aspect of the teacher actions rather than the academic aspects. Teachers actions that foster positive classroom environment are important as they make the students feel cared for and connected with the teacher and the learning process (Martin et al., 2016). It is not only the teachers' actions which are important but also their attitudes towards the students and the learning process. Teachers with positive attitudes will reinforce learning as opposed to those with negative attitudes. Warm teacher actions will evoke and intensify students respect and care for each other, while negative teacher actions may set off a spiral of negative energy and interaction. These studies however did not establish if the class sizes prevailing in the schools allow for effective teacher student engagement, which the current study established.

Cognitive engagement is student-centred instructional process whereby the faculty promotes reflective learning, synthesis and innovativeness. It involves the extent to which learners are able to create solutions to issues; thus being creative. Cognitive engagement can also be defined as the action extent and imaginativeness concerning certain theories and are curious and interested in what they are learning which mainly is triggered by the teacher getting very engaged and concerned about the amount of learning taking place in class. As a result, learners reciprocate by getting down to learn concepts deeply (Blatchford, Basset & Brown 2011). The quality and type of instruction that is taking place in the classroom is a fundamental concern in the cognitive development and learning academic content. When the teachers communicate high expectations to the students and support them when they fail can be a predictor of learning outcomes (Korpershoek et al., 2016). This improvement in cognitive engagement can be measured in terms of increased reading scores. When learners are actively engaged in learning activities, their achievement in exams improve. This is usually achieved when the teacher interacts with students and challenges them academically to the point of increasing the levels of student engagement. Student engagement to a large extent depends on the pedagogical strategies used in content delivery.

Warea and Guantai (2005) in a study on class size indicate policy requirement on class size across counties. Japan policy on class size is 42 students per class. The study indicates that the Japanese government has put measures to facilitate only 42 pupils per class to enhance their achievement. Japanese teachers are taught about class organization with only 42 pupils in the class and this is what is practised. This has led to the teacher having great class control and enhanced attendance to all the pupils. However, the study failed to establish the influence of student class sizes on learners' achievement; which this study sought to establish with a different population.

In South Korea, the class size comprises of 65 students in the junior high school classes and the teacher training bears this in mind while training. In these classes, teachers organise extra tuition, administer class tests after every two weeks and they use students to teach other students. Remedial and other enrichment exercises are equally organized (Warea & Guantai, 2005). Kenya's student class size according to policy requirement is 45 students though studies have indicated different class sizes across the counties. This study sought to determine the influence of the class sizes on quality of students learning.

Class size determines the level at which the teacher caters for student individual differences in class. Big class sizes may not allow the teacher to attend to the students' individual differences given the limited amount of time allocation per lesson. This then influences learning output. This concept is backed by Guyana Education Department (2019) that classroom management is a challenge that requires appropriate discipline, motivated learners and manageable number of students in class, gender and participation. The size of the class may be determined by the gender of the students. For example, when classes are formed according to subjects, they may be influenced by gender. It is true that gender determines the educational choices that students make. Science-based subjects attract more male students while female students are inclined towards art subjects. This notion is backed up by Vleuten (2016) who notes that both genders significantly concentrate on different educational programs and occupations. Girls have therefore been known to lean more towards the choice of art subjects and have always performed better than the boys in languages (Republic of Kenya, 2019). This current study sought to establish the alternative view in mathematics and science subjects regarding the students' class size and its influence on learning output.

A study by the Republic of Kenya (2019) on the class size in Kenyan schools indicates that there were 68,541 classrooms and that learner to classroom ratio was at 45 students per class, noting that the country had realized the recommended learner to classroom ratio. However, the study alludes that there were disparities in

class enrolment across the country but failed to establish disparities in the class sizes nor relate the influence of the class sizes to learner's scores. This current study sought to establish how various class sizes influence students learning output.

2.2. Class Size at Beyond Policy Value and Learning Output

A study by Gasteen's (2019) conducted in the United Kingdom indicate that as a result of the government trying to promote the study of science, technology, engineering and mathematics (STEM) subjects, due to a shortage of qualified individuals to pursue the subjects at higher levels which is a consequence emanating from skewed secondary subject educational choices which feed tertiary institutions, girls and boys have continued to evidently make different choices. For instance, Biology is more likely to be studied by females while Physics by males. These differences are noted to be attributed to the social conditioning and gender-based environments rather than innate biological differences. Despite subject selection being more evidently following gender pattern, more girls currently have penetrated the initially perceived male dominated subjects and the class sizes are large (Wolfe, 2019; Gasteen, 2019). The study did not establish the effect of the class sizes on learner scores. This study aimed to establish how subject choice determined class sizes and its influence on learning output.

In a similar vein, Warea and Guantai (2005) study in the United States on class size and its effects on students' achievement through survey revealed that, smaller classes perform better than larger classes though with reservations on bigger classes. They note that larger classes had instances of better performance only when more time was allocated to the students' individual differences and teacher quality taken into consideration. In most cases, smaller classes led to better teaching and learning. Warea and Guantai (2005) further observe that, in countries where passing examination is emphasized, class size reduces in upper grades and the classes are daunted with class repetition and dropouts.

The legislative action mandated class size reduction but the prevailing fiscal environment has forced the United States of America to rethink their class reduction policies given the high cost of maintenance of smaller classes. They note that increasing the pupil teacher ration by one student raises the expenditure by 12 billion dollars per year because even the teacher salary has to go up coupled with additional learning resources. Therefore, if maintaining smaller classes require more resources which are already scarce, the effect of additional number of students in these classes on learning output could be evident which is why this study was carried out on n a different populace.

The OECD (2012) study in Denmark, Iceland, Finland, Greece, Portugal, Russian Federation and Slovenia, indicate that the average class size in the countries is between 20 and 30 students or fewer. Many states are today rethinking their policies on class sizes given the high cost of maintaining small class sizes though the substantial expenditures required to sustain small classes are justified by the belief that smaller classes are more effective. This is because they increase students learning, and the economic benefits outweigh the costs. The study did not establish the anticipated effect of increasing class sizes on learning and how they would mitigate the challenges of large class sizes, yet they are on cost reduction strategy. This study assessed the effect of class size on teacher student interaction and its influence on learning output.

Rampell (2009) study on teachers perception on class size, as cited by Ndethiu (2017) study on teachers' and principals' perspectives and strategies on teaching and learning with large classes points out that what constitutes a large class is a matter of a person's perspective; culturally, economically and politically. In china, what constitutes a large class is one that has between 50-100 students. In the USA there have been notions of congestions, yet the average class size is 24:1 in lower secondary schools while embracing humanistic approach in teaching. The study concludes that context and specifically culture play a very significant role in determining a teacher's degree of tolerance for large classes, the large class is one that has more students than the teacher prefers to manage, and available resources can support. The study noted that Asian countries such as Korea, Japan have some of the best performing students in the world despite their record of huge class sizes. There is no guarantee that small classes would perform better thus, the need to check on high stakes for students and teachers, remedial instruction, allocation of resources, teacher quality and average class size. Class size is not a cure for all challenges leading to low student output. This study corroborated the findings with varied class sizes in different populace and established the influence.

Ngome and Kikechi (2015) did a survey in Tanzania on educational gains and class sizes. They highlighted that educational gains are undermined by persistently large number of students who take more than one year to complete a particular grade or who drop out of school before completing the education cycle which proves to be a pointer to issues in the process of teaching and learning. This study confirmed the prevailing current class sizes, teacher student interaction during teaching and learning process and their influence on learning output.

The number of students in a class determines how seats are arranged in the classroom. If the class has more students beyond the policy recommended capacity, then the recommended arrangement and spacing cannot be adhered to and failure to adhere to policy requirements may have some implication on the teaching and learning process. Overcrowded classrooms would mean that, there will be no adequate spacing between learners which

may hinder easy movement of the teacher to different points within the classroom during teaching and poor air circulation making concentration to learning uncomfortable. Consequently, the teacher is unable to reach out to individual students to monitor their work. Some students therefore may not be very aggressive to learn concepts that may be challenging to them due to the looseness in monitoring students work in class. In such an instance, the teacher may not reach them due to poor seating arrangement. Some students thus may hide and joyride within the crowd. This thought is supported by Ngugi and Thinguri (2017) study which assert that good classroom arrangement contributes to easy movement of the teacher within the classroom while monitoring students work. Big class sizes on the other hand, may lead to lack of cohesiveness within the class as learners are left on their own discretion and may depend on learner to learner to organise effective group discussions.

Ndethiu (2017) studied the Kenyan secondary teachers and principals' perspectives and strategies on teaching and learning with large classes. He reveals that 58.8 percent of Kenyan teachers use lecture method of teaching in classrooms, 88.9 percent neither embrace class discussion nor group work methods of teaching. The study further reveals that a class size of up to 59 students impacts negatively on teaching and learning due to; heavy workload on teachers in terms of marking, lack of individual attention and limited resources. The study recommends integrating ICT in teaching as the demand for secondary education continues to grow, noting that many developing countries have not embraced the use of ICT in teaching. The study only assessed the perception of teachers and principals on big class sizes but failed to explore the actual achievement variations across the class sizes.

Nevertheless, it cannot be assumed that big or small class sizes on its own can be the determinant of learning output. There are other factors contributing to learning in relation to teacher student interaction in class and other mitigating and remedial actions for the class such as, group discussions and effective monitoring of students in their work. This study assessed and established how the seating arrangement within classrooms influenced students learning output. Omatsu (2020) notes the hardships university fresh students go through as they attend lectures without much classroom individual attention with the lecturers who only prepare lesson plans, focusing on content and gauge how well they teach by how well they organise and present material, only to be puzzled when their students fail on tests or assignments. The gist of this study was to establish the influence of teacher student classroom interaction level on learning output. The study revealed the importance of class size, teacher student interaction and students learning output which perhaps is not continued to the tertiary level. Also, if the results are poor how much contribution do these classroom dynamics make to learning output in secondary schools?

Gremmen, Yvonnne, Berg, and Cillessen (2016) ascertain that teachers mainly prefer small group arrangements to promote students' cooperation as a tool for managing learning. Burden (2020) adds that appropriate seating arrangement enables real time management of student behaviour thus, the importance of creating a supportive learning environment. How well a student sits is key in promoting effective learning.

2.3. Statement of the Problem

Despite the diverse and rich literature on the effect of class size on learning outcome of students, it is imperative that the actual optimal size has not been agreed upon by the researchers from different countries reviewed. There is thus a knowledge gap regarding the effect of class size on learning outcomes and how policy pronouncements can support teachers to come up with pedagogical strategies that enhance learning in the context of the emerging large classes occasioned by 100 percent transition policy in Kenya.

As noted by Omatsu (2020) as well as Thunguri (2017) , teacher success is attained when a teacher attends to learner problems effectively which in turn leads to an increase in students' academic achievement. It is arguable that classroom dynamics is integral to effective teaching and learning. Although some researchers such as Ngugi and Thunguri (2017) concur that classroom dynamics should be analysed well because of variations in class sizes, they have not recommended the optimal class size that might spur effective learning. Instead, most studies have only assessed the impact of classroom dynamics on social interactions in school and did not relate the seating arrangement as a quality variable with learning output. In light of the spurious finding in most studies reviewed, the current study sought to assess the classroom dynamics in Siaya County in reference to number of learners in a class, seating arrangement and teacher-student classroom interactions following the execution of the policy on 100 percent transition to secondary schools

2.4 The Purpose and Objectives of the Study

The purpose of this study was to determine the influence of class size on learning output in science and mathematics in Public Secondary Schools in Siaya County, Kenya. The study was guided by three main objectives:

1. To examine the status of class size and learning output in science and mathematics subjects in public secondary schools in Siaya County, Kenya.
2. To determine the influence of class size at beyond policy value on learning output in science and

mathematics subjects in public secondary schools in Siaya County, Kenya.

3. Determine the influence of class size at policy value on learning output in science and mathematics subjects in public secondary schools in Siaya County, Kenya.

2.5 Theoretical Framework

The study was based on Education Production Functions Model by Hanushek (2008). The Education Production Functions Model embraces the underlying principle in the theory of Production, which states that the quantity of output that a firm can produce is a function of the quantity of inputs to production which a firm employs. The production function is expressed in a linear form as; $Q= f(X_1, X_2…..X_n;K_1, K_2…..K_m)$ where Q denotes the quantity of a firm's output, X_1, X_2 and X_n are the presumed variable factor inputs while K_1, K_2…..K_m denote the fixed factors employed in the production of Q (Solow, 1966, KIPPRA, 2017). When adopting the theory of production to an education context, the inputs are converted to produce a range of outputs through the teaching and learning process as exploited in this study through the realms of the Education Production Functions Model by Hanushek (2008). The education production function model was relevant to this study because; the concept helped in the evaluation of key quality input areas to education and assessed their contribution to learning output, through regression models.

3. RESEARCH METHODOLOGY

The study employed mixed methods research design by specifically using convergent parallel design in a four step multiphase whereby; in the first phase of the research process, quantitative and qualitative data were collected independently though concurrently. Second, quantitative and qualitative data were analysed concurrently but separately. Third, the quantitative and qualitative results were merged while discussing the areas of convergence, divergence and complementarity. In the final phase, the quantitative and qualitative results were interpreted to help answer the research questions by deducing the general picture of the results per objective area (Orodho, Nzabalirwa, Odundo, Waweru & Ndayambaje,2016) . This design was appropriate to this study because it enabled the generation of quantitative and qualitative information about a similar concept; the status of the school quality variables. It also allowed for in-depth views and explanations from the participants on the same concept (Creswell, 2014; Orodho,2017).

The study target population comprised of 6,175 school principals, science and mathematics teachers and students (class secretaries and subject representatives) from all the public secondary schools in Siaya County, Kenya. From the target population of 6,175, there were 247 principals, 988 teachers and 4,940 students. The Science (Chemistry, Biology and Physics) and Mathematics teachers were targeted because they are the direct facilitators of learning in the subjects; thus, one teacher per subject area (head of subject) hence four teachers for the four subjects (Chemistry, Biology Physics and Mathematics) per school totalling to 988 teachers across the 247 schools. Science and Mathematics teachers were targeted because the subjects have consistently recorded the lowest achievement mean index in the national examination in the county. The students' class secretaries and subject representatives from Form one to Four, were targeted because they are tasked with the responsibility of representing their classes effectively in any issues.

The study employed stratified and simple random sampling. The sampling units were schools drawn categorically from; sub- county, county, extra county and national schools. These schools were either mixed day schools, boarding girls' schools, boarding boys' schools or mixed day and boarding type. Slovene (1960) formula to determine the sample size as sample size of 376 participants.

Three types of instruments were used in this study. They include document analysis guide for the principals, questionnaires for the school principals, questionnaires for teachers and students, and interview schedules for principals, teachers and students on school quality variables and learning output. The use of multiple instruments on each type of respondent is in conformity with the requirements of the mixed methods design to enable the generation of both quantitative and qualitative data for corroboration and complementarity purposes.

Piloting was conducted in public secondary schools in Siaya County to help determine validity and reliability of the instruments thus help identify any ambiguities in the research questions from the instruments. About one (1) % percent of study units and respondents in each category was used. Quantitative data analysis was conducted with the assistance of Statistical Package for Social Sciences (SPSS), while qualitative data was analysed thematically (Orodho, Ampofo, Bizimana, & Ndayambaje, 2016).

4. FINDINGS ANDDISCUSSION

4.1. Teachers Responses on Class Size

Science and mathematics teachers were asked to supply information regarding the number of students in their classes and the data received is presented in Table 1.

Table 1: Teachers Responses on Class Size

Class Size Range	f	%
44 and below	4	6.7
45	0	0
46-60	36	60
61 - 80	20	33.3
Total	**60**	**100**

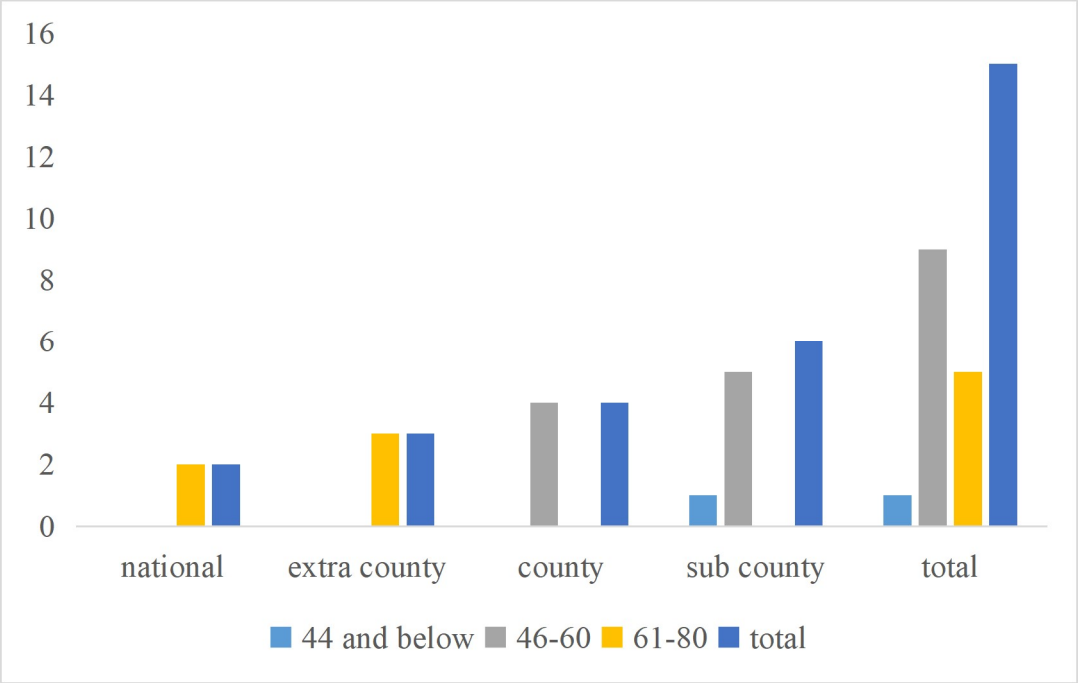
N = 60

Source: Teachers Questionnaire

Table 1 shows that nearly two thirds, comprising (60 %) of teachers indicated their students class sizes to range between 46 and 60 students per class. No teacher indicated a class size of 45 students. About 6.7% of teachers indicated that their student class sizes were below 44 students which was only associated with one school. While 33.3% of the teachers indicated that their class sizes were between 61 and 80 students per class. This implies that nearly all the teachers (93.3%) indicated that their students' class sizes were beyond the policy standard requirement of class size of 45 students per class.

4.2 Class Size by Category of Schools

The teacher and student respondents were asked to provide information regarding the category of their schools. They were to specify whether the school is; National, Extra County, County or Sub County. The information received is displayed in Figure 1. Figure 1 illustrates the class size variations by category of schools. The results in Figure 4.3 shows that all the national schools (2) had their class enrolment range between 61 and 80 students per class. In the extra county category, all the study schools (3) had their class sizes mean range between 61 and 80 students per class. All the county schools (4) had their class sizes mean range between 46 and 60 students per class.



N= 361

Figure 1: Class Size by School Category

Source: Teachers' questionnaire and students' questionnaire

This implies that nearly all (14) schools had their class sizes between 46 and 80 students per class which is above the policy standard requirement of 45 students per class. Nearly all school categories registered class sizes of above the policy requirement by over 20 students per class. The class sizes are explosive due to the policy of 100% transition from primary school. The class size policy requires that each class should contain 45 students. However, in actual practice nearly all public secondary schools in Siaya County had their class sizes above the policy standard requirement of a class size. The interest of this study was to determine the influence of class size on students' scores in science and mathematics subjects.

4.3. Influence of Class Size on Learning Output

The study considered class size as a variable that could influence students learning output in public secondary schools in Siaya County. The number of students in a class was measured against the learners' scores so as to establish the influence of class size on learners' scores.

A linear relationship was established through scatter plot also across various school categories. Therefore, a multiple regression analysis was conducted to establish the influence of class size on students learning output. The results are presented in Table 2 .

Table 2: Statistical Measurements of the Class Size on Students Learning Output

Model	R	R^2	Adjusted R^2	β	Constant	Std. error
1	.35[a]	.12	.11	-.35	5.23	.12

N= 60

Source*: *Teachers' questionnaire

Table 2 shows regression results between class size and students learning output in science and mathematics subjects in public secondary schools in Siaya County, Kenya. The Pearson's R = .35 indicate that there was a weak positive linear relationship between class size and students learning output in secondary schools in public Siaya county. The coefficient of determination (R2) yielded a value of .11 meaning that only 11% of the total variation in learning output can be explained by variation in class sizes

The following regression equation exhibit that class size influenced learning output by decreasing learners' scores in the schools within the locale.

$LO = 5.23 - .35X + \xi(x)$

Where: LO represent the students learning output in the locale, X represents Class Size category and $\xi(x)$ is the chance of variation of the predictor variable. The Beta weight (β) value of -.35 predicts that one unit increase in class size caused .35 decrease in students learning output in science and mathematics in public secondary schools in Siaya county. The constant value suggests that the predicted value of students learning output is 5.23 holding all factors constant. The actual value was computed to be 3.99, it is therefore confirmed that the class sizes reduced students learning output (mean score) by 1.24. The standard error of estimate found at .12 suggest that there were other factors not observed in the model which had some influence on students learning output.

From the interviews, respondents were asked to give their views about the prevailing number of students in their classes and the effect on learning. The responses are presented in the following quoted texts.

A principal from an extra county school narrated that:

> *Student numbers in classes have exploded beyond policy requirement, our classes have 60 students and above, meaning a teacher attends to extra 20 students thus teachers are not able to move freely checking progress, some do not check students work and other teachers will not give enough assignments because marking will be a problem and this reduces students' performance too because some students will dodge doing the assignments nor take to the teacher to mark and the teacher will not be able to follow up on every student* (Principal 3, January, 2021).

From the interviews with the principals, it was confirmed that the prevailing huge class sizes were indeed a hindrance to quality learning.

A teacher from a county school reported that:

> *My form 2 chemistry class has 67 students while form 3 and form 4 have 59 and 61 students respectively hence we are not able to manage every student adequately. Additionally, since the school has not been able to avail enough apparatus for every student to have his/ her own station during practical lessons, we resort to teaching by demonstration from one or few stations, this has not been an effective way of learning because only few learn by doing which is key strategy in teaching science subjects and this has negatively influenced our students' performance* (Teacher 12, January, 2021)

A student from a county school narrated that:

> *We are many in our class and as a result, you may find that during a mathematics lesson, some students may engage in doing their own things because the class is congested and the teacher cannot monitor them at the back of the class. Such students have even given up their efforts on mathematic and are constantly performing poorly. Actually in our school, majority of the students need close monitoring which is not sufficient now due to the large student numbers in our classes* (Student 12, January, 2021).

The qualitative findings corroborate the quantitative findings on huge number of students in the classes and that the huge class sizes influence negatively on the students learning and scores in tests. Complementary information is also yielded that teachers are not able to sufficiently monitor individual learners, neither

administer regular assignments nor mark the assignments and this hinder effective learning leading to poor learning output.

These findings are in agreement with the study done by Hong and Sullivan (2013) which reported that academic engagement should involve the intentional course related activities such as participation in class and submitting assignments; that learners who are involved in their work demonstrate high achievement and those who lurk in their academic work achieve dismally. Basing on a study by Warea and Guantai (2005) study in Japan, which indicate that the Japanese government observe class size rule of 42 learners per class and that schools are adequately provided for as prescribed in policy. Warea and Guantai (2005) study reported that this led to great class control and enhanced teacher attendance to all pupils. Guyana education department (2019) also reported that classroom management is key and requires manageable number of students in a class. This study corroborates Ngugi and Thunguri (2017) study which found lack of cohesiveness with big class sizes as most learners are left on their own. Ngome and kikechi (2015) study in Tanzania also found a positive relationship between educational gains and class sizes and reported that educational gains are undermined by the huge number of students who take more than the one year to complete a particular grade.

Table 3: Statistical Measurements of the Class Size on Students Learning Output by category of schools

	Dependent Variable: Learning Output			
Regression Statistics	**Sub county schools**	**County schools**	**Extra county schools**	**National schools**
R	.44	.76	.17	1.00
R- Squared (R^2)	.19	.58	.03	1.00
Adjusted R-Squared R2	.18	.55	-.09	__
Beta β	-.44	.76	-.17	1.00
Standard Error of Estimate (E)	.32	.17	.44	__
Constant	5.07	3.17	4.67	-2.00
Mean Learning output	2.91	3.66	4.53	7.17
Descriptive Statistics				
M	3.39	3.43	3.90	3.50
SD	.58	.75	.32	.71

N= 361

Source*: *Teachers' questionnaire and Students Questionnaire

Table 3 shows the mean enrolment per class whereby; the sub county schools had a mean class enrolment of 3.39 (SD= .58), the county schools mean class enrolment was at 3.43 (SD = .75), the extra county schools had a mean class enrolment of 3.90 (SD = .32) and the National schools mean class enrolment was at 3.50 (SD = .71). This meant that the class sizes in all the school categories was averaging at the class size range of between 46 and 60 students per class. The average students' class size in Siaya County was at an average of 55 students per class, implying that the class size was beyond the policy requirement of 45 students per class.

Table 3 also presents data of a simple regression analysis results between the predictor variable component; class size and the dependent variable; students learning output in public secondary schools in Siaya County, Kenya. Although the class sizes in the various school categories were in similar class size ranges, they posted variations in their influence on learners' scores.

The sub county schools yielded a Pearson's R = .44 which indicated that there was a moderate positive linear relationship between class size and students learning output in science and mathematics subjects in public secondary schools in Siaya County. The R- squared (R^2) computed yielded a value of .20 suggesting that class size in the sub county schools explained 20% of the variations in students learning output in public secondary schools in Siaya County, with the percentage difference being explained by other factors not included in the model. This implied that class size was an important determinant of the quality of learning in the schools. The adjusted (R^2) = .19 confirmed that class size explained 19% percent of the variation in students learning output.

The Beta weight (β) of -.44 for the sub county schools predicted that one-unit increase in class size was expected to cause .44 reductions in the students learning output in the schools. The constant value of 5.07 suggest that the predicted value of the students learning output is 5.07 if the value of class size is at policy requirement of 45 students per class. The actual mean score for the county schools was at 3.35 thus there was a decrease in the students mean score by 1.72 which was caused by the class size. This denoted that, increase in class size contributed to a decrease in students learning output in the schools. The standard error of estimate (E) was found to be .324, suggesting that there were other factors not observed in the model but which had some influence on the students learning output.

The National and county school categories realised a Pearson's R = 1.00 and R = .76 respectively. Thus,

correspondingly the national schools had a perfect positive linear relationship between class size and students learning output and the county schools had a strong positive linear relationship between class size and students learning output in science and mathematics subjects in public secondary schools in Siaya County. The R-squared (R^2) computed was higher in the national schools at 1.00 than the county value of .56 denoting that class size in the National schools explained 100 % of the variation in students learning output while in the county schools, the class size explained 58% of the students' variation in the students learning output in public secondary schools in Siaya County. The adjusted (R^2) = .55 in the county schools confirmed that class size explained over 50% of the variation in students learning output in the schools unlike the national schools where class size perfectly influenced learning output.

The extra county schools registered a Pearson's R of .17 indicating that there was a very weak positive linear relationship between class size and learning output in science and mathematics in the schools. The R-Squared (R^2) of .3 implied that class size explained about 3% of the variation in the learners' scores in the extra county schools.

The standard error of estimates (E) of .444 revealed that there were other factors of magnitude .444 that influenced students learning output in the extra county schools, albeit not observed nor included in the model. These findings link class size to having influence on students learning output though in varying magnitude across different categories of schools in Siaya County.

The following regression equation exhibit that class size influenced learning output by either increasing or decreasing learners' scores in varying magnitude across the categories of schools within the county.

$LO_{SC} = 5.07 - .44_X + \xi (x)$
$LO_C = 3.17 + .76_X + \xi (x)$
$LO_{EC} = 4.67 - .17_X + \xi (x)$
$LO_N = -2.00 + 1.00_X + \xi (x)$

Where: LO_N, LO_{EC}, LO_C and LO_{SC} ; represent the students learning output in the National, Extra County, County and Extra County School categories in the County respectively; x represents Class Size of the school category and $\xi (x)$ is the chance of variation of the predictors.

The study used constant value to predict the students learning output if the value of all other predictor variables are held constant at zero. In this regard, the Equation for the sub county school category shows that holding other factors constant, the learners' scores in the sub county schools would be 5.07 denoting that there would be a decrease in learners' scores by 1.72 from the actual average mean score of 3.35 due to the influence of class size. The Beta weight predicted that one-unit increase in the students' class size caused a decrease in the learners' scores by .44 in the sub county schools which was confirmed by a decrease in the actual mean score by 1.60. The regression equation for County school category indicated that holding other factors constant, the students learning output would be 3.17 implying that there would be an increase of 0.97 in students' scores from the actual mean score value of 4.14. This was confirmed by the Beta weight of .78 for the county schools predicting that, one-unit increase in the students' class size caused an increase in the learners' scores by .78.

For the extra county schools, the regression trend predicted a constant of 4.67 indicating an increase in the learners' scores by 1.94 from the actual average score of 6.61. The Beta weight of -.167 predicts that one-unit increase in the students' class size caused a reduction in the learners mean score by .167. Beta weights of β = 1.00 for National schools predicted that, one-unit increase in the students' class size was expected to cause 1.00 increase in the students learning output which was seen in the increase in the students means score by 6.81.

The learning output is seen to increase even with the increase in class size in national and county schools. However, for the sub county and the extra county schools increase in the students' class size caused the students learning output to decrease.

The study participants were also interviewed so that they could explain their views regarding the prevailing class sizes and their influence on learners' scores. A principal from a county school reported that:

> *The number of students are in excess in all the classes, this reduces teachers' supervision time per student. A learner may not be reached as per stipulated lesson time thus many learners become idle, reducing the amount of learning in the classes, leading to reduced performance* (Principal 8, January, 2021).

A mathematics teacher from a sub county school reported that:

> *My mathematics classes are averagely 55, the large number of students in class interferes with students' attention during the lesson as students who need strict supervision may feel the loose connection with the teacher thus take advantage and simply not concentrate to learn, marking class assignments is a problem considering the number of lessons in week and the student numbers in the classes* (Teacher 24, January, 2021).

A student from county school reported that:

> *We are 71 in our class so a good number of students do not do mathematics*

> *assignments, they dodge, because the teacher is not able to follow up on everybody but assist only those who come up to be assisted during extra time. This has seen our mathematics class mean go down* (Student 15, January, 2021).

The convergence between quantitative and qualitative validate that the class sizes were greatly beyond the policy standards which hindered effective teaching and learning. The teachers could not effectively engage all the learners during a lesson. Some learners who needed constant teacher monitoring were greatly disadvantaged because teacher student interaction was greatly reduced because of the large student numbers in the classes.

Subsequently, the huge class sizes contributed to loose classroom management and leading to reduction in students learning output. These findings are in agreement with a study by Alicea, et al. (2016) which support learning by engagement in science and mathematics subjects for desirable outcomes. Similarly, there is congruence with Warea and Guantai (2005) study on class management policy which suggested that an addition of one student in class be followed with an extra teacher or increased teacher salary and other physical resource requirements for continued effective learning. Similarly, a reduction in the number of students by one in the classrooms could save the government 12 billion dollars which would have been used to maintain quality in those classes.

Hanushek (2008) listed class size as factor input of an education process in his Education Production Function (EPF) model. His findings were varied as some huge and smaller class sizes posted better and lower performance and there was no confirmed nor ascertained order of performance with small or big class sizes. Therefore, classroom management and planning with appropriate teaching resources put into consideration could have a great positive influence on students learning output.

These study findings also concurred with Wolfe (2019) and Gasteen (2019) which found that gender is no longer a hindrance to subject selection and girls have continued to improve in their performance in the STEM subjects as seen in the case of the national schools and extra county schools. However, Elena et al. (2019) found that maths, physics followed by chemistry were perceived as male domains which depicts a contrary finding with the current study's stance that both boys and girls schools did not record a significant difference in performance in mathematics and science subjects. In this study, there were cases where girls outshined boys though predominantly in their cluster of schools.

This study's findings further concur with Janssen et al, (2017) and Burgis (2018) that good seating arrangement promotes good cooperation and interaction between the teacher and the learners. Teachers could not move freely to give the crucial individualised attention to learners because of lack of space within the classrooms. The student desks were placed in the walking spaces due to the congestion, since the classrooms carrying capacity of 45 students was greatly exceeded by 20 to nearly 40 students in a class. Marking all the students' books to monitor their progress in the class assignments could not be sufficiently done before a subsequent lesson. This slowed down teachers' efforts to effectively monitor individual students' progress so as to offer individualised attention that could help the students improve in performance.

The class sizes were significant to this study because the classroom processes have an influence on student engagement during teaching and learning. Learning takes place more effectively when there is student engagement with the teacher (Alicea, Suárez-Orozco, Singh, Darbes, & Abrica, 2016). This is also supported by Ngugi and Thunguri (2017) that classroom dynamics should be analysed well because of variations in class sizes.

4.0. CONCLUSION AND RECOMMENDATIONS

The class sizes though varying per school, nearly all the schools had class sizes beyond the policy standard requirement of 45 students per class which negatively influenced learning. However, reducing the prevailing class sizes to meet policy standard requirement may not in itself be sufficient to improve learning output, unless incorporated with increased teacher student interaction for more individualised learning and availability of the right infrastructure for learning such as; laboratories and laboratory equipment and chemical for practical lessons. Schools were struggling to meet quality standards in classroom planning and management meaning quality learning was a mirage in the majority of the study units. Therefore, most teachers were getting demoralised and demotivated in their work due to the big class sizes which constantly reduced teacher's individualised attention to student thus worsening off the students learning output. Majority of the teachers therefore focused on syllabus coverage rather than individualised learning and this was reflected in the low learning output.

Mixed results with varying class sizes were also realized with this study whereby; some big class sizes posted better learning output while other big classes posted reduced learning output and also compared to the relatively smaller class sizes. This study could place such findings on other factors not accounted for by this study though could have played a role in contributing to the outcome of this study, as depicted by the standard error of estimates.

Policy Recommendation

1. The study findings indicated that large class sizes of over 55 students per class across all school categories contributed greatly to poor classroom planning, management and low learning thus reduced learning output. Hence, the government should increase infrastructure funds for classrooms, laboratories and their content, and subsequently employ more teachers as this will help decongest the classrooms if quality learning is to be realized in schools.
2. In the same vein the government should reduce further the class sizes below the prevailing policy standards to 35 students per class and even lower for practical lessons to a manageable maximum range of between 20 and 25 students for a practical lesson, for increased teacher student individualised attention which is key to quality learning.

Acknowledgement

This work would not have been completed without God's mercies, Glory to Him. Sincere and profound gratitude to my supervisors; Prof. John, Aluko Orodho and Dr. Thaddaeus Ogola Rugar, both of the department of Educational Management, Policy and Curriculum Studies, School of Education, Kenyatta University, for their tireless efforts which enabled the completion of this study. Special thanks to the schools where the research was undertaken. To my family all who helped in one way or the other, may the Almighty God bless you abundantly!

REFERENCES

Alicea, S., Suárez-Orozco, C., Singh, S., Darbes, T., & Abrica, E. (2016). Observing classroom engagement in community college: A systematic approach to educational evaluation and policy analysis, 38(4), 757-782. Retrieved June 20, 2020, from www.jstor.org/stable/44984564

Baluch, H., U., M. & Shahid, S. (2008). Determinant of enrolment in primary education. A case of District Lahore. *Pakistan Economic and Social Review,* 46(2), 161 – 200.

Blatchford, P., Basset, P. & Brown, P. (2011). Examining the effects of class size on classroom engagement and teacher- pupil interaction: differences in relation to pupil prior attainment and primary vs. Secondary. Retrieved from www.researchgate.net.

Bugis, R. (2018). *Seating arrangement in improving student speaking skills at IQRA Buru University. Al-Lisan Jurnal Bahasa (e - Journal)*, *3*(1), 1 – 15.

Burden, P. R. (2020). *Classroom management: Creating a successful K-12 learning community.* Burdens639985.

Creswell, J. W. (2014). *Research design: qualitative, quantitative, and mixed methods approaches*. 4th ed. Thousand Oaks, California: SAGE Publications.

Gasteen, A. (2019). Gender and STEM Subject Choice. *International Journal of Population Data Science, 4 (3). doi:10.23889/ijpds.v4i3.1328.*

Glaser, B. G. & Strauss, A.L. (2009). *The discovery of grounded theory: Strategies for qualitative research.* New Brunswick. Aldine.

Gremmen, J., Yvonnne, H. M., Berg, V.D., Cillessen, E. & Antonius H. N. (2016). Consideration for classroom seating arrangement and the role of teacher characteristics and beliefs. Retrieved from http://www.springerlink.com.

Grover, J. R. & Chingos, M., M. (2011). *Class size: What research says and what it means for State Policy.* USA: The Brookings Institution.

Hanushek, E. A. (2008). *Education Production Functions*. Basingstoke: Palgrave Macmillan.

Korpershoek, H., Harms, T., de Boer, H., van Kuijk, M., & Doolaard, S. (2016). A meta-analysis of the effects of classroom management strategies and management programs on students' academic, behavioral, emotional, and motivational outcomes. *Review of Educational Research*, *86*(3), 643–680. https://doi.org/10.3102/0034654315626799.

Martin, N. K., Schafer, N. J., Mcclowry, S. & Emmer, E. (2016). Expanding the definition of classroom management : Recurring themes and new conceptualizations. *Journal of Classroom Interaction*, 51(1), http://www.jstor.com/stable/26174348

Margare, S. (2005). No child left behind; 10 facts about K-12 education funding. US Department of Education. Jessup.

Movchan, S. (2018). What makes a good learning environment? Retrieved from https://www.raccoongang.com.

Nderitu, J., K. & Njihia, M. (2014). *The use and usefulness of school grants*: *Lessons from Kenya*. UNESCO: IIEP.

Ndethiu, S. M. (2017). Kenyan secondary teachers' and principals' perspectives and strategies on teaching and learning with large classes. Retrieved from https://ir-library.ku.ac.ke.

Ngome, K., C. & Kikechi, R., W. (2015). Educational wastage in Kenya. A threat to internal efficiency in Bungoma County Secondary school education. Retrieved from zeetart.com.

Ngugi, M. & Thunguri, W. (2017). *A critical analysis of the impact of classroom dynamics on students' social*

interaction in Secondary Schools in Kenya. European journal of education studies, 3(1), 30-36. doi:10.5281/ze nodo.244292

OECD, (2014). *Education at a glance.* Paris: OECD Publishing

Omatsu, G. (2020). Understanding Classroom Dynamics: A Critical Factor in Teaching Freshmen. Retrieved from https://www.csun.edu.

Orodho, J.A. (2012). *Elements of education and social science research methods.* Maseno; Kanezja Publishers.

Orodho, J., A. (2014). Financing basic education: What are the equity and quality implications of Free Primary Education (FPE) and Free Day Secondary Education (FDSE) Policies in Kenya? *International Journal of Development Research, 4*(3), 477-487.

Orodho, J. A. (2017). *Techniques of writing research proposals and reports in education and social sciences: An illustrative approach to scholarly excellence.* Nairobi: Kanezja Publishers &Enterprises.

Orodho, J., A., Ampofo, Y. S., Bizimana, B. & Ndayambaje, I. (2016). *Quantitative data management: A. step by step guide to data analysis using Statistical Package for Social Sciences.* Nairobi: Kanezja Publishers & Enterprises.

Orodho, J., A., Nzabalirwa, W., Odundo, P., Waweru, P., N. & Ndayambaje, I.

(2016). Quantitative *and qualitative research methods: A step by step guide to scholarly excellence.* Nairobi: Kanezja Publishers &Enterprises.

Republic of Kenya (2012). *Kenya Vision 2030 Medium Term Plan to Education and Training 2013-2018* Nairobi: Government Printer.

Republic of Kenya. *(2013). Basic Education Act 2013*. Kenya. Nairobi: Government Printer.

Republic of Kenya. (2020). *Secondary schools 2020 fees structure for national schools, extra county, county, sub county and day schools.* Retrieved from https://teacher .co.ke.

UNESCO. (2014). *The Kenya Vision 2030*. RTRIVED from https://www.unesco.org.

UNESCO. (2015a). *Education 2030 Framework.* New York.

UNESCO. (2015b*). EFA Global Monitoring Report 2015; Education For All 2000- 2015, Achievements And Challenges*. Global education monitoring report. Paris: UNESCO.

Warea, M. R. K. & Guantai, L. (2005). Class size: Effect on achievement in East and Southern Africa. *International Invitational Educational Policy Research Conference*, Paris, France.

WHO (2019). Global Spending on Health: A World in Transition. World Health Organization.

Zingier, D. (2014). Class size and academic results, with a focus on children from culturally, linguistically and economically disenfranchised communities. *Evidence base,* 2014(1): 1-24, doi10.4225/50/5582118f8790.