THE INTERNATIONAL JOURNAL OF HUMANITIES & SOCIAL STUDIES

Time Series Modeling of Students' Performance in Mathematics among the Selected Four Senior High Schools in Bongo District, Ghana

Matilda Aziko
Assistant Registrar, Department General Administration, Bolgatanga Polytechnic, Ghana
Rafiatu Imoro
Lecturer, Department of Statistics, Bolgatanga Polytechnic, Ghana
John Ayuekanbey Awaab
Lecturer, Department of Statistics, Bolgatanga Polytechnic, Ghana
Theresa Adonga
Midwife, Municipal Health Directorate, Maternity Ward, Ghana

Abstract:
The study paper aims at examining the pattern in the performance of students in mathematics using analysis of the time series. Analysis of the time series was carried out on a longitudinal data of the performance of students' in mathematics for four consecutive years, from 2015 to 2018. The research employed the Box-Jenkins methodology. The study revealed that the performance of the students in mathematics was best represented with a quadratic pattern and ARIMA (0,0,0). Further, the results showed that the students ' performance in mathematics is likely to stagnate in the near future as seen in the forecast curve. The study concluded that the average mathematics performance of the students over the four-year period is very low and this suggests a decrease in the standard of education within the district of Bongo.

Keywords: Autocorrelation function, partial autocorrelation function, stationarity, parameter estimation, parsimonious model and differencing, time series analysis, linear trend model and quadratic trend model.

1. Introduction

Abreh (2017), said that countries ' progress and improvement carefully correlate with the equalvintage of schooling provided to their citizens. This relation among education and development informs choice taking in many areas of the economy, together with allocating price range to the world, further to advancing staff capital and different assets to the schooling zone

Realized otherwise, achieving the aim of schooling to empower individuals and methods for practical benefits consists of fostering the development of cultural, social, science, and technical awareness, skills, and capacity of school-age youngsters to get entry to and obtain first-rate training. In effect, the kind of expertise, skills, and attitude made available to beginners will permit them to compete with their friends on both neighborhood and worldwide systems at innovative and exceedingly innovative levels (Lee, 2006; Shanmugaratnam, 2006).

Education is said to be crucial to the financial boom of all countries inside the world. The position of arithmetic and technology education, however, is even more critical to the accelerated financial growth and management of those new economies produced by generation-led technologies. In reality, the significance of schooling in empowering people and structures isn't always in dispute, and Ghana was willing to use arithmetic and science to build an era-pushed economy. For example, when technological know-how and technology approaches took place in the two important seaports in Ghana in less than three months, there were huge economic benefits, decreases in clearing time and reduces in port fraud, demonstrating the capacity for rapid expansion of these areas enlargement within the economy (Tarlue, 2017). Nations ' education structures are designed to fulfill the desires of their economies and their priorities for growth. While there are very diffused systemic variations within the worldwide company of education structures, most, if now not all, are based at 3 levels, number one or basic, secondary, and tertiary. Secondary education gives a link between number one / basic school and tertiary training. This is a post-primary/basic schooling system that trains the students for middle-stage employment as well as offers the possibility for others to transport to tertiary.

Hence secondary training is very critical in each a student's and a nation's life. The hassle is that, if students are useless in secondary education, it is difficult for them to advance to the tertiary degree of the educational ladder, to expand employable competencies in academic colleges, technical universities or conventional universities in Ghana, for example. Therefore, it is pleasing that the constitution of Ghana demands that every effort be made to make certain that schooling, especially on the secondary level, slowly becomes common and more and more loose (Ghana Republic, 1992). In addition, the cutting-edge situation, where secondary education is unfastened for first-12 months Ghanaian excessive college

students, represents a step toward rising get admission to and equality of secondary schooling. The secondary faculty level in Ghana presents its customers with in depth and technical / vocational education. Thus, even though some excessive school students take the comprehensive secondary education, which in Ghana constitutes the easy majority, others receive handiest technical / vocational training. High faculty college students in Ghana study four core subjects and a selection of elective topics (as a minimum three), which is determined with the aid of the form of curriculum college students chose to learn.

The newcomers are encouraged to be essential and analytical in these studying surroundings of the twenty first century. Thus, mathematics provides the sort of foundation for college students to assume objectively and analytically. Therefore it is not shocking that secondary colleges throughout the globe are making arithmetic a mandatory part of the curriculum for this academic level. Ghana's Government acknowledges the role that science, math, and technology play in attaining the nation's development agenda.

This policy recognition has contributed to the acknowledgement of arithmetic as one of the foundations of country wide growth (Ghana Ministry of Education, 2014) .To this end, the Ghana Government has introduced a few interventions and injected incentive schemes aimed at enhancing the participation and fulfillment of college students in technological know-how and arithmetic, mainly on the secondary training level since the 1990s. For e.g., the Science Resource Center Project, the Ghana Investment Fund for Electronic Communication (GIFEC), ICT-related programs, the MASTESS (Mathematics, Science and Technology Scholarship Scheme), and the SEIP (Secondary Education Improvement Project) are just a fewof these initiatives. Some similar and interrelated factors are stated to be contingent on achievement at the secondary schooling level (Chua & Mosha 2015).

According to Chua and Mosha (2015), of the variables that stand out inside the present day literature are those relating to the science and mathematics curriculum and the teacher and coaching variables .It is known that the curriculum guides the coaching, learning, and evaluation activities in order to occur in the schools.

Aspects inclusive of the syllabus and textbooks specifically have an effect on academic achievement (Dembélé & Lefoka, 2007; Pridmore, 2007; UNESCO, 2016; World Bank, 2008). The curriculum's reach, consistency, and significance also have an effect on what stakeholders do with the program, as well as their capability to gain the expected outcome. In addition to concerns with the curricula, the pleasant way to train, assign and hire teachers has been delivered to the fore. The maximum promising path is the fundamental circulate in attracting strong trainer candidates by way of investing in superinstructor schooling programmes (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2008; Coalition for Teaching Quality, 2016; Darling-Hammond, Bransford, LePage, Hammerness, & Duffy, 2005). Furthermore, it was discovered that college districts hiring uncertified teachers often deployed them to underserved areas, and these instructors usually had underserved backgrounds themselves (Darling-Hammond, 1999).

As Hanushek, Kain, and Rivkin (2004) have pointed out, teacher mobility is likewise a large trouble in underserved regions, main to pockets of inequality in these areas in particular rural faculties in contrast with their city counterparts. Moreover, it was located that college districts using uncertified instructors frequently deployed them to underserved areas, and these instructors commonly had underserved backgrounds themselves (Darling-Hammond, 1999). As Hanushek, Kain, and Rivkin (2004) have pointed out, trainer mobility is likewise a large trouble in underserved regions, leading to wallet of inequality in these areas in particular (Darling-Hammond, 1999; Hanushek et al., 2004; Wilson, Floden, & Ferrini-Mundy, 2001). Simply put, if instructors are qualified and capable in acting their obligations and responsibilities while sure variables are stored constant, there may be a highlikelihood of excessive achievement on the a part of college students. Teachers ' pedagogical practices rely in large part on their expertise of content, pedagogical enjoy, experience of pedagogical material, and abilities that they follow to teaching inside the classroom (Borko, 2004; Wilmot, 2009).

Literature also claims that underserved and hard-to-reach secondary colleges result in the disparity in achievement observed in the rural – city divide. As a result, assigning seasoned, trained instructors to low-performing schools and college students is possibly to pay off in improved results and decreased gaps. One of the effects that made the hassle even greater obvious is inside the research of Laczko-Kerr and Berliner (2002), which indicates that the fulfillment of mathematics by means of elementary pupils taught via new, uncertified teachers made the fulfillment tests significantly decrease than those taught by using newly qualified teachers did.

In addition to the effect of instructor education on the overall performance of the students, the elements causing terrible or constantly bad overall performance in mathematics are multifaceted. (Swars, Daane, & Giesen, 2006; Swars, Hart, Smith, Smith, & Tolar, 2007; West African Examinations Council [WAEC], 2014, 2015, 2016). The central feature of these research is that instructors and teachers are critical to modern educational trends, in particular as learning outcomes and student achievements come to the forefront.

Of example, most of the useful instructor-related studies have concentrated on elementary or fundamental school. Although a few studies imply that the teaching factor is somewhat less in high colleges, much more look at and studies need to be carried out before delineating which regions of the secondary education gadget suffer from research deficit in Ghana. There is a need to pressure the education machine a little extra in phrases of opportunities and working situations that might draw exceedingly successful teachers to historically hard-to-staff faculties and underserved Ghana population, to organize access and equity at Ghana's secondary level.

The current poor performance of college students in technological know-how and arithmetic at West African Secondary School Certificate Examination necessitates the want to examine the education system at secondary college level (WASSCE; WAEC, 2014, 2015, 2016, 2017,2018). Education stakeholders and the general public have raised questions about student fulfillment in arithmetic coaching and learning across the world. Because of the poor overall performance in arithmetic, most extensively in core mathematics at the West African Senior School Certificate

Examinations (WASSCE), many college students cannot meet the entry requirements as mentioned above each year. Place, for instance, in August 2016 .City Fmonline.Com finished an overview of the findings of WASSCE released through Rev. Nii Nmai Ollenum, Head of the WAEC National Office of Ghana, and made some tragic conclusions. The outcomes of 234,871 candidates have been published out of a total of 274,262 candidates who had sat for the examination that year. Of that total, 77,108 applicants representing 32.83 percent of A1-C6 grade applicants. Aside from that, 65,007 applicants representing 27.68 percentage had received grades

While a few stakeholders notion the students ' overall performance in arithmetic changed into strong, others notion it became bad. With the sort of divided opinion on the topic of pupil effects, while there is little to no proof to support such arguments and conclusions, it is crucial to observe the outcomes styles of students in the four decided on senior excessive college in Bongo District. However, without clean proof of overall performance styles, it would, for the maximum part, be impossible for state organizations in price of schooling and coverage makers to implement effective progressive education policies. Thus, this study aimed to provide information on overall performance styles at secondary school degree in mathematics, which might be currently not available inside the literature. Mathematics passes the core necessities for entering better establishments in Ghana. As mathematics is a full-size subject within the educational curriculum, research into the overall performance of mathematics students within the4selectedexcessive schools inside the District of Bongo is appropriate. The consequences of the college are higher or higher even lower than the state's country wide averages, this means that that there may be something particular about the district while it comes to scholar fulfillment in WASSCE mathematics. This work therefore aims to assess students' achievement in mathematics between 2015 and 2018. In addition, inside the wake of the interventions brought in current years into the Ghana secondary education system, the take a look at also sought to explore feasible explanations for the trends discovered by using the WAEC outcomes. Three studies questions had been therefore formulated to direct the analysis, which had been given as follows:

1.1. Specific Objectives
- To determine the trend of students' performance in mathematics Ghana District.
- To develop appropriate model that best fit students' performance in mathematics Ghana District.
- To make a five year forecast of the students' performance in mathematics Ghana District.

1.2. Research Questions
- Is there any trend of students' performance in mathematics Ghana District?
- What is the appropriate model that best fit students' performance in mathematics Ghana District?
- What is the five year forecast of the students' performance in mathematics Ghana District?

2. Research Methods
The research made use of the annual report of WASSCE results. The data were collected from the selected four Senior High Schools identified in the Bongo District. The data covered periods ranging from January 2015 through December 2018. The performance of students in mathematics in Ghana District was predicted using autoregressive integrated moving average (ARIMA) models to create a predictive tool for the performance of students in mathematics. The non-seasonal model order defined by ARIMA (p, d, q) represents auto-correlation over a maximum order of p months; differentiating order of d adjacent months and moving averages of q annual cycle order. The Box and Jenkins methodology has been used to define the trends best representing the time series of results of the students. Performance incidence plot was created for the students to detect and correct issuance of non-stationarity. Models of varying orders were fitted after stationarity and compared using standardized Bayesian information criterion (BIC), mean absolute error (MAE), and Stationary-R Square. Autocorrelation (ACF) function measuring the correlation between the time series data and the Partial Autocorrelation (PACF) function showing the correlation between the autoregressive time lags used to determine the parameters of the ARIMA model. The values of correlation fell within the confidence limit set for the ACF and PACF; an indication of reasonable forecasting performance. When evaluating the parameters p and q of the ARIMA model, ACF and PACF graphs of normalized data were used. The method of trial and error was used to determine the final structure of the predictive model. For forecasting reason the model with the least BIC, AIC, HQ and the highest Stationary-R Square was chosen. Review of the data was conducted using minitab, gretel, and R-program.

3. Results and Analysis
An exploratory data analysis on the success of students in mathematics was also used for the fifteen consecutive year, using primarily Minitab software, R system and Gretel software, and the time series analysis Box-Jenkins techniqueSome calculations were made to obtain first the descriptive statistics regarding the success of the students in mathematics, followed by time series plots and a trend analysis.

3.1. Descriptive Statistics of Students' Performance in Mathematics

Mean	32.68055556
Standard Error	6.144052696
Median	3
Mode	0
Standard Deviation	73.72863235
Sample Variance	5435.911228
Kurtosis	14.87019293
Skewness	3.587142943
Range	496
Minimum	0
Maximum	496
Sum	4706
Count	144
Confidence Level(95.0%)	12.14490103

Table 1: Students' Performance in Mathematics

The minimum performance of students in mathematics was found to be 0 and a maximum of 496 while the average performance was 32.68 with a corresponding standard deviation of 6.14, which suggests that the data is widely distributed around the mean. The 18.79 per cent coefficient of variation also indicates that the data has a very high variance .The output of the students in mathematics distribution also shows positive skewedness of 3.59 suggesting that most of the scores are clustered to the right of the mean and have a positive kurtosis value of 14.87 also suggesting that the data is platykurtic, thus having flattened and that there are more of the students' scores at either extreme of the distribution thus flattened than normal peak. This means the quality of education within the district have dropped
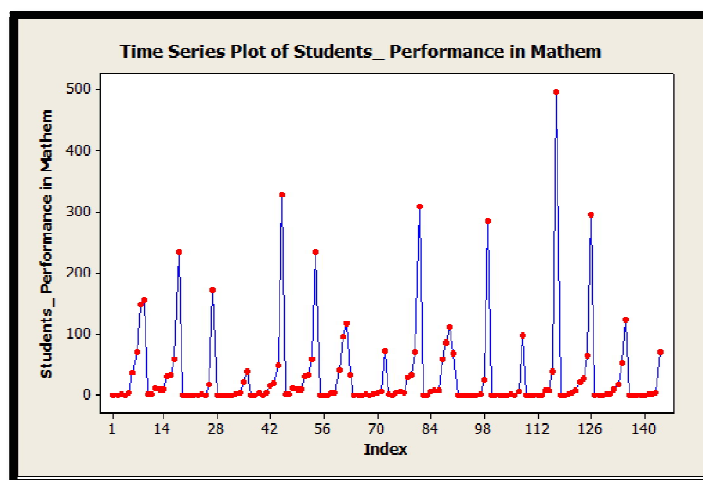

Figure 1: Time Plot of Students' Performance in Mathematics

The plot in Figure 1 shows the output of the students with respect to time variations. From figure 1 it can generally be observed that no decreasing trend in the plot is significantly sharp over the time of analysis. But the success of students .In 2015, 2016, 2017 and 2018, respectively, there was no major downward or upward transition. The series displayed a typically no-increasing non-decreasing trend in the time graph implying that there is no change in mean while the fluctuations indicate constant variance over time suggesting that the series is stationary.

3.2. Tests for Stationarity
A stationary cycle has mean and variance that doesn't change over time and there are no patterns in the cycle. The series must be stationary in order to continue with the estimation of an ARIMA model, as this analysis used the Augmented Dickey-Fuller (ADF) test and the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test for proof of stationarity in the performance of students in quantitative methods.

3.3. Augmented Dickey-Fuller Test
We test the hypothesis for the ADF test that;
- H0: the sequence is not stationary.

- H1: A stationary sequence.

At a meaning point of 95 per cent, a p-value of less than 0.05 means a rejection of H0, meaning that the sequence is stationary, otherwise the H0 would be retained.

3.4. Kwiatkowski, Phillips, Schmidt and Shin Test

So the KPSS test has an analogous result to the ADF test;

- H0: the sequence is stationary.
- H1: Non-stationary set.

This means that a p-value of less than 0.05 at a meaning point of 95 percent means we deny H0 and assume the series is not stationary, then it is stationary
.

TEST	TEST STATISTIC	P-VALUE
KPSS	0.021298,	0.1
ADF	-7.1264,	0.01

Table 2: Tests for Stationarity

The series differentiated four times in order to achieve stationarity and the results are shown in table 3 after the fourth discrepancy. From the KPSS test values in table 2, with a significance amount of 5 percent, the inference is that the sequence is stationary since the p-value (0.1) is greater than 0.05. The ADF check with an inverse null hypothesis, however, shows that the data is stationary at p-value 0.01. In all, the data is concluded stationary on the basis of time map, correlogram, KPSS, and ADF test proof.
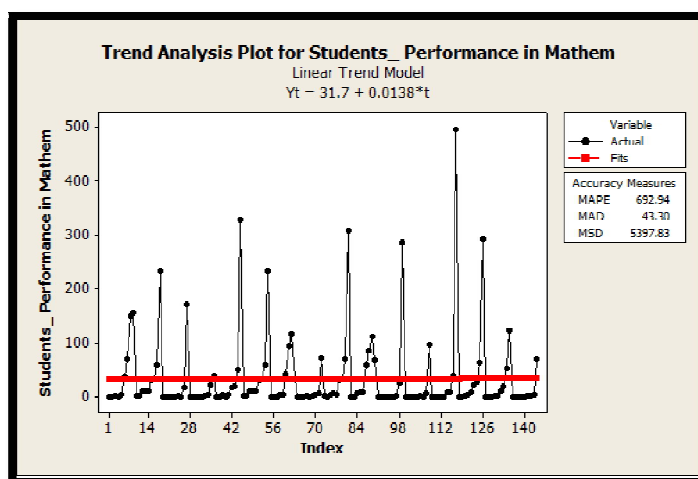

Figure 2: Linear Plot of Students 'Performance in Mathematics
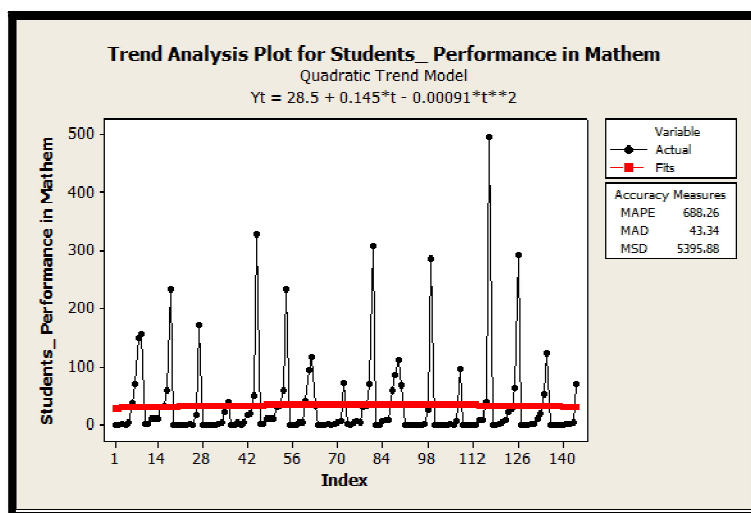

Figure 3: Quadratic Plot of Students' Performance in Mathematics

Figures 2 and 3 display the respective linear and quadratic versions. Round dotted lines represent the real values of the output of the students in each of the figures while the dotted square lines represent the configured values based on the different models.

Model	MAPE	MAD	MSD
Linear	692.94	43.30	5397.83
Quadratic	688.26	43.34	5395.88

Table 3: Measures of Accuracy

The most suitable model from Table 3 representing the pattern in the output of the students is the one with minimal errors. A closed observation of the errors generated by three models, the quadratic model has the minimum MAPE, MAD and MSD, is therefore considered the best model to explain the trend in the performance of students in mathematics
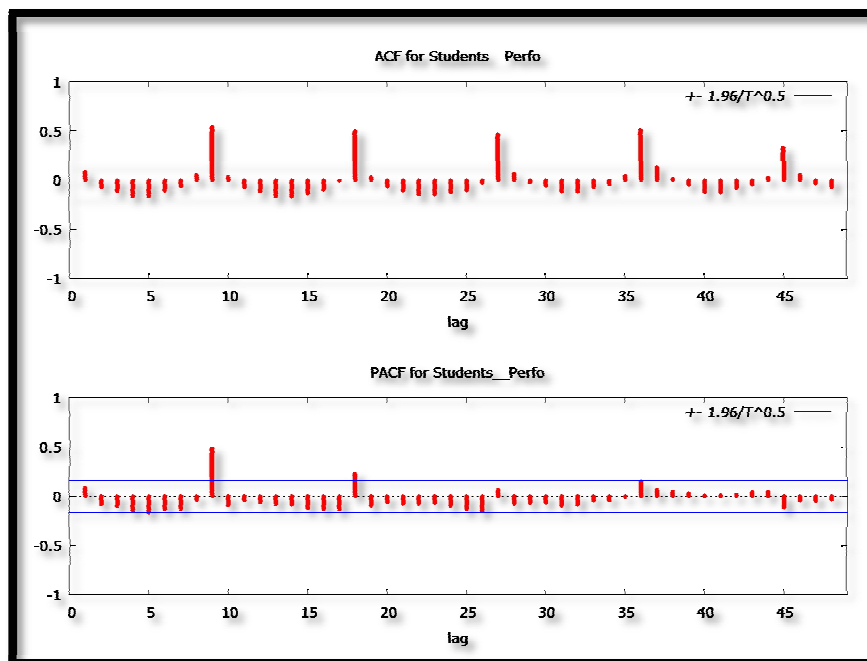

Figure 4: ACF and PACF Plot of Students' Performance in Mathematics

Further analysis and tests on the Autocorrelation Function (ACF) plots and the Partial Autocorrelation Function (PACF) plots were performed. It can be noted that the data tend to be stationary with an interval of confidence of 95 per cent. The ACF and PACF are not major spikes at any lags as shown in Figures 4. It means that both ACF and PACF re-affirmed that the sequence is stable, or non-decreased.

Model	AIC	BIC	HQ
Arima(0,0,0)	1648.163	1651.133	1649.370
Arima(1,0,1)	1664.707	1652.828	1657.655

Table 4: Model Identification

The model with the minimum Akaike Information Criteria (AIC), Bayesian Information Criterion (BIC) and Hannan-Quinn (HQ) is the most suitable for the sequence. Therefore, by testing all the competing models in table 4, the ARIMA model (0, 0, 0) has the lowest values and therefore the best predictive model

3.5. Parameter Estimation

Table 5 below displays estimates of System ARIMA parameters (0, 0, 0). The constant parameters are important with coefficients and p-values of 5 per cent (32.6806, 1.04e-07) respectively. P-value of less than 0.05 shows the parameters ' importance.

Type	Coefficient	Standard error	Z value	P-value
Constant	32.6806	6.14405	5.319	1.04e-07

Table 5: shows Parameter Estimation

3.6. Model Diagnosis

The following diagnostics are performed to ensure that the model selected is the best one suited to the data

3.7. Residuals Plots

The residual trends over time around the zero mean as shown in figure 5 below demonstrate that the residuals are random and independent of each other, thereby suggesting that the model is suitable.
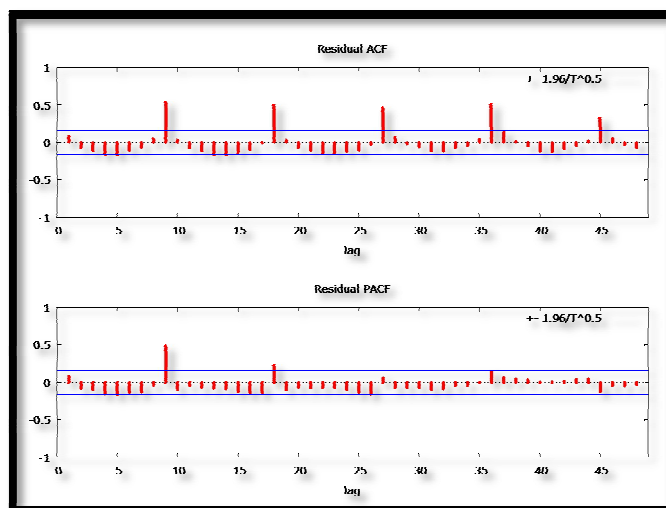
Figure 5: Residual Plot of ACF and PACF

Figure 5 indicated that the ACF and PACF residual plot is not important and this indicates the model is considered suitable.

3.8. The Normal Q-Q Plot

The Standard Q-Q Plot is yet another residual diagnostic test to determine whether it fits regular distribution. The standard likelihood map (Q – Q map) is used to do this. It is a plot, a plot based on quantile estimates. The normal Q-Q plots are used to equate a sample distribution to a theoretical distribution.
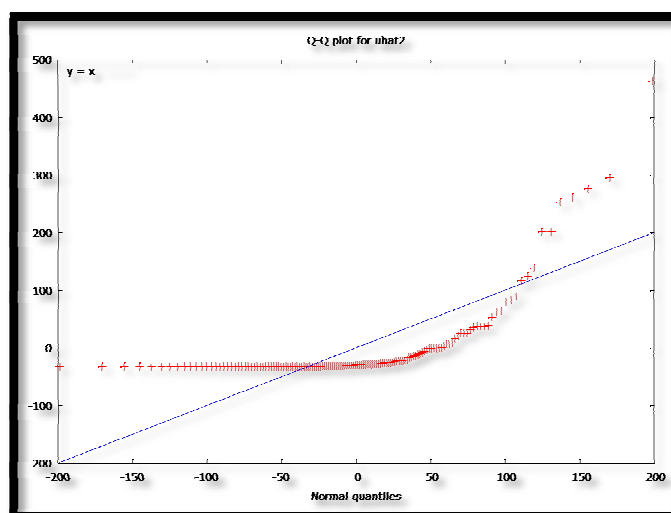

Figure 6: Q-Q Plot of Students' Performance in Mathematics

From figure 6 almost all the points are on the straight line suggesting a good fit for the pattern.

3.9. Ljung-Box Q Statistics

A test of the overall adequacy of the model is performed using the statistics of the Ljung-Box Q. This shows that the model is generally satisfactory with a p-value of 0.834 which is much greater than 0.05.

MODEL	Statistics	DF	Sig.
Arima(0,0,0)	5.8	10	0.734

Table 6: Ljung-Box Q Statistics

3.9.1. Forecast

Since the model tests to be in good shape, we can now predict the next 3 observations for future values in this case

| Index	prediction	std. error	95% interval
145	32.68	73.729	-111.82 - 177.19
146	32.68	73.729	-111.82 - 177.19
147	32.68	73.729	-111.82 - 177.19
148	32.68	73.729	-111.82 - 177.19
149	32.68	73.729	-111.82 - 177.19
150	32.68	73.729	-111.82 - 177.19
151	32.68	73.729	-111.82 - 177.19
152	32.68	73.729	-111.82 - 177.19
153	32.68	73.729	-111.82 -177.19
154	32.68	73.729	-111.82 - 177.19
155	32.68	73.729	-111.82 - 177.19
156	32.68	73.729	-111.82 - 177.19
157	32.68	73.729	-111.82 - 177.19
158	32.68	73.729	-111.82 - 177.19
159	32.68	73.729	-111.82 - 177.19
160	32.68	73.729	-111.82 - 177.19
161	32.68	73.729	-111.82 - 177.19
162	32.68	73.729	-111.82 - 177.19
163	32.68	73.729	-111.82 - 177.19
164	32.68	73.729	-111.82 - 177.19
165	32.68	73.729	-111.82 - 177.19
166	32.68	73.729	-111.82 - 177.19
167	32.68	73.729	-111.82 - 177.19
168	32.68	73.729	-111.82 - 177.19
169	32.68	73.729	-111.82 - 177.19
170	32.68	73.729	-111.82 - 177.19
171	32.68	73.729	-111.82 - 177.19
172	32.68	73.729	-111.82 - 177.19
173	32.68	73.729	-111.82 - 177.19
174	32.68	73.729	-111.82 - 177.19
175	32.68	73.729	-111.82 - 177.19
176	32.68	73.729	-111.82 - 177.19
177	32.68	73.729	-111.82 - 177.19
178	32.68	73.729	-111.82 - 177.19
179	32.68	73.729	-111.82 - 177.19
180	32.68	73.729	-111.82 - 177.19

Table 7
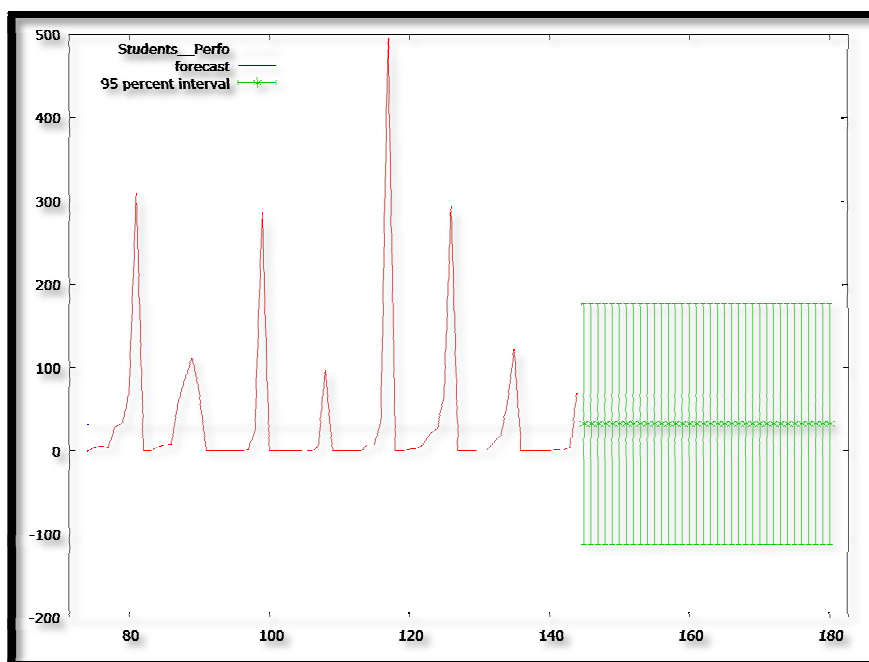
Figure 7: The Graph for the 3-Year Forecasted Model of Students' Performance in Mathematics

From the forecast curve the performance of the students in mathematics is likely to stagnate in the near future if the police makers are unable to address the issue at stake.

4. Summary and Conclusion

Findings revealed that the minimum performance of students in mathematics was found to be 0 and a maximum of 496 while the average performance was 32.68 with a corresponding standard deviation of 6.14, which suggests that the data is widely distributed around the mean. The 18.79 per cent coefficient of variation also indicates that the data has a very high variance. The output of the students in mathematics distribution also shows positive skewedness of 3.59 suggesting that most of the scores are clustered to the right of the mean and have a positive kurtosis value of 14.87 also suggesting that the data is platykurtic, thus having flattened and that there are more of the students' scores at either extreme of the distribution thus flattened than normal peak. This means the quality of education within the district have dropped

From the forecast curve the performance of the students in mathematics is likely to stagnate in the near future if the police makers are unable to address the issue at stake.

The model with the minimum Akaike Information Criteria (AIC), Bayesian Information Criterion (BIC) and Hannan-Quinn (HQ) is the most suitable for the sequence. Therefore, by testing all the competing models in table 4, the ARIMA model (0, 0, 0) has the lowest values and therefore the best predictive model

The most suitable model from Table 3 representing the pattern in the output of the students is the one with minimal errors. A closed observation of the errors generated by three models, the quadratic model has the minimum MAPE, MAD and MSD, is therefore considered the best model to explain the trend in the performance of students in mathematics

The series were not differentiated in order to achieve stationarity and the results are shown in table 3. From the KPSS test values in table 3, with a significance amount of 5 percent, the inference is that the sequence is stationary since the p-value (0.1) is greater than 0.05. The ADF check with an inverse null hypothesis, however, shows that the data is stationary at p-value 0.01. In all, the data is concluded stationary on the basis of time map, correlogram, KPSS, and ADF test proof.

The plot in Figure 1 shows the output of the students with respect to time variations. From figure 1 it can generally be observed that no decreasing trend in the plot is significantly sharp over the time of analysis. But the success of students .In 2015, 2016, 2017 and 2018, respectively, there was no major downward or upward transition. The series displayed a typically no-increasing non-decreasing trend in the time graph implying that there is no change in mean while the fluctuations indicate constant variance over time suggesting that the series is stationary.

5. Conclusion

The research paper concluded that the students' performance in mathematics can best described by a quadratic trend and ARIMA(0,0,0).From the forecast curve the performance of the students in mathematics is likely to stagnate in the near future if the policies makers are unable to address the issue at stake. The research further concluded that the overall performance of the students' in mathematics over the four years period is very poor and this implies that the quality of education within the district has dropped.

6. References

i. Abe, T. O. (2014). The effect of teachers' qualifications on students' performance in mathematics. Sky Journal of Educational Research, 2, 10-14. Google Scholar
ii. Abreh, M. K. (2017). Involvement of school management committees in school-based management: Experiences from two districts of Ghana. Educational Planning, 24, 61-75. Google Scholar
iii. Blaug, M. (1970). An introduction to the economics of education. London: Allen Lane, The Penguin Press. Google Scholar
iv. Boyd, L., Grossman, P., Lankford, H., Loeb, S., Wyckoff, J. (2008). Teacher preparation and student achievement. Retrieved from http://www.nber.org/papers/w14314.pdfGoogle Scholar
v. Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. Educational Researcher, 33, 3-15. Google Scholar | SAGE Journals
vi. Chua, C. L., Mosha, H. J. (2015). Managing school internal mechanisms for performance improvement in secondary education: Case of six secondary schools in Eastern zone in Tanzania. SAGE Open, 5(4), 1-9. Google Scholar | SAGE Journals
vii. Coalition for Teaching Quality (2016). Building a strong and diverse teacher and principal recruitment pipeline. Retrieved from http://www.coalitionforteachingquality.org/images/upload/201606_Recruitment.pdfGoogle Scholar
viii. Darling-Hammond, L. (1999). Teacher quality and student achievement: A review of state policy evidence. Seattle: Center for the Study of Teaching and Policy, University of Washington. Google Scholar
ix. Darling-Hammond, L., Bransford, J., LePage, P., Hammerness, K., Duffy, H. (Eds.). (2005). Preparing teachers for a changing world. What teachers should learn and be able to do. San Francisco, CA: Jossey-Bass. Google Scholar
x. Dembélé, M., Lefoka, P. (2007). Pedagogical renewal for quality universal primary education: Overview of trends in sub-Saharan Africa. International Review of Education, 53, 531-553. Google Scholar | Crossref
xi. Ghana Ministry of Education. (2014). Education sector performance report (2010). Accra: Author. Google Scholar

xii.   Hanushek, E. A., Kain, J. F., Rivkin, S. G. (2004). Why public schools lose teachers. Journal of Human Resources, 39, 326-354. Google Scholar | Crossref | ISI

xiii.   Hill, H., Sleep, L., Lewis, J. M., Ball, D. L. (2007). Assessing teachers' mathematical knowledge: What knowledge matters and what evidence counts. In Lester, K. F. (Ed.), Second handbook of research on mathematics teaching and learning (pp. 111-155). Reston, VA: NCTM (National Council of Teachers of Mathematics). Google Scholar

xiv.   Laczko-Kerr, I., Berliner, D. C. (2002). The effectiveness of 'teach for America' and other under-certified teachers on student academic achievement: A case of harmful public policy. Education Policy Analysis Achieves, 10(37), 1-53. Google Scholar

xv.   Lee, H. L. (2006). Speech by Prime Minister Lee Hsien Loong at the Teachers' Day Rally 2006. Retrieved from https://www.pmo.gov.sg/newsroom/prime-minister-lee-hsien-loongs-national-day-rally-2006-englishGoogle Scholar

xvi.   Liakopoulou, M. (2011). Teachers' pedagogical competence as a prerequisite for entering the profession. European Journal of Education, 46, 474-488. Google Scholar | Crossref

xvii.   Obasi, M. N. (2010). Urban-rural differential in teaching and learning of geography in Ahiazu Mbaise and Owerri Municipal Council in Imo State. Report and Opinion, 2, 41-50. Google Scholar

xviii. Pridmore, P. (2007). Adapting the primary school curriculum for multigrade classes in developing countries: A five-step plan and an agenda for change. Journal of Curriculum Studies, 39, 559-576. Google Scholar | Crossref

xix.   Republic of Ghana. (1992). Constitution of the republic of Ghana. Accra: Government of Ghana. Google Scholar

xx.   Shanmugaratnam, T. (2006). Speech by Tharman Shanmugaratnam, Minister for Education and 2nd Minister for Finance at the MOE NE Forum for Principals. MOE Edutorium. Retrieved from http://www.nas.gov.sg/archivesonline/speeches/view-html?filename=20060824991.htmGoogle Scholar

xxi.   Swars, S., Hart, L. C., Smith, S. Z., Smith, M. E., Tolar, T. (2007). A longitudinal study of elementary pre-service teachers' mathematics beliefs and content knowledge. School Science and Mathematics, 107, 325-335. Google Scholar | Crossref

xxii.   Swars, S. L., Daane, C. J., Giesen, J. (2006). Mathematics anxiety and mathematics teacher efficacy: What is the relationship in elementary preservice teachers? School Science and Mathematics, 106, 306-315. Google Scholar | Crossref

xxiii. Tarlue, M. (2017, September 12). Paperless ports grabs GH¢230M. Daily Guide. Retrieved from http://dailyguideafrica.com/paperless-port-revenue-shoots-ghc130m-ghc230m/Google Scholar

xxiv.   United Nations Educational, Scientific and Cultural Organization. (2016). What makes a quality curriculum? Retrieved from http://unesdoc.unesco.org/images/0024/002439/243975e.pdf

xxv.   Google Scholar

xxvi.   West African Examinations Council. (2014). Chief examiners report for 2014. Retrieved from https://www.waecgh.org/Portals/0/PDF/General%20Resume2014.pdfGoogle Scholar

xxvii. West African Examinations Council. (2015). Chief examiners report for 2015. Retrieved from https://www.waecgh.org/Portals/0/PDF/General%20Resume%20W15.pdf20Resume2014.pdfGoogle Scholar

xxviii. West African Examinations Council. (2016). Chief examiners report for 2016. Retrieved from https://www.waecgh.org/Portals/0/PDF/General%20Resume%20W16.pdfGoogle Scholar

xxix.   Walshaw, M. (2012). Teacher knowledge as fundamental to effective teaching practice. Journal of Mathematics Teacher Education, 15, 181-185. Google Scholar | Crossref

xxx.   Wilmot, E. M. (2009). Teacher knowledge and student performance: Begle re-visited in Ghana. Journal of Science and Mathematics Education, 4, 13-30. Google Scholar

xxxi.   Wilson, S., Floden, R., Ferrini-Mundy, J. (2001). Teacher preparation research: Current knowledge, gaps, and recommendations. Retrieved from https://www.education.uw.edu/ctp/content/teacher-preparation-research-current-knowledge-gaps-and-recommendationsGoogle Scholar

xxxii. World Bank. (2008). Curricula, examinations, and assessment in secondary education in sub-Saharan Africa. Washington, DC: Author. Google Scholar | Crossref

xxxiii. Zuzovsky, R. (2009). Teachers' qualifications and their impact on student achievement: Findings from TIMSS 2003 data for Israel. Retrieved from https://www.iea.nl/fileadmin/user_upload/IRC/IRC_2008/Papers/IRC2008_Zuzovsky2.pdf Google Scholar