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Nature of mathematics homework in secondary schools in Kenya

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Abstract

Mathematics is a central subject in most national school curriculums designs before students move out to specialist pathways. This study investigated the nature and context of mathematics homework through a cross-sectional descriptive survey across Kenyan secondary schools. A total of 2000 students were used to obtain their responses through self-administered questionnaires to selected students and their 153 teachers in 50 schools around Kenya. The sample was stratified by gender, class and by residential status of students. Data were analyzed using SPSS software using descriptive and inferential statistics. It was found that homework is used in all schools, with little change in format. Homework was given in all schools visited, it was the same for all students, sourced from the class text and always given at the end of the lesson. The study found no significant difference in the time boys and girls take in homework, but found significant differences between boarders/day scholars and Form 2/Form 4 students in the time they spent in homework with boarders and Form 4s spending more time on homework. It suggests ways of improving the management of homework for better student learning in mathematics.

Key Words: Kenya; Mathematics homework; Homework organization; Gender in mathematics

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Introduction

Mathematics is considered important for scientific and technological development and consequently, is a compulsory subject in the Kenya secondary school curriculum, (Cockcroft, 1982; Travers and Westbury, 1989; Kimani, 1998; Rivkin, Hanushek & Kain, 2005). The place of mathematics in science and technology has been lauded as being "at the centre of socio-numeric transactionism and technological development (Gunga, 1998) and as the foundation stone of Scientific and Technological education (Kimani, 1991; Igbokwe, 2003; Reddy, Van der Berg, van Rensburg, & Taylor, 2012). According to Kuhr (1990) the social and economic development of any country or continent could be measured in terms of its development in science and technology. Being such an important subject to Science and Technology, Mathematics is a compulsory subject to all pupils in all countries in the world. Three international studies on the teaching and learning of Mathematics were based on such considerations (Hussen, 1967; Travers & Westbury, 1989). For this reason mathematics is a central subject in national curriculums taking 12 to 15% of instructional time in school (Travers & Westbury, 1989; OECD., 2014). Further mathematics is even more important than literacy in predicting future earning ((Crawford and Cribb, 2013; Duncan et al, 2007). In view of the importance of mathematics in society and in the schools, the efficacy of mathematics teaching and learning demands continued and sustained scrutiny.

The problem of poor performance in mathematics is worldwide. For example, Holmes (1983) reported low performance (with many failing) in Mathematics in Israel, although this has since improved to make Israel a worthy competitor in TIMSS rankings (RAMA, 2017). Similarly poor performance has been cited in Nigeria, (Igbokwe, 2003; Alordia, Akpadaka & Oviogbodu, 2015) and in South Africa (Van der Berg and Louw, 2006) and in Kenya (KNEC, 2010). The problem of raising mathematics performance has been widely discussed (Kline, 1980; Nichter 1980, Republic of Kenya, 1976; Daily Nation, 1998; National Mathematics Advisory Panel, 2008). Mathematics performance in Kenya generates a lot of comment from all walks of life, the political and academic elite and from general readers of public newspapers. The government of Kenya has also put in their leadership by changing the mathematics curriculum design four times in the last 55 years; first with the traditional Mathematics in the 60s, the new/modern in the 70s, and lastly the appropriate mathematics since the 80s, and now the new CBC approach of the 2-6-3-3 system.

According to the Merriam-Webster dictionary, homework is defined as a piecework done at home for example, an assignment given to a student to be completed outside the regular class period or preparatory reading or research (as for a discussion or a debate). For clarity in this paper, it may be added that it is assigned by or in conjunction with a teacher in class to be done after lesson time, no matter where it is done. It may be done within the school, at home, or elsewhere. Some may refer to it as assignment, perhaps to emphasize that it is given by the teacher, and to remove the association with the home for boarding schools. Almost every pupil in Kenya is familiar with homework, being an old instructional technique. Most mathematics textbooks contain many exercises after every topic which students are expected to work on with the assumption that students would attempt/or do the problems after the explanations, and in so doing learn mathematics (Leder and Gunstone, 1990).

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Statement of the Problem

At the secondary school level of the current 8-4-4 system, there are seven and six instructional periods per week for mathematics, which works to about 15% of the school time. Mathematics also receives the largest amounts of homework and tuition. Yet mathematics is usually the lowest performer in the secondary school examination. For example in the 2016 Kenya Form 4 examination, KCSE, the mean grade was D with 50% of students scoring the fail grade E (KNEC, 2016). One wonders why Mathematics which is given so much time on the timetable is the least well performed in Kenya national examinations. One would expect that, other things being equal, time allocated to a subject would be roughly related to achievement in the subject (Paden & Stell, 1997; Psacharopoulos, 1986; Krohn & O'Conner, 2005). Other research, however, seems to show no significant relationship perhaps because allocated time is only a rough indicator of time actually spent learning, (Rosenshine & Berliner, 1978; Nonis, 2005; Ng et al., 2014). Coulter (1979) argues that out of class learning especially homework is an important factor not considered in such time-achievement studies.

Though there is plenty of research on factors that contribute to success in mathematics there is a dearth of literature on how homework is organized in Kenya or how it contributes to failure or success in Mathematics. Homework is a variable that teachers themselves can alter to improve learning in mathematics. Mathematics homework can serve as feedback to the student and teacher in the learning of mathematics. Have the skills learnt today been mastered? Are the students ready to move on to the next topic? But it can also be used negatively, perhaps unwittingly, to convince the student that they are not good at all in Mathematics. There hasn't been so much research locally on what is done, how it is done, and how homework (like classwork) can be planned to meet the needs of different pupils and to allow all pupils equal opportunities towards success in mathematics.

Literature Review

Good mathematics performance in school is important. Students who avoid Mathematical courses also tend to avoid courses that need Mathematics, (Sells, 1976), while students who choose to study Mathematics are more likely to pursue science courses, (Thomas, 198; Bethell, 2007). One reason pupils could do poorly in mathematics is from their low motivation that results from poor teaching methods. Good and Brophy (1987) suggest that for students to be motivated to learn they need a supportive environment, appropriate level of task difficulty and meaningful practice on learning objectives.

Homework is one such aspect of teaching mathematics, being one of the teacher's strategies (Eshiwani, 1983; Caillods and Postlethwaite, 1989; Stern, 1995; Arends 2011; NCTM, 2014). OFSTED (1995) in their report on homework concluded that homework has the potential to raise standards, extend the curriculum coverage, allow more effective use of class time and improve students' study skills and attitudes to learning. ILEA (1984) also called the Hargreaves Report (1984) similarly emphasized the importance of homework in cutting down instructional time in British secondary schools. Yet, homework is either ignored or given the least attention in Education courses (Stern, 1995). Nevertheless, homework, practice and drill must be well organized , not

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mere proven instruments of student control (Butler, 1969 ; Grambs and Carr, 1979; Klieband, 1995), and it must be motivating.

Ashworth (1981) advocates that teachers select homework carefully to ensure that students can do most or all the problems given, otherwise homework would just be a proof that they are not good in mathematics. In secondary education homework can contribute the equivalent of at least 20% saving in full time study and that poor homework policies contribute to enlarging the achievement gap between higher and lower achievers (The Hargreaves Report, 1984) , it can teach autonomy (Spandano, 1996), and is an equitable way to raise student achievement (Calloids and Posthewaite, 1989; Arends, 2011). Some studies, however, argue that homework can be a waste of time and does not promote achievement (Nonis, 2005; Nonis and Hudson, 2010; Kirkorian, wartella & Anderson, 2008). Studies have focused on mathematics student factors in relation to mathematics performance such as SES, aptitude, and attitude, but this study focuses on the nature of homework and the context in which it is performed. Duckworth and Seligman predicted that self-discipline in studying alone is a good predictor of school achievement and that peer support is more important than family support in assignments (Rao & DiCarlo, 2000; Goethals, 2001; Giuliadori, Lujan, and DiCarlo, 2006).

In Kenya gender differences in mathematics performance have been reported in favor of boys, in terms of the mean score or numbers attaining a pass in high school mathematics (KCSE, 2011). Boys are reported to outperform girls in mixed schools, while girls do much better in mathematics while in single sexed schools (KNEC, 2007). Gender differences in mathematics have been ascribed to various factors such as differences in math anxiety levels (Devvine et. al, 2012), social economic status (aspirations (Mwathi, 2000; Miller Byrnes and Miller), attitude (Gutzzel 2004 and gender bias (Spiel man, 2008), Scantlebury, 2012 and teacher practices (Bayazit & Gray) 20004; Jung and Chung, 2005).

Research Questions

The study attempted to answer the following research questions:

1. What is the nature of mathematics homework given to secondary school students in Kenya?
2. What is the context of such homework?
3. Does time spent on homework differ by student characteristics (gender, class and boarding status)?

3.1 Hypotheses of the study

The following three research hypotheses were used to answer research question 3, tested from the data.

- i. HO1: There is no significant difference in the time taken on homework by boys and girls.
- ii. HO2: There is no significant difference between boarders and day scholars in the amount of time taken in homework.
- iii. HO3: There is no significant difference in the mean time taken on homework by Form 2s and Form 4s.

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Methodology

This study was a cross sectional survey that sought to describe homework , context in terms of student gender, boarding status, class, time and the place where homework is done. A random sample of twenty students per class was selected in Form 2 and Form 4 at each school. Three mathematics teachers for the mathematics classes were also picked to fill a questionnaire. Self-administered questionnaires for students and teachers were used, which had both structured and open items. A lesson observation schedule was used in a few selected classes as a way to contextualize and triangulate the questionnaire data. Data collected were entered into computer, cleaned and analyzed using SPSS software.

Results and Discussion

All in all 1783 students responded to the questionnaire making 87.4% of the expected return. The students were from rural (43%), semi-urban (34%) and urban (23%) locations around the country. The student mean ages were 16 years and 18 years for Form 2 and Form 4 students respectively. Boys were significantly older than girls with means $M_1 = 17.27$ (1.46) and $M_2=16.88$ (1.27) respectively. This seems consistent with the observation that the better students, with minimum repetition in classes are more likely to go to boarding (read relatively better) schools while the weaker go to day schools. The age groups are summarized here below in years:

Table 1

Mean Ages of Students by Gender and Class.

Class	Gender	No.	M (yr.)	SD (yrs)
Form 2	Boys	442	16.32	1.07
	Girls	452	15.98	0.90.
Form 4	Boys	428	18.26	1.12
	Girls	448	17.79	0.90

In almost all schools visited, 96% of teachers reported assigning homework at each mathematics lesson. Only in a very few classes was weekly homework assigned. However, the frequency of assigning of homework seemed more of an individual teacher characteristic, than a school one. 84.6% of students reported that their homework was checked regularly, though frequently by themselves. Homework was always given by the teacher, and sourced from the class text (91%) or from past papers as mentioned by 52% of teachers. Only 26.7% of teachers said that all their students' complete homework that they assign, with single sexed schools rated higher on completion than coeducational schools. The teacher who considers student difficulties when

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assigning homework is more likely to encourage students towards ownership of homework (Spadano, 1996). Among these respondents, 373 (71%) complained of some aspect of mathematics teaching and learning in relation to homework. It is in mathematics more than in any subject that the teacher's skill is most valuable (Cockcroft, 1982; Fenennema and Sherman, 2000; and Bayazit and Gray, 2004).

On marking, 52 teachers (36%) reported that they rarely marked students' work with teachers in girls' schools reporting a higher percentage than average (twenty teachers or 44%). 40% of the teachers reported that they mark all homework. We should put a caveat in interpreting this percentage because a number of comments from students implied that teachers may mark only books of selected few students or ask students to mark for themselves. The methods that teachers found practical to homework were mainly: commenting on difficult problems asked by students in class (42%), marking each pupil's work (38%) and providing answers for students to mark for themselves (18%). Homework was reported as marked regularly by more (5% points higher) boys than girls, and by more form 2 than form 4 students. From the data, more girls than boys did not mind non-completion of homework, a form of gender bias, which could negatively affect learning in mathematics (Scantlebury, 2012). Similarly, Orton (2007) wrote that teachers in mathematics classes paid more attention to boys than girls. About 90% of teachers reported to giving answers to assignments at the beginning of the next lesson and any issues arising discussed.

On the worst thing about homework according to teachers, 43% indicated that they were concerned about students copying each other's work, 22% complained of homework being too much work for the teacher to mark, while 17% said students never complete homework. It was also reported by five teachers that homework may lead to students practicing errors. This shows that teachers themselves were not excited about homework, but they still assigned it. On an open question about any other remarks about mathematics homework by teachers, 32% of the teachers commented on the importance of homework, 18% complained of student attitude to homework, while another 8% complained of class size and teaching load. It was noted that students do not mind the frequency of homework (after every lesson) as they believed practice is important, but they were not happy with the amount of homework, as evidenced by the 60% of students expressing dissatisfaction with the amount of homework. Two student remarks here may help clarify this dissatisfaction with homework:

Give us about 5 problems, not 30 like we are given so that you can finish quickly, practice and reread what you did. In addition, a lot of homework in mathematics consumes a lot of time and discourages students who are unable to do hence they copy from friends or guess (cook') so as to avoid bad comments from our teacher and punishment [Girl, 50: 4-2].

"Personally, I don't think that a lot of homework helps much since you may be given a lot, yet you did not understand thus it may even discourage you. Therefore a little homework perfectly done and lots of personal practice is what helps students to pass maths" [Boy, 42:2-8].

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When asked what was the worst thing about homework, over 70% of student comments centred on homework amount, and having to work on it alone. About half of the students regardless of gender, class or boarding status thought that homework was too much work. Actually more boys than girls thought that the worst thing about homework is working alone. Day scholars, regardless of gender, were 10 % points more in their worry on this working alone (Day scholars 27.6% vs. boarders 17.3%) . one may have to guess why this is so. Interestingly more girls (29%) than boys(19.8%) in Form 4 thought that working alone was a worst thing about homework, a reversal from the Form 2 figures (Boys 27.8%, Girls22.8%). According to Duckworth and Seligman (2005), studying alone implies self-regulation and learnt discipline. They reported that this self-regulation and discipline are even more important in predicting achievement than even IQ. Well-organized homework could help develop students' independence (Ofstead, 1995).

Where is homework usually done? One expects mixed responses to this item because of the varied locations from which student's school. Of the 1748 students who answered this question 70.3 %, 12.7%, and 13% reported that they usually do their homework in class, sitting room and /or in a bedroom room at home. The class is likely to be free of distractions (except in poor discipline schools), and more comfortable too. Fortunately, 92% of boarders and about 45% of day scholars used the class, as the place where they usually did their mathematics homework. Only 44 % of girls and 47% 1 % of boy day scholars did their homework in class in the school, which means more than half of day scholar students completed their work at home. Relatively fewer girls than boys were left in class to finish homework after school, possibly because they were expected home on time, and were more likely to be assigned other household chores like looking after younger siblings or helping in the kitchen. The percentages of boys and girls who did their homework in a bedroom /private room are 26.7% and 25.7% respectively. Such a girl student could be punished for not completing homework but she was the one more groomed to be a responsible member of the society.

At home students studied in the sitting room or in the bedroom. At home, more boys (25.2%) than girls (20.1%) seemed to do homework in the sitting room or a private room. The sitting room in a residential house is more of a common room, a more distracting environment — the television is there, and other members of the family use it as a social room. The bedroom/private room has fewer distractions but it is likely to be shared by other family members and possibly lack in necessary furniture. Some students may not have a study desk in the bedroom and resort to doing homework on the bed. The situation for boys is likely to be different, especially in the rural areas where boys have out huts, which nevertheless may be shared by other boys in the family. This has implications for homework. The work output of a boy intending to do homework might be influenced by the work ethic of the other occupants of the hut. For boys, this might also make the problem of asking for help from friends, in case of difficult homework, easier.

When do students prefer to do their homework? Table 2 provides a synopsis of the responses. Generally, the early mornings seemed to be a preferable time for students (over 50%)

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to do homework. The percentages of students who preferred to do homework in the early morning are higher for the boarders than day scholars and for girls more than boys regardless of their residential status. Day school girls are more likely to be involved in household chores in the evening and be very tired at the end of the day, preferring to study, do homework, early in the morning. Relatively more day school boys than girls may have studied in the evening because they had relatively fewer responsibilities in the evenings. Some boarding schools, especially boy's schools, allowed boys to stay on after the compulsory prep at about 10 p.m. In mixed boarding schools it was noted that boys were likely to have more prep time in the evening since girls were asked to leave for their dormitories about thirty minutes before the boys did, ostensibly to prevent them from mingling mischievously with the boys. Working on homework after prep for both boys and girls in such schools seems more unlikely for the same reason of caution.

As seen in Table 2, relatively a higher percentage of day, scholar s than boarders seemed to prefer doing their homework in the evening/night teacher was assigned students who do homework in the evening might remember what was taught what was taught in class more readily, but they are likely to lack Concentration due to tiredness. Should they require help from neighbor student s. the time may also present problems especially for the girls.

Table 2

Percentage of Students and Preferred Homework Time

Group	Gender		Morning (%)	Evening (%)
Day	boys (385)	53.1	41.1	
	Girls (408)	60.1	36.8	
Boarding	Boys (445)	57.5	39.6	
	Girls (447)	66.1	29.8	

Some day schools required their students to stay on after Lesson time (about 4 00 p.m.) to do their own prep. This gave day school students an opportunity to complete homework in a convenient environment. These preferred times for doing homework might, however, be disrupted if enthusiastic teachers came to class during such times to cover teach.

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Table 3 shows the responses to the question "Who helps in case of difficult homework?"

Table 3

Persons Who Help in Difficult Homework by Class/Gender (%)

Class	Gender	Parents	Teachers	Friends
Form 2	Boys n = 341	4.9	16.9	71.1
	Girls n = 357	6.7	24.3	65.2
Form 4	Boys n = 359	2.4	17.9	77.2
	Girls n = 376	1.8	16.4	78.2

Girls in Form 2 seem to have relied on teachers more than boys, and relied less on peers than boys. In Form 4, the percentages of boys and girls are comparable. Note, however, that the percentage of boys in Form 2 and 4 who asked the teacher for assistance seems to remain unchanged while the percentage of girls who asked the teacher for help drops significantly. The reader may note the different percentages for day scholar boys and girls in Table 3; in whom they asked for help. One also notes that only about a quarter of the students consulted the teacher when faced by difficult homework. The help patterns was similar for boys and girls in boarding schools with about 79% seeking help from friends, compared to 65% in day schools. More day scholars mentioned the teacher as the source of help more than boarders (22.5% vs. 14.8%). A close study of the patterns in individual schools also showed that Form 2 students especially sought help from the teacher. It is puzzling to find that in schools where pupils reported more punishment, more pupils also sought help on homework from the teacher. One explanation is that some pupils may have been trained (or learned) to be independent and confident in homework while other students might wish to attract teacher attention through asking questions related to homework.

Day scholars, who usually dispersed from school after lessons, may have been particularly disadvantaged. They scattered away from their friends and may have been limited in the consultation they would get from the easily accessible neighbours. They would be at a disadvantage because the friends were not around and the teacher didn't seem to be as accessible as one would suppose. In towns the problem is likely to be exacerbated since houses of fellow students are scattered over the suburb or even in different suburbs, and where culture may discourage 'unnecessary' visitors in the spirit of privacy. In such a case, the pupil is likely to be

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discouraged, spend time practising errors or even feel frustrated, all with negative consequences in achievement. Day scholar girls were less likely to get help from especially if homework was done in the evenings. Girls are more likely to be assigned nonacademic chores around the house after school, and are less likely to be allowed out into the night, possibly due to the extra protection that is usually accorded girls in the Kenya African culture.

Some students, especially in day schools, got help from parents with more girls getting such help but decreasing from Form 2 to 4. We may note the relatively higher percentage of students in Form 2 who received help from parents compared to Form 4. This is likely to motivate such students to learn mathematics. The Percentages of students who received parental help in homework got lower at Form 4 as possibly the content became more technical for the parent, and as the student got more independent. Another interesting observation is the fact that boarders seem to get help more help from friends (79%), while a higher percentage of day scholars gets help from the mathematics teacher(s). Some 307 students gave a second choice, and when that is taken into consideration the percentage of students who consult friends, teachers and parents add to 74.6%, 33.6% and 5.5 % respectively showing that friends, peers are the most important source of help for mathematics homework. This needs to be strengthened as it agrees with previous research on the positive effect of peers in raising achievement (Rao & DiCarlo, 2000; Hanushek, Kain, Markman, & Rivkin, 2002 ; Giuliadori, Lujan, and DiCarlo, 2006).

Students were also asked if their teacher minded if homework was completed or not. The percentage of students who thought the teacher did not mind was 16%,. But this seems to increase from Form 2 to 4 from 13% to about 20%. Whereas boys and girls in Form 4 had the same percentage (19.7%), girls in Form 2 are 5% points higher than the boys (15.3% and 10.2%). Why should more Form 2 girls than boys have thought that teachers did not mind completion of homework? Perhaps teachers were more lenient to younger girls, (possibly the teacher seeing the girls innocence in non- completion) or more girls than boys simply did not complete homework. This may also be a case of teacher gender bias, which could lead to underperformance in mathematics (Scantlebury, 2007). This may have implications for teachers in terms of pacing mathematics independence towards higher classes.

Objective number 3 on comparison of time spent on homework by gender and boarding status was answered through testing the stipulated hypotheses. There were three hypotheses tested during the study. The self-reported time spent on homework was averaged to get a mean for each of the cohorts compared. The two sample means were then subjected to the independent samples t-test to determine if they were significantly different.

HO1: There is no significant difference between boys and girls on the time they spend on Homework.

HO2: There is no significant difference between boarders and day students in the time they spent on homework.

HO3: There is no significant difference between form2 and form 4 students on the time they spent on mathematics homework.

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The independent t- test for gender differences showed that the time spent by boys and girls in homework was not significantly different, ($t(2) = 0.840$, $p = .401$). On the hypothesis on time spent on mathematics by students' residential status, the result was highly significant with boarders spending more time on homework than day scholars, $t(2) = 5.921$, $p = .000$. This agrees with Alordia et. al.(2015) who also found differences in the performance of mathematics between students from higher SES locations significantly outperforming those from lower SES locations. Finally, on the comparison between time spent on homework by class seniority, it was found that Form 4 spent significantly more time on mathematics homework than Form 2 students.

Conclusion and Recommendations

This study has implications for the organization of homework in our schools. There is a need to talk about homework in our teacher training curricula and ways to support out of class learning. Students seem to get more help from peers, so this could be factored in assignments for example by requiring homework to be done in groups. This study showed that peers are an important way of learning mathematics through homework. Further, there is need to investigate a little more on the extent homework to which homework could facilitate collaboration and communication between students, and in developing learner autonomy in mathematics in the manner proposed in the new BECF curriculum (KICD, 2017).

There is need to get each teacher and students to be educated on the homework policy of the school through some relevant office. Such office should co-ordinate the amount and quality of homework assigned by different departments in a school. Pupils who don't finish their work could be referred to such a person. It is suggested that the Guidance and Counseling teacher or Director of Studies office could perform such a function. Such a teacher could support to ensure pupils are left with a teacher to guide them if necessary.

For day schools, there should be community study centers for day scholars to mediate, and equalize the effects of the home. Rural electrification which has been championed by the current government should help in such efforts, for students to study jointly in the evening. Such centres could stock some common books for mathematics. Members of the community could organise how to supervise such study. This could be done through community initiatives. The day schools can lead in such activities by opening up their facilities to their students and community after official school hours and during holidays.

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