Learning Time of Day and Students' Academic Achievement at School Certificate Level: A Case Study of Chibote Girls' Secondary School.

Dr. Henry M Mulenga[1]   Angel Mukuka [2*]

1.School of Mathematics and Natural Sciences, Copperbelt University, P.O Box 21692, Kitwe, Zambia
2.School of Mathematics and Computer Science, Mukuba University, P.O Box 20382, Kitwe, Zambia

Abstract
A case study presented here is an investigation into whether time of day for instruction has an effect on students' academic achievement in Mathematics, Science, Biology and English at school certificate level by focusing on the grades candidates obtained after sitting for national examinations. The focus is primarily on 33 randomly selected morning and afternoon pupils at Chibote Girls Secondary School. We hypothesized that morning pupils perform better than afternoon pupils owing to the fact that pupils who learn in the morning have a higher retention rate as compared to those who learn in the afternoon when the temperature is quite high. This hypothesis was tested using a non-parametric Mann-Whitney U test which showed that there was no statistically significant difference across the categories of the two learning modes in Mathematics, Science and English. Furthermore, the same results were analysed through a component plot in rotated space (factor analysis) which showed a significant difference in students' performance between Mathematics and English for both learning modes. Descriptive statistics were computed and the general picture was that pupils performed poorly in all the four subjects with mathematics placed at the tail and English in the lead.
Keywords: Learning time, Academic achievement, Core subjects.

1. Introduction

One of the purposes of teaching and learning Mathematics, Sciences and English is to equip the learner with knowledge and skills to live effectively in this modern age of Science and Technology and to enable the learner to contribute to the social and economic development of the nation. This is why those subjects are examined at Grade 7, 9 and 12 levels of education in Zambia. It is a requirement by higher institutions of learning that a candidate obtains a credit (i.e. a 6) or better for them to be considered for training and the world of work. However, performance in the above mentioned subjects at all levels, over the years, has been poor. One major challenge faced by some candidates is a lack of mastery of the content.

In Zambia most secondary school class schedules are randomly assigned to students, and therefore, students have classes in mathematics, english and sciences at various times of day. Since time-of-day for most secondary school classes is assigned by chance, students may not be learning at their optimal times. Sjosten-Bell (2005) reported that teacher workroom conversations often center on how to motivate students in afternoon classes, and teachers consistently report their afternoon classes are harder to teach. So the present study positions itself in finding out whether afternoon classes perform poorly in the four core subjects as compared to the morning classes. According to a policy document on education, Educating our future (1996), mathematics, science, biology and english are considered to be the four core subjects in the Zambian secondary school curriculum.

1.1. Statement of the problem

Unemployment levels among the youths of today are quite high and this has become a major concern among most Zambian communities. The blame has always been shifted to government's failure to provide more employment opportunities especially to the school levers. However, some school levers have got no access to tertially education in the sense that the minimum requirement for one to be given a place at a Zambian college or university is a credit in five subjects which in most cases should include one or more of the core subjects (English, Mathematics, Science and Biology). Unfortunately, the low proportion of learners obtaining a credit or better especially in the natural sciences at school certificate level has been quite prominent. For instance, an ECZ 2014 performance report revealed that, "a total of 284 627 candidates sat for the mathematics examination in 2014. Of the candidates that sat, 1524 (0.52%) got zero in Paper 1 and 16 823 (5.6%) got zero in Paper 2. The mean performance in paper 1 was 35 percent and paper 2 was at 22 percent. A report such as this one is quiet alarming and it is imperative to findout whether there is a significant difference in academic achievement between the regular pupils who learn in the morning when the temperature is a bit lower as compared to afternoon pupils who usually have their lessons in the afternoon when the temperature is quite higher. Another compelling ground for the conduct of the present case study is the fact that Chibote Girls' Secondary School decided to stop offering afternoon classes by claiming that afternoon pupils performed poorly as compared to

morning classes.

1.2. Objectives of the study
The study explored the following objectives:
1.2.1.   To findout whether there is a difference in performance between the morning and afternoon pupils at Chibote Girls Secondary School.
1.2.2.   To find out whether there is a difference in performance among the four core subjects at Chibote Girls' Secondary School.

1.3. Research questions
The above objectives translated into the following research questions:
1.3.1.   Is there any difference in performance between morning and afternoon pupils at Chibote Girls' Secondary School?
1.3.2.   Is there any difference in performance among the four core subjects at Chibote Girls' Secondary School?

2.   Literature review
The issue of the relationship between school schedules and the effectiveness of learning arises from time to time within the framework of discussions of holistic changes in educational institutions. In some schools it is assumed that the time of day at which different subjects are taught, morning, noon or afternoon, does not signicantly influence the quality of learning. Therefore, responsibility for scheduling is given to administrators, whose planning considerations are technical rather than psycho-educational. But a study conducted by Klein (2001) revealed that there were significant differences in attention levels at different times of day: the later the hour, the lower the level of attention. Additionally, a study conducted by psychologists, Serge Onyper and Pamela Thacher at St. Lawrence found some statistical data proving a correlation between class time and preformance. They concluded that "for every hour of class that you have later, you get about a .02 difference, so three hours of difference between class start times would result in a .06 difference in grades".

Furthermore, it is believed that different people function more efficiently at different times of day. In educational settings, this can affect whether students are performing at their best during instructional and testing times (Hartley &Nicholls, 2008). Time-of-day when academic subjects are taught could affect student achievement. Millar, Styles and Wastell (1980) claimed morning learning is associated with superior immediate recall when compared to learning in afternoon or evening. Biggers (1980) also believed that at this age (high school pupils) attention is greatest in the morning and decreases during the rest of the day.

Accumulated findings point to the need to map attention levels among pupils who represent a broad spectrum of cognitive capacity at all hours of the school day, over a wide range of ages and in a variety of disciplines representing different cognitive processes. This should facilitate adaptation of different subject schedules in every school to the effective learning hours of its pupils. Although we are not aware of any studies of this sort conducted in Zambia, the goal of the present study was to ascertain whether statistical evidence will approve the claim that morning pupils at Chibote Girls' Secondary School in Kitwe District performed better than afternoon pupils especially in the four core subjects. Furthermore, the present study also positioned itself in determining whether results from the past research done outside Zambia would be in line with a typical Zambian secondary school for girls.

3.   Methodology
3.1. Data collection and sampling procedures
Data was collected from the guidance office at Chibote Girls Secondary School with the help of Mr. Mwilima Lubinda, who is, at the same time, a teacher of mathematics at a named school. We randomly selected examination results for 33 candidates of which 20 were coming for lessons in the morning while the other 13 attended their classes in the afternoon.

3.2. Data analysis
Some descriptive statistics were computed from the grades obtained for all the 33 candidates in English, Mathematics, Science and Biology to get the general picture regarding their performance on average. Thereafter, the sample was split into two learning modes (morning and afternoon) to determine whether there was a statistically significant difference in performance between morning and afternoon pupils using a non parametric Mann-Whitney U test. In our present study, we settled for this test owing to the fact that the normality assumption was open to doubt. In other words, our research questions were not developed on the premise that heavily depended on the shape of the distribution nor did we pay attention to the parameters of the underlying population. As indicated in the following section (Results and findings), our null hypothesis for each of the four subjects was that the two samples came from identical populations. The Mann Whitney U test was conducted in

search for answers to our first research question.

Finally factor analysis was conducted to determine whether there was a difference in students' academic performance among all the four core subjects. This technique was employed in search for answers to our second research question. The compelling ground for the use of such a technique was due to the fact that there was a systematic interdependence among the four subjects and we were interested in finding out something more fundamental or latent, which created the commonalities or differences in performance among all the four core subjects. It is well known by statisticians and other data analysts that factor analysis is not a single unique method but a set of techniques. In this respect we chose to use a principal component method which eventually helped us to point out some interesting relationships among the four subjects that might not have been obvious by a mere inspection of the input data alone.

4. Results and Findings
4.1. Difference in performance between the two learning modes

Generally the performance of the candidates was below average in all the subjects. This is due to the fact that the proportion of those who failed was higher than those who passed except for English. Table 1 below gives percentages of the grades obtained in each of the four subjects. The percentages have been computed by considering the number of candidates who obtained a particular grade divided by the total number for that particular group and then multiplied by 100. The grades were categorized as follows: Distinction (1 & 2), Meritorious (3 & 4), Credit (5 & 6), Satisfactory (7 & 8) and Fail (9).

Table1: Summary of grades obtained in percentage.

	Maths		English		Science		Biology	
Grade	Morning (n = 20)	Afternoon (n =13)	Morning (n = 20)	Afternoon (n=13)	Morning (n = 20)	Afternoon (n =13)	Morning (n = 19)	Afternoon (n = 13)
Distinction	0	0	0	0	0	0	0	0
Merit	0	0	20	8	5	0	11	0
Credit	20	23	30	0	5	0	32	8
Satisfactory	10	8	50	92	70	46	47	77
Fail	70	69	0	0	20	54	10	15

Results from Table 1 indicate that the performance in all the four subjects was below average and no distinction was recorded in any of the four subjects across the two learning modes. However, there is an indication that the sampled candidates performed better in English as compared to the other three core subjects. In this case we suspect that girls perform better in English as compared to the natural science subjects but a study is required to justify this claim or suspect. In addition, Table 1 results indicate a slight difference in performance between the two learning modes. Morning pupils performed better in English, Science and Biology. For easy comparison, we present Table 1 results pictorially in Figure 1 as shown below.
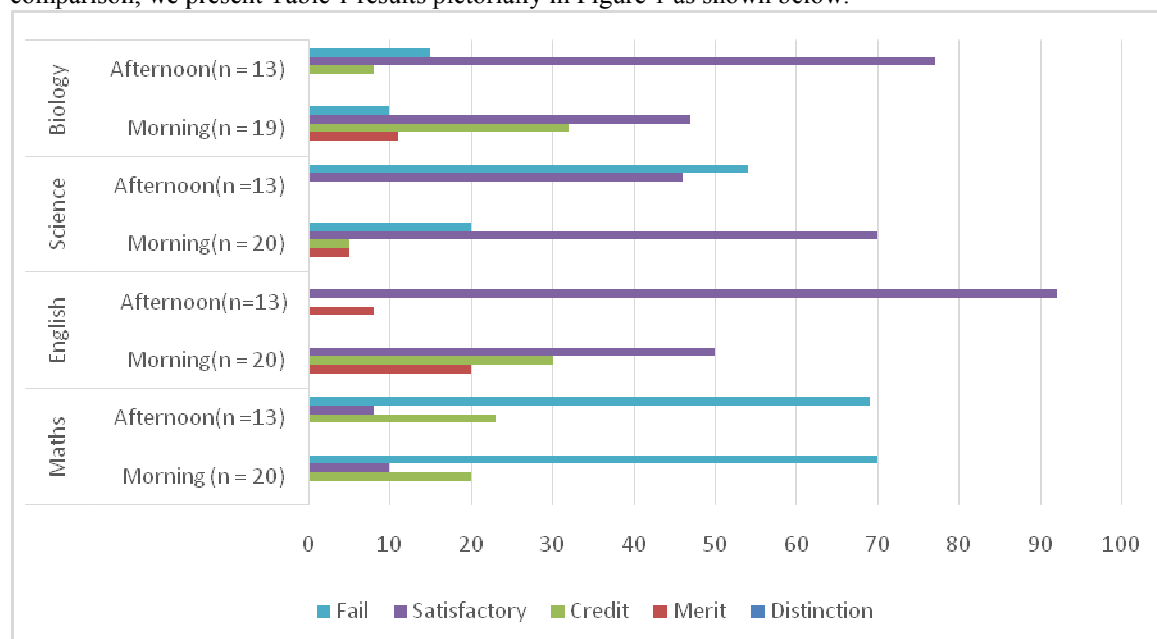

Figure 1: Comparisons of the grades obtained across the two learning modes

At a glance, results from Table 1 and Figure 1 indicate a slight difference in performance in Science, English and Biology with morning pupils performing better than the afternoon pupils. However, a non-parametric Mann - Whitney test indicates that the difference was not statistically significant especially in

Mathematics, English and Science as reflected in Table 2.

Table 2: Hypothesis test summary

Null hypothesis (H$_0$)	Test	Sig.	Decision
1. The distribution of Mathematics is the same across categories of learning mode	Independent samples Mann – Whitney U Test	.957[1]	Retain the null hypothesis
2. The distribution of Science is the same across categories of learning mode	Independent samples Mann – Whitney U Test	.062[1]	Retain the null hypothesis
3. The distribution of English is the same across categories of learning mode	Independent samples Mann – Whitney U Test	.062[1]	Retain the null hypothesis
4. The distribution of Biology is the same across categories of learning mode	Independent samples Mann – Whitney U Test	.006[1]	Reject the null hypothesis

Significance levels are displayed. The level of significance is .05. [1]Exact significance (p- value) is displayed

The first three tests in Table 2 show no statistical significant differences in performance between morning and afternoon pupils in the sense that *p-value > 0.05* except for the fourth test in which *p-value < 0.05*. This implies that performance significantly differed only in biology. This partly confirms the results displayed in both table 1 and figure 1 but dispels our earlier suspicion that morning results in science and English were better than those of afternoon pupils.

4.2. Difference in performance across the four core subjects

To have an idea on the general performance of the school with regards to the four selected factors (subjects), factor analysis results showed that Mathematics and English don't go together. This is an indication that candidates who performed better in English did not do well in Mathematics. The rotated component matrix shown in Table 3 clearly indicates that English and Mathematics were inversely proportional.

Table 3: Rotated Component Matrix[a]

|	Component			
	1	2	3	4
Mathematics	.972	-.086	.147	.163
Science	.158	.195	.949	.191
English	-.091	.957	.191	.200
Biology	.179	.210	.195	.941

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

Table 3 indicates that English loads more on component 2 while mathematics loads more on component 1. Although Biology and Science seem to load on different components, none of the two recorded a negative factor loading on any of the four extracted components. So our main area of interest was on English that recorded a negative factor loading on component 1 while Mathematics seemed quite prominent. A similar situation occurred with mathematics that recorded a negative loading on component 2 where English topped the list. On the other hand, a component plot in rotated space below indicates a close link between biology and science with mathematics and English separated far apart.

Component Plot in Rotated Space
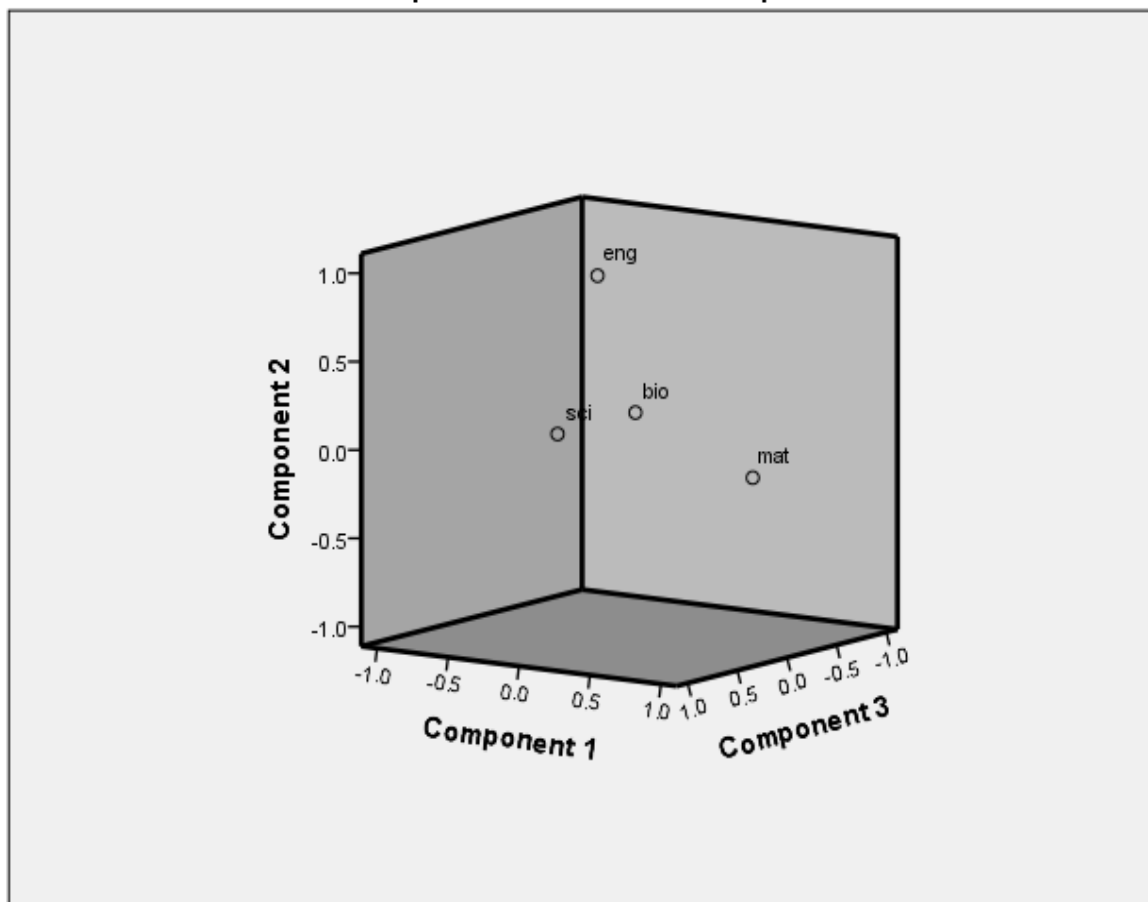
From the above plot, it can be noticed that performance patterns in Biology and Science were similar while those of English and Mathematics were far apart.

5. Discussion of the findings

The results presented in the foregoing section have shown that there was a slight difference in the way morning pupils performed as compared to the afternoon pupils. From both Figure 1 and Table 1, frequency counts put morning pupils in the lead in performance with regards to English, Biology and Science. In this respect, we would say that results of the present study are 'somehow' related to some previous studies such as Millar, Styles and Wastell (1980) who claimed that morning learning is associated with superior immediate recall when compared to learning in the afternoon. Results displayed in both Figure 1 and Table 1 also confirms the conclusion made by Klein (2001) that: "the increase in apparent learning potential of tenth graders in the morning hours suggests the likelihood that early shift pupils in secondary schools will show higher attention levels and superior achievement". However, we cannot completely agree with them owing to the fact that the interpretation of both Table 1 and Figure 1 for the present study is based on a mere inspection rather than statistical significance.

Since the statistical test (non parametric test) showed no significant difference in performance between the two learning modes in Mathematics, Science and English, we can infer that there was no need for the school to stop offering afternoon lessons. Consequently the school administration just needed to devise the mechanism that would have helped in improving the general performance of the pupils regardless of the time when those lessons were to be delivered. Principal component analysis test also indicate that girls performed better in English than they did in Mathematics while Science and Biology were closely related. Again, this clearly indicates that the school needed to come up with strategies for improving performance in mathematics and natural sciences so as to equalize them with English.

6. Limitations of the study and future directions

It should be noted that this study was conducted all in one grade level and one school, state, and climate. These restrictions are useful for controlling variability and for increasing precision, but caution is necessary in

extrapolating to other types of age groups, school systems, and climates. The study also had a bias in gender and so, future studies should take the issue of gender into account. Although the case study was conducted with a view to determine whether it was necessary for the school to stop offering afternoon lessons, citing poor performance by afternoon pupils, we believe that the topic is a very important one and so there is need to explore it with a larger sample and representation from different environments.

7. Summary and conclusion

Indeed, intelligence is not the only determinant of academic achievement of students. This ascertains the belief that academic achievement of students is always associated with so many components of the learning environment and "time of day" when lessons are delivered is one of those factors. The significant inferences that can be drawn from this study are that time of day for academic instruction has an effect on the performance of pupils. However, the statistical tests that were conducted showed that the effect was not so significant. Looking at the current scenario of Chibote Girls Secondary School, there was no need to stop offering afternoon lessons because the results between those who received instruction in the morning did no differ significantly from those who received instruction in the afternoon. Results of the present study only demonstrate the need to try and reduce the quality landscape that has been exhibited in the way the sampled candidates performed especially in the areas of Mathematics, Science and Biology. We propose that developing positive attitude, motivation and proper guidance, using suitable approaches in relation to the time of day for instruction, provision of adequate teaching materials, provision of more classrooms and furniture, provision of libraries and laboratories, proper supervision and inspection of teachers especially those teaching in the afternoon, developing good school-community relationship and, ensuring proper ventilation in classrooms where learning occurs are some of the ways of improving performance among the said pupils in Mathematics, Science, English and Biology.

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