Performance on the Philippine Nurses' Licensure Examination: Variability and Roughness Analysis

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Abstract

The study compares the fractal dimensions of the board examination percentage scores for nursing graduates in June 2012 and December 2012. The purpose of such a comparison is to assess the ruggedness or roughness of the scores over the two assessment periods. The more rugged the scores viz. higher fractal dimensions, implies the variability of the students' performance. Results revealed that the June, 2012 test scores have higher fractal dimension than the December, 2012 test scores. The paper concludes that students behavior pertinent to the assessment varies in June than December PNLE. This is in contrast to the usual notion that it is with test difficulty where disparity of performance takes place. The author deduced some observations minimizing such disparity.

Keywords: fractal analysis, fractal dimension, school performance, below and above national passing percentage, Philippine Nurses' Licensure Examination (PNLE)

1.0 Introduction

One of the vital goals of education is to learn effectively how to generate and solve problems in the realities of life. Teachers are task to edify learners to its fullest potential (skills, knowledge and attitudes). Attaining these requires a curriculum that conveys academic activity in a systematic and enjoyable manner. As a result, it prepares students to sharpen critical thinking skills necessary to triumph over future examinations. Success can be best measured by passing board examination (Borek, 2006). Moreover, a determinant in selecting qualified workers.

The Philippine Nurse Licensure Examination (PNLE) is a standardize test conducted to nursing graduates given by Professional Regulation Commission (PRC) but developed and formulated by the Board of Nursing. The exam evaluates nursing knowledge or skill necessary to effectively, efficiently, ethically and safely practice the profession. The result of the PNLE was declining; in 2006 it showed a very low rating in the history with 35.25%, to present. These can be attributed to several substandard schools opened in 2006 (CHED, 2011); the same year where examination leakage occurred that put pressures to the Government officers and agencies. The delivery of quality nursing education has been compromised for the sake of business. According to Talete (2009), in 24th November of 2009, the Commission on Higher Education (CHED) chair Dr. Emmanuel Angeles cautioned 152 nursing schools were observed performing below the set standards of PRC. As amended by the CHED Resolution No. 378-2009 that provides: "higher education institutions (HEI) whose performance in licensure examinations in the last three consecutive years is greater than 50 percent but lower than the national passing

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rate shall be given an initial warning to improve their performance"(Dioquino, 2012). Aftereffect, leads to voluntary closure of 15 nursing schools. Despite controversial issues in the global arena the concerned agency was struggling in uplifting quality education. Approximately 85% of Filipino nurses (more than 150,000) are employed globally" (Aiken, et.al., 2004), and almost 70% of all Filipino nurses are working overseas according to Health Alliance for Democracy (2006) as cited in Bach, 2003. The drive to achieved economic stability fortified their drives in pursuing their dreams in working abroad. While there have been increases in studies of predictive variables that identify regular patterns of distribution in an effort to intervene brain drain phenomena (Estella, 2005; Borek, 2006), such as: (1) nursing faculty profile (Varona, 2007); (2) curriculum and student's intellectual quotient (del Rosario & Estrada, 2006 & Gloria, 2008); (3) review program; and (4) many others.

The study will then predict the fractality of the performance of Philippine Nurse Licensure Examination among schools in the Philippines. It allows school managers to forecast appropriate time in taking exam, especially those who performed below the set standard of pre-board examination. Thus, it prepares them holistically in taking future examinations. Moreover, it will explain the dimensional disparity between high and low performing schools, and the June and December takers.

2.0 Conceptual Framework

In this study, fractal analysis is applied to determine the ruggedness or roughness of the existing data of the PNLE in two periods. Mandelbrot (1982) describes fractal geometry as a general term that provides mathematical explanation of apparently multifaceted shape in nature. Such shape varies in smaller to larger scale but has distinguishable characteristics of self-similarity and fractional dimensions. This concept was adopted in the study of Lovejoy & Mandelbrot (1985) that utilized fractal model in generating various structures of simulated rain in accordance to actual rainfall shapes. Another study of La Barbera & Rosso (1989) also employed fractal in investigating the scaling properties of the parameters in illustrating drainage basin form and process.

The geometric fractals of Mandelbrot (1985) serve as new paradigm information to the study of fractal statistics of Padua, et.al (2012). Fractal statistics operated various applied mathematics in determining the fractal dimensions of a given data. Padua & Borres (2013) stipulated fractional dimension as a dimension whose value lies between integral values of 1 and 2 or 2 and 3 ($1< \lambda <2$, or $2< \lambda <3$) dimensional figures. In the applicability of this study, the school performance based on school passing percentage in nursing academe in the entire country was subjected for fractal analysis. The fractal dimensions in two test periods are determined and analyzed on which test periods is more difficult. The computation of fractal disparity of below and above national passing percentage was generated from the difference between the averages raise to the power of fractal dimensions ($\overline{x_1}^{\lambda_1} - \overline{x_2}^{\lambda_2}$).

3.0 Design and Methods

The design of the study focuses on the development of an index that will provide information on the test characteristic and ruggedness/variability of the test takers' performance. The usual way that these two characteristic are determined involves the use of item analysis (difficulty index) and the computation of the coefficient of consistency/stability. We seek a new measure that incorporates that two in a single index, namely the fractal dimensions.

The licensure examinations of the different disciplines confronted many colleges and universities around the world in the pursuit of academic excellence and high quality of performance in actual settings. Similarly in the Philippines, licensure examinations are regulated by the Professional Regulation Commission (PRC) as authorized by the Philippine Nursing Act of 2002 to ensure the integrity and honesty of the results being tested by the examinees in many disciplines. In the nursing perspective, the Board of Nursing prescribes guidelines and regulations governing nursing profession. They are responsible in constructing board exam questions in Nurses' Licensure Examination (NLE) to set high standard.

On its broadest sense, the researcher believed that the performance of nursing schools in the country in terms of passing percentage adhering to national passing percentage is not normally distributed. Thus, the researcher purposively utilized the database results of Nurses' Licensure Examination taken last June and December 2012 with 451 and 489 participating nursing schools respectively in the Philippines through PRC online website. The national passing percentage served as point of reference in categorizing below and above national passing percentage of each nursing school's individual performance.

The data mentioned above was subjected for fractal analysis using Minitab Statistical Software Release 16. This software aids in analyzing the data through the presentations of its histogram, probability plot, time series, and computation of probability of density functions using the equation of fractal statistics as shown in the paper by Padua, et.al. (2013). The interpretation and analysis of the irregularities, self-similarities and ruggedness of the data being transcribed from PRC database sources was more emphasized. The data generated in terms of percentage was subjected to the computations of alpha, theta, lambda and scale to determine the fractal difference and disparity between June and December NLE results and among below and above national passing percentage. The fractal dimension is derived from the fractal distribution which is mathematically defined by Padua,et.al. (2012). The formula is shown below:

To give more emphasis on the interpretations and analysis of the data being generated, the presentations of histogram determined the presence of fractality and its type as shown with irregularities and ruggedness of the data. The probability plot identifies the distribution of the data as normal or not normal. When the P-value of the data shows less than 0.05, it was classified as non-normal distribution. The data with abnormal distribution was subjected for computations of probability of density functions as enumerated above. To showcase the irregularities and ruggedness of the data is the primary objective of time series utilizing lambda and scale computations. It gives clear views to the researchers regarding the fractality of the data being generated. The mean of the lambdas determined the fractal difference and disparity between the totality results of June and December school performance and between below and above national passing percentage of both test periods of PNLE.

Month	Number of Passers	Number of Takers	National Passing Percentage	Source
June 2012	27, 823	60, 895	45.69%	Professional Regulation Commission (2012)
December 2012	16, 908	49, 066	34.46%	Professional Regulation Commission (2013)

Table 1: Database of Nursing School Performance of June and December 2012

4.0 Fractal Model and Analysis of School Performance in NLE

The histogram of the school performance passing percentage of the samples of nursing schools shows a definite pattern of non-normal distribution as shown in Figure 1.

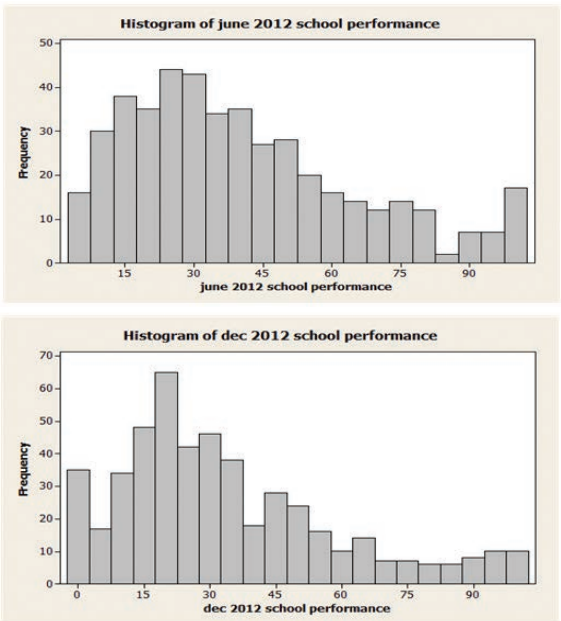

Figure 1 : Histogram of June and December 2012 School Performance

The histogram of below and above national passing percentage of June and December 2012 of the samples of nursing schools shows a definite pattern of non-normal distribution as shown in Figure 2.

The non-normal distribution is also evidenced in the probability plot of school performance of June and December 2012 with P-value of <0.010 as shown in Figure 3.

The non-normal distribution is also evidenced in the probability plot of below and above national passing percentage of June and December 2012 with P-value of <0.010 as shown in Figure 4 and 5.

Figure 6 and 7 show the time series of values from a non-normal distribution of June and December 2012. Spikes are observed in the graph of the time series of school performance.

The time series plot of below and above national passing percentage of both June and December 2012 are presented in Figure 8. It shows distinctive patterns of both timeframes. The self-similarity of the time series plot in both below and above national passing percentage is observed in the presentations.

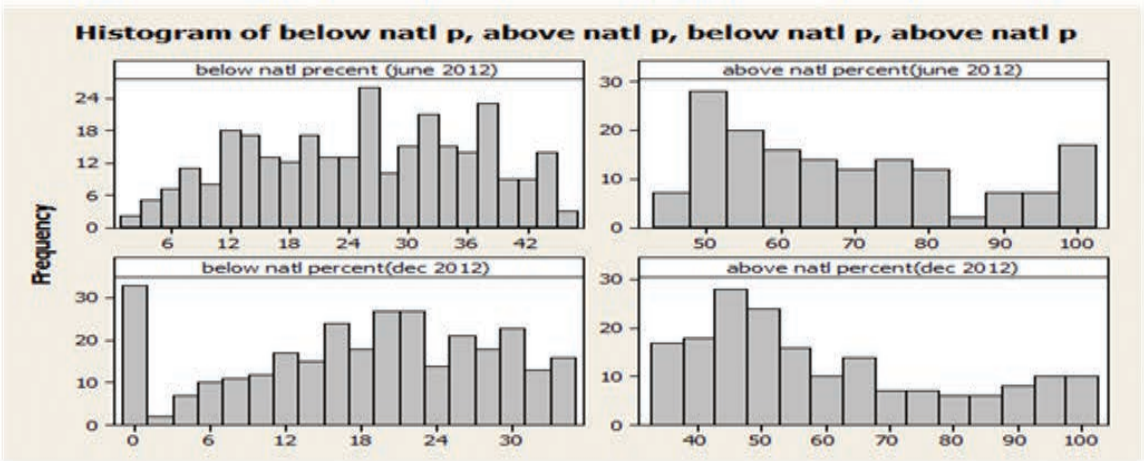

Figure 2: Histogram of below and above national passing percentage (June and December 2012)

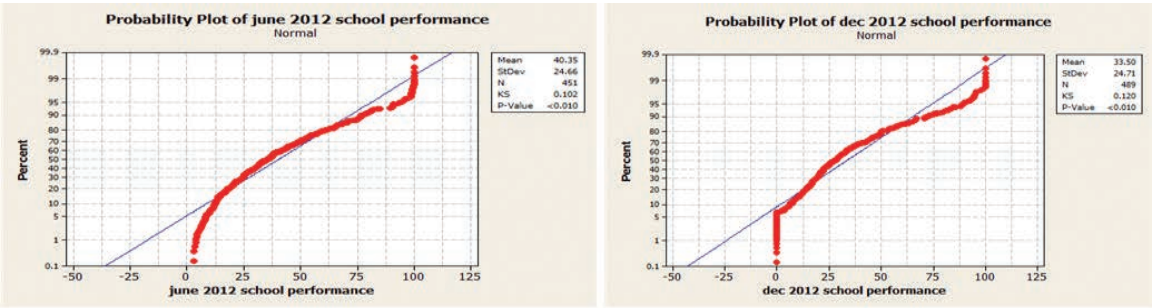

Figure 3: Probability Plot of June and December 2012 School Performance

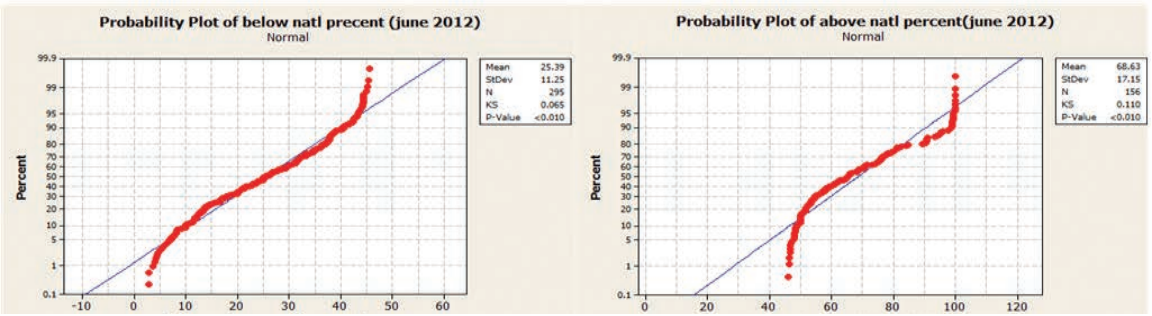

Figure 4: Probability Plot of below and above national passing percentage (June 2012)

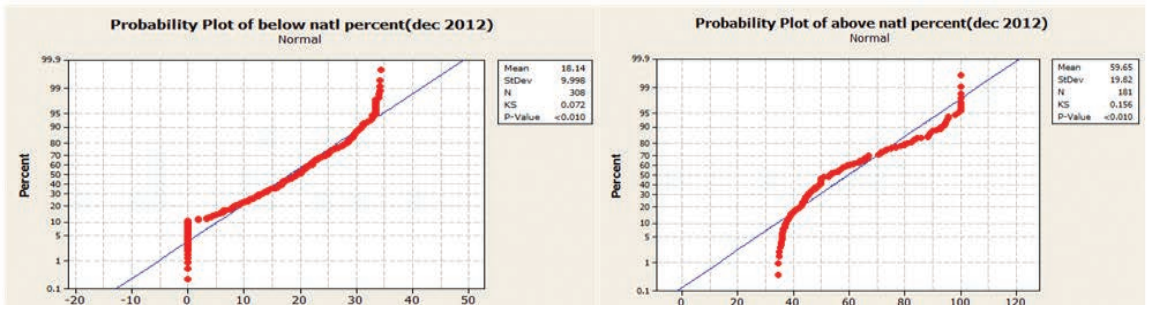

Figure 5: Probability Plot of below and above national passing percentage (December 2012)

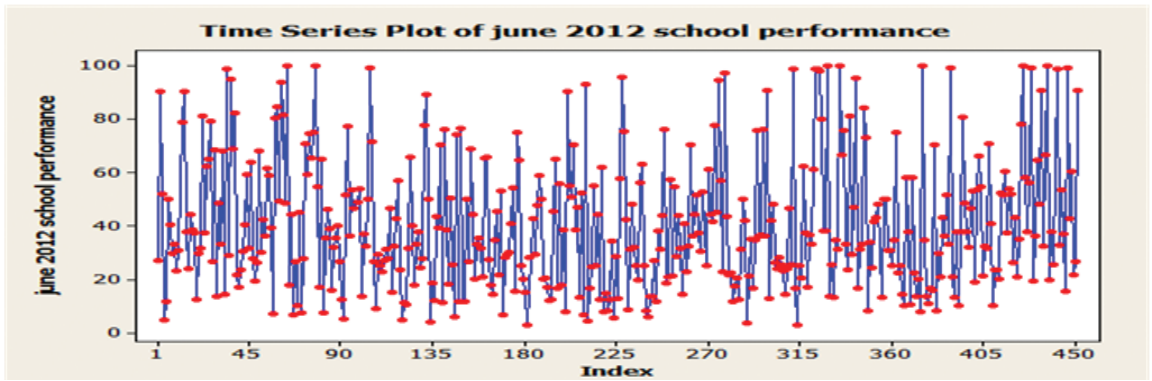

Figure 6: Time Series of School Performance (June 2012)

The histogram of the estimated values of lambda for June and December 2012 and below and above national passing percentage respectively from the standard normal distribution shows a definite pattern of exponential distribution as shown in Figure 9 and 10.

5.0 Results

The values of both lambdas of June and December 2012 school performance are presented in Table 2. It shows that June NLE is more irregular and rugged compared to December NLE.

The values of lambdas in school performance with below and above national passing percentage in both June and December 2012 are shown in Table 3. It shows that those nursing schools belong to below national passing percentage of NLE performance in both June and December have high lambdas compared to above national passing percentage.

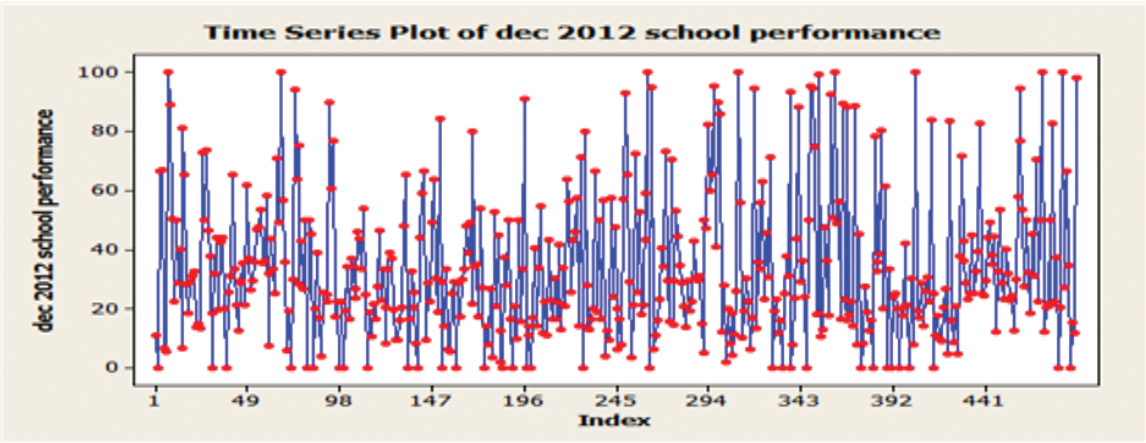

Figure 7: Time Series of School Performance (December 2012)

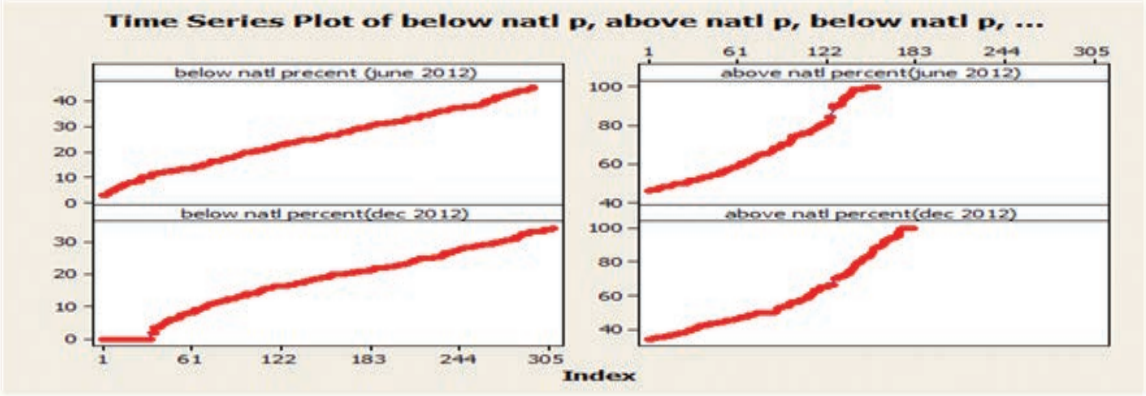

Figure 8: Time Series of below and above national passing percentage (June and December 2012)

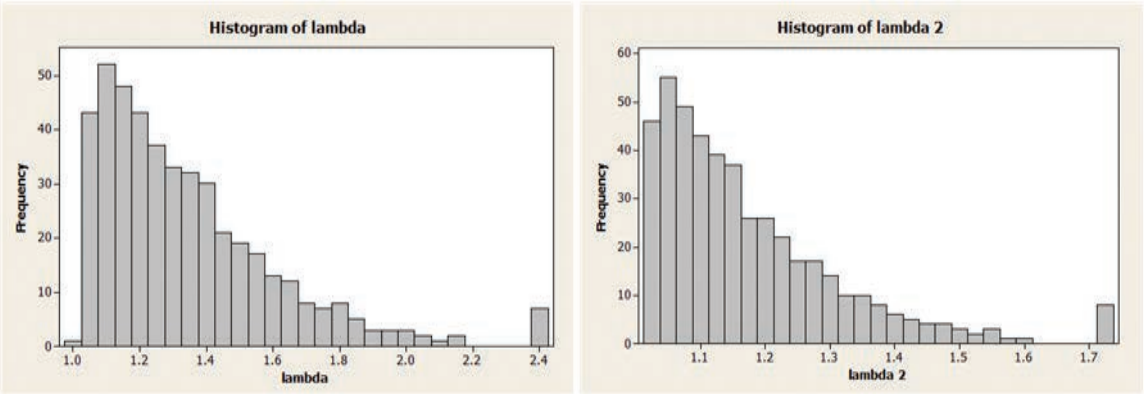

Figure 9: Histogram of the values of lambda (June and December 2012)

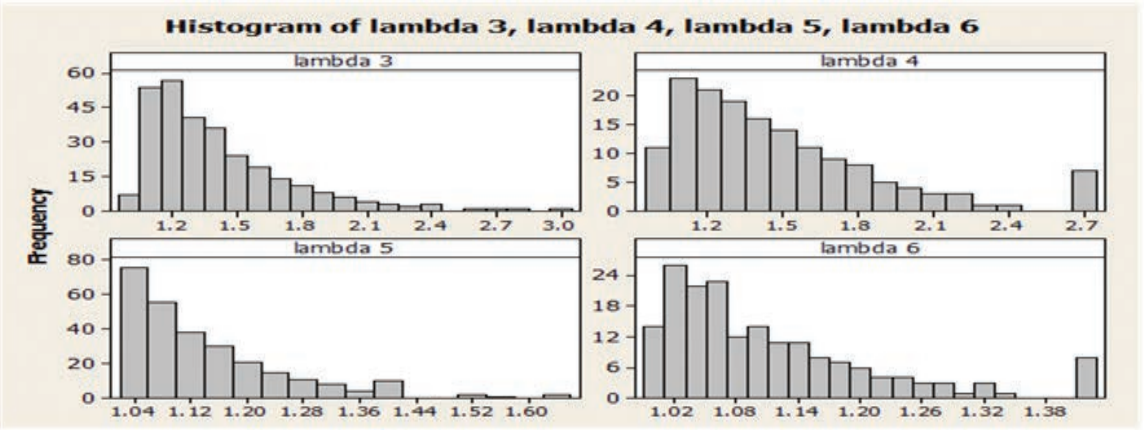

Figure 10: Histogram of the values of lambda of below and above national passing percentage (June and December 2012)

Variable	N	Mean	SE Mean	StDev	Minimum	Median
Lamda 1 (June 2012)	451	1.3437	0.0127	0.2694	1.0241	1.2760
Lambda 2 (December 2012)	489	1.1739	0.00661	0.1411	1.0219	1.1351

Table 2: Descriptive Statistics for Fractal Dimensions (June and December 2012)

Variable		N	Mean	SE Mean	StDev	Minimum	Median
June 2012	**Lambda 3 (below national passing %)**	295	1.4107	0.0197	0.3369	1.0370	1.3169
	Lambda 4 (above national passing %)	156	1.2984	0.0214	0.2673	1.0023	1.2226
December 2012	**Lambda 5 (below national passing %)**	308	1.1408	0.00702	0.1162	1.0216	1.1057
	Lambda 6 (above national passing %)	181	1.1123	0.00773	0.1040	1.0007	1.0814

Table 3: Descriptive Statistics for Fractal Dimensions of below and above national passing percentage (June and December 2012)

Figure 11 shows the scatterplot of lambda versus scale of June and December 2012. Note that the function appears to be a single humped continuous function up to scales. This illustrates that the data may have come from a monotone and multifractal distributions.

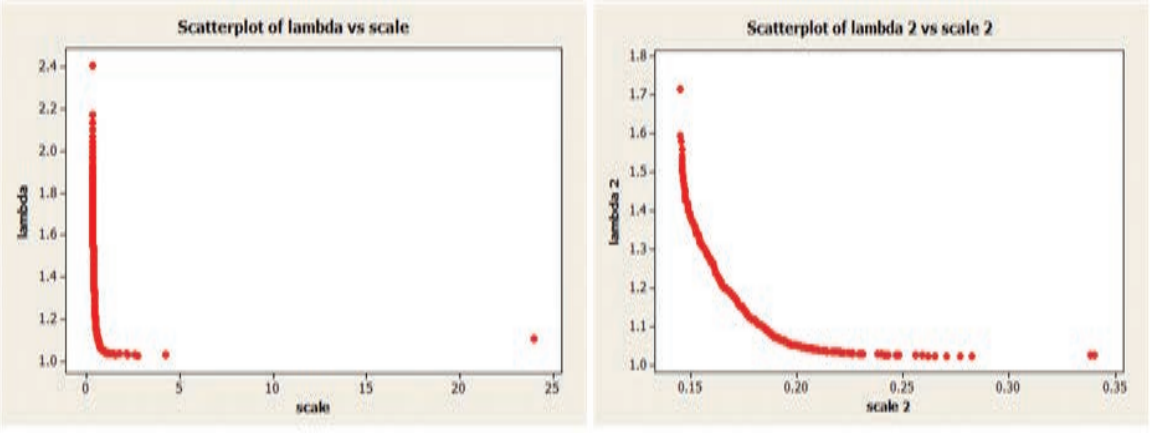

Figure 11: Spectrum of lambda versus scale (June and December 2012)

Figure 12 showcases the scatterplot of lambdas and scales of both below and above national passing percentage in December 2012.

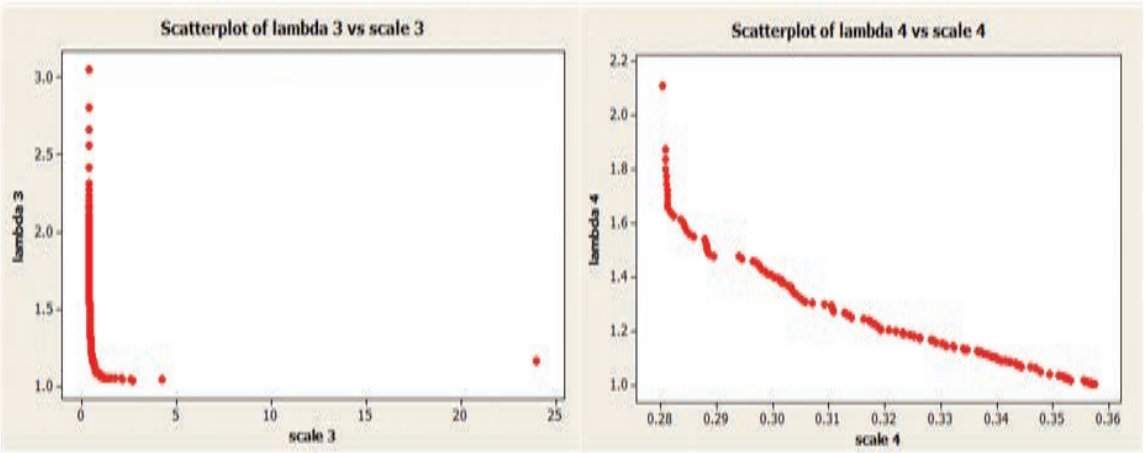

Figure 12: Spectrum of lambda versus scale of below and above national passing percentage (June 2012)

Figure 13 shows the spectrum of lambda values of below and above national passing percentage of December 2012 NLE school performance has distinctive appearance of multifractal distribution.

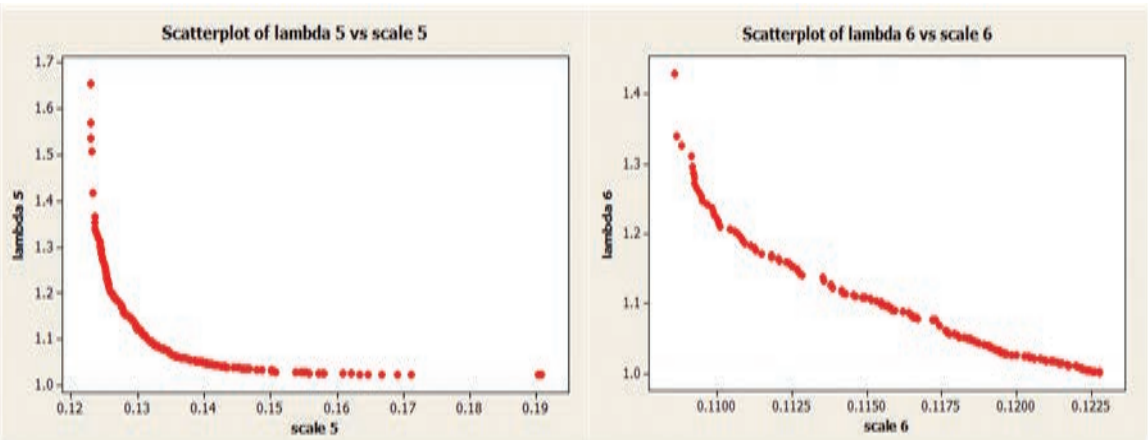

Figure 13: Spectrum of lambda versus scale of below and above national passing percentage (December 2012)

Table 4 shows the lambdas and average percentage between June and December 2012 NLE school performances. It shows that June NLE school performance has higher lambdas and average compared than December NLE school performance.

	June 2012 School Performance	December 2012 School Performance
λ	1.34	1.17
Average Percentage	40.34	33.50

Table 4: Fractal difference between June and December 2012

Table 5 shows the values of lambdas and average percentage in both below and above national passing percentage NLE school performances in both June and December 2012. It highlights the fractal difference between below and above national passing percentage. This highlights that June NLE school performance has high fractal dimensions compared to December NLE school performance.

June 2012 School Performance		
	Below National Passing Percentage (<45.69%)	Above National Passing Percentage (>45.69%)
λ	1.41	1.29
Average Percentage	25.39	68.63
December 2012 School Performance		
	Below National Passing Percentage (<34.46%)	Above National Passing Percentage (>34.46%)
λ	1.14	1.11
Average Percentage	18.13	59.65

Table 5: Fractal difference among below and above national passing percentage (June and December 2012)

Table 6 shows the fractal disparity between June and December 2012 NLE school performance. It shows that June NLE school performance has high fractal disparity compared to December NLE school performance.

	Below Passing Percentage	Above Passing Percentage	Fractal Disparity
June 2012	93.56	233.93	**140.37**
December 2012	27.20	93.52	**66.32**

Table 6: Fractal dimensions and disparity between below and above national passing percentage (June and December 2012)

6.0 Discussions

In the analysis of June and December NLE school performances, the fractality of the data is being observed and that both test periods are not normally distributed. The time series plot of both below and above national passing percentage in both June and December 2012 NLE school performances shows self-similarities, irregularities and ruggedness.

Based on the findings, the researchers found out very important and useful insights for the improvement in the quality of nursing education in the Philippines. It also geared towards more planned and well-developed strategies in achieving high performance rating in taking NLE. The following are the findings of the data:

The June NLE school performance has higher lambda (λ=1.34) compared to December (λ=1.17). This means that June NLE performance is more rugged and irregular than December NLE result.

The values of lambda of below national passing percentage of June NLE (λ=1.41) and December NLE (λ=1.14) is higher compared than above national passing percentage of June NLE (λ=1.29) and December NLE (λ=1.11). This entails that those nursing schools with below national passing percentage in both June and December NLE is more rugged and irregular compared than above national passing percentage in both June and December NLE.

The June and December NLE performances show both multifractal spectrum. The characteristic of self-similarity in both June and December is also being observed in below and above national passing percentage performances as shown in the previous presentations (see Figure 11 to Figure 12 and 13). There is self-similarity in the patterns of both large and small scales.

The fractal disparity in below national passing percentage shows (93.56) and above national passing percentage shows (233.93) in June NLE. However, the fractal disparity of below and above national passing percentage shows (27.20) and (93.52) in December 2012 respectively. The fractal disparity in June is (140.37) which is higher than December (66.32). Mathematically, this means that those nursing schools taking December has low variability in their test scores compared to those in June.

The computed value of T-test (4.25) between two test periods displays significant difference in their respective performances.

In the utilization of fractal analysis, the first finding is exhibited since many nursing schools around the country set screening procedures in their first batch of takers usually adapted during

June. This implies that those students likely passed the pre-board examinations and with thorough positive evaluations from review centers and nursing schools themselves are usually qualified and allowed to take the examination as first batch who will take during June. These representatives of their respective schools tend to pull the variations among performances. Their high scores contribute to the increase of the national passing percentage during June where some of the non performing schools cannot achieve. Those who failed in the pre-board and actual board are likely advised to take December NLE. The variations in December school performance as noted with low fractal dimensions derived from almost the same performance of test scores. The students who failed in the previous examination and the second batches of examinees significantly contribute to the low variability of performance in December. These strategies are observed in many nursing schools as being adopted. Many of the high performing nursing schools in the country commonly take the said examination in June than December as noted in most number of years. According to Elliot, McGregor, & Gable (1999) find out on their study that persistence and effort relative to learning outcome mediate the relationship between performance-approach goals and exam performance.

The second finding states that those nursing schools with below national passing percentage in both June and December NLE is more rugged and irregular may be due to lack of screening procedures and strategies implemented in review sessions. Many nursing schools with low performance do not follow the same strategies compared to schools with above national passing percentage. It may be due to many students despite being failed in the pre-board examinations still insisted in taking the risk of failing. This is highly observed in many nursing schools around the country. The fractal dimensions in December 2012 displayed in both below and above national passing percentage performances are almost normal in distribution. This happened due to screening procedures practiced in many nursing schools. The second batch taking December are usually low performing compared to June takers though not applicable to all. Chamorro-Premuzic & Furnham (2003) argued that personality traits of students such as achievement striving and self-discipline plays an important input in the forecast of academic success and failure in many learning institutions specifically in highly selective and competitive settings.

The third finding revealed that June and December NLE shows multifractal spectrum. This means that more nursing schools with above national passing percentage and high performing schools are taking June than December. It also shows that more students with average or above average intelligence are taking June than December due to screening procedures. Such variations happened due to adherence to accreditations. The accreditations in PAASCU, AACCUP, PACUCOA and many other accrediting bodies in higher institutions is one of the contributing factors that influenced many schools to adhere to the standards in achieving quality education. The high performing schools are usually accredited in any accrediting bodies. The multifractal presentations of high

performing nursing schools are due to various levels of accreditations and admission policy being implemented. The opposing standpoint in many nursing schools followed the various types of admission policy such as selective, quota and open admission-strict retention policy that caused irregularities, ruggedness and self-similarity of the fractal data of the schools performance in terms of passing percentage. The high performing schools are usually implemented either selective or quota policy. These two policies are more standard than open admission-strict retention policy due to selection process of more ready and suitable students taking nursing. It cannot be denied the fact that many colleges and universities are offering BSN curriculum in 2006 due to high demand abroad. This turning point serves as an avenue for grabbing business gain with more enrollees in nursing (quantity) rather than quality education.

On its widest scope, the June 2012 school performance in NLE has higher dimensional disparity compared to December 2012. This shows that school performance during June is more diverse, irregular and rugged compared during December as noted in the fourth finding. Although, the test questions on both test periods are generated in one test bank system as claimed by the board examiner themselves, still it project diverse performances as fractal dimensions are being measured. The causative factor of such variations laid down on the students' behavior and dominance of intelligence in June compared to December. This diverse pattern of schools performance was remarkably achieved due to the fact that most of the high performing schools around the country opted to take June than December.

In summary, the high fractal dimension in the performance of June 2012 compared than December 2012 implies the need in the improvement of quality nursing education in the country. Lockheed & Verspoor (1991) stressed out that improving the quality of education is indeed precondition in the development of health workforce in meeting the drastic change in technology of the 21st century. The last finding revealed that there is significant difference in the performances of PNLE in two test periods. Hence, the noteworthy discovery of such disparity in performances contributes to possible modification of existing policy regarding the conduction of board examination in terms of test period. That the PNLE will be conducted once a year so as to address the disparity of each performances in two test periods. Such revisits on the board exam policy prescribing the nursing academe to adhere in one test period policy is a timely motion in the current situation since there is low turn-out of students who enrolled in the said course. Rather than giving them the option to decide what test period is most strategic and effective, the institutions will now be complied to produce quality takers which would eventually compel the institutions to provide quality nursing education. After all, the quality of education is highly regarded as the achievable phenomena in defining success in institutional performances.

7.0 Conclusion

In the findings of the fractal analysis,

the researchers conceded to formulate two conclusions from two different perspectives. (1) The dimensional disparity of June NLE results (λ=1.34) is higher compared to December NLE results (λ=1.17). The high dimensional disparity of June school performance possibly relates to most of the high performing schools with above average students preferably taking June NLE than December. (2) There is higher fractality observed in the low performing schools (λ=1.41 & 1.14) compared to the fractality of the high performing schools (λ=1.29 & 1.11). This means that percentage of the high performing schools is more rugged, rough and irregular versus the low performing schools. The gap of percentage in high performing schools is more diverse than low performing schools. Consequently, many high performing nursing schools preferred to take June than December and most of the above national passing percentage displayed patterns in self-similarities, irregulaties and ruggedness despite different test periods. Thus, the study concludes that students' behavior pertinent to the assessment varies significantly in two test periods.

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