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Fractal Dimension Analysis of Pre-Board and Licensure Examination Results of Teacher Education Graduates

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Abstract *- This study aimed to analyze the Fractal Dimensions of pre-and licensure examination results of teacher education graduates of one State University in the Philippines to find the strengths and weaknesses for possible intervention programs. In this study, the descriptive-correlation method of research was utilized. Data of 2132 graduates were requested in the Office of the Professional Regulation Commission (PRC) through the consent of the University President. Triangulation of the result was done through unstructured interview to the dean and associate deans of the different campuses of College of Teacher Education in the State University. Fractal dimensions among the ten consecutive licensure examinations were utilized. Results of the study showed that fluctuations on the pre-licensure examination performance significantly influence the fluctuations on the actual licensure performance. Also it was found that the higher the diversity on the performance in the pre-licensure examination, the more compressed is the performance in the actual licensure examination. Based on the result, it was recommended to study further the status of Licensure examination result of the universities and analyze possible predictors of fluctuations.*

Keywords – *Fractals, Non-Parametric, Pre-LET, LET, Teacher Education*

INTRODUCTION

Across the globe, studies about the teacher's qualification and its implication to the teaching and learning performances have been recorded [1-4]. One of the salient features of teacher's qualification that have been mentioned by several literatures is the licensure, board exam, or certification of the professional teachers. when teacher learning is considered an important factor to improving teacher quality and ultimately student achievement, the likeness that the process of Board certification may provide positive impact on the quality of instruction [5]. Additionally, teachers who have a certification standard have a positive influence on student scores in relative to teachers who either hold certification in private school or are not certified in subject area [6]. Another finding showed that after analyzing the relationship between the certification of teachers by the National Board for Professional Teaching Standards (NBPTS) and elementary-level student achievement, consistent evidence that NBPTS is identifying the more effective teacher applicants and that NBCT are generally more effective than teachers who never applied to the program [7].

In the Philippines, the history of the Licensure Examination for Teachers (LET) can be traced back to when Republic Act (RA) 7836, (an Act to Strengthen the Regulation and Supervision of the Practice of Teaching in the Philippines and Prescribing a Licensure Examination for Teachers and for Other Purposes) otherwise known as the "Philippine Teachers Professionalization Act of 1994" became a law in 1994. In this Act, Article IV section 27 stated that except as otherwise allowed under this Act, no person shall practice or offer to practice the teaching profession in the Philippines or be appointed as teacher to any position calling for a teaching position without having previously obtained a valid certificate of registration and a valid professional license from the Commission.

Thus, every higher educational institution performs duty with great extent of efforts to produce graduate who are capable of

meeting the demands in the educational reform. In response to this, State Colleges and Universities in the Philippines think of varied strategies to improve the Licensure results [8]. Before taking the actual licensure examination, several universities in the Philippines practice giving a series of pre-licensure review and examination which is considered as one of their best practices to address the slow increase in performance of the graduates in the Licensure Examination. The graduates who were engaged in the said endeavor, and later took up the licensure examination include those who enrolled in the different curricular offerings in teacher education.

However, despite of the strategies done by the Teacher Education Institutions, poor performance in the Licensure examination for teachers has been an issue in state colleges and universities in the Philippines for the past fifteen years [9]. Passing this examination has also been a long term debate among educators [10]. Though, several researches were conducted focus on the performance of different higher education institutions in the licensure examination [11-13], some teacher education institutions are less confident when it comes to predicting the result of the licensure examination for teachers. In addition, the Philippine Business for Education (PBEd) reported that the performance of examinees in the Board Licensure Examination for Professional Teachers (BLEPT) has been poor from September 2009 to March 2017 [14]. Thus, the presented scenario calls for further research in relation to licensure examination.

The presented ideas above can be associated to fractals. Fractals are geometrical shapes that show self-similarity which link the integral and fractional dimensions. Accordingly, Mandelbrot (1984) stated that nature exhibited not simply a higher degree but an altogether different level of complexity. The number of distinct scales of length of patterns is for all purposes infinite. The existence of patterns contests many to study those forms that Euclid leaves aside [15].

Several studies found the importance of fractals. In music, using box counting algorithm it was found out that the fractal dimension of the music samples is 1.65 and varies between a high of 1.69 and a low of 1.60. Music according is not just random noise since random noise sample had a much higher fractal dimension than music samples [16].

A unique application of fractals in forensic handwriting analysis was utilized in a study where a similarity index based on the fractal dimension of a handwritten document was proposed. In the study, it was observed variations are within 1% of the fractal dimension of the specimen handwriting. The similarity indices computed per individual registered values well beyond 99% which meant each of the documents written by an individual has 99% or more similarity with his specimen document [17].

Barabat and Cabardo (2014) [18] analyzed the forms and roughness feature changes of selected Cebu City landmarks having its aim to examine the physical change of the old and new photographs of selected Cebu landmarks. After thorough analyses, the fractal dimension explains the space-filling property of the image. The change in of the fractal dimension between the old and new image may be attributed to a number of factors such as environmental change, local development agenda and legislative clarity.

Another study [19] utilized a fractal analysis by computing the fractal dimension of the population distribution of Bukidnon. Findings showed that the fractal dimension has a slight increase from 1995 to 1999. However, in 2000 to 2001 there was a tremendous disparity. Likewise, from 2002 to 2005, fractal dimension had a slight increased. It was also found that by 2006 to 2010, the movement trend of the population increased. Fractals are also used to examine literacy rates in countries across the globe [20].

In terms of fractal applications on teachers' and students' performance, it was found that the performance of teachers in extension had the highest fractal dimension approaching an integer value followed by the performance of teachers in instruction and

research. The variable with the highest performance in extension is a good indicator of better performance of students [21].

The performance variations in Mathematics, Science, English and Filipino were investigated using fractal dimensions. Results of the study revealed that the academic performance of students is a bounded fractal. Self-replication was also found among four subject areas [22]. Parallel to this, a study confirmed that there was a new development in research using Fractal analysis and statistics which do not only focus on central tendencies but more on geographical presentation of certain variables that researchers consider in dealing with research [23]. In many statistical analyses, the normality of data set is often assumed. But more often, not all data set follows normal distribution. Fractal dimensions as statistical quantities are strong measures which are not easily affected by extreme observations as compared to other variance-based measures. With the cited literatures and studies, this study tried to describe the fluctuations in the pre-and licensure examination results of one State University in the Philippines using Fractal Dimension analysis.

OBJECTIVES OF THE STUDY

This study arrived to analyze the Fractal Dimensions of pre-and licensure examination percentile rank of teacher education graduates of a State University as basis for curricular enrichment program. Specifically, the study sought answers to the following:

1. What is the status of teacher education graduates in the pre-and actual licensure examination in terms of variability as measured by fractal deviations?
2. Is there a significant relationship between the fractal dimensions of pre-and licensure examination for teachers?

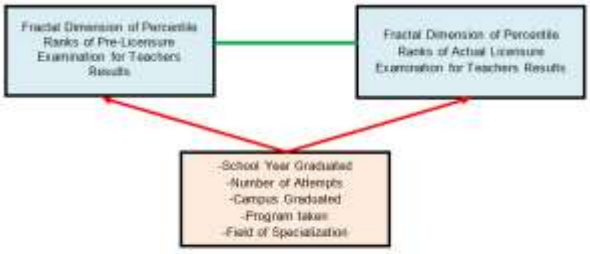


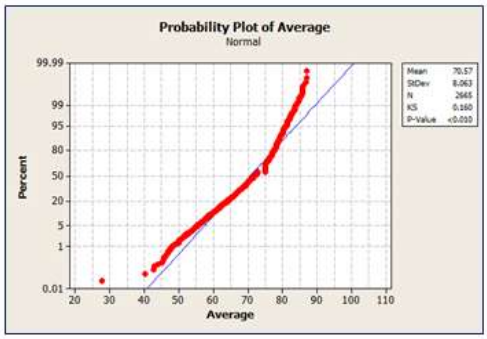
Figure 1. Conceptual Framework showing the interplay of the variables

MATERIALS AND METHOD

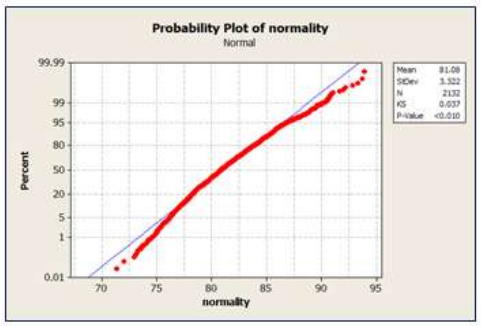
This study utilized descriptive research design particularly correlational design. In this design, the aim of the research is to determine the relationship between one variable (an independent variable) and another (a dependent or outcome variable) in a population. Accordingly, a descriptive study establishes only associations between variables [24]. Since it was hypothesized that the variations in the pre-licensure examination result is associated with the variations in the actual licensure results, the researcher requested the licensure examination data to the Professional Regulation Commission (PRC) through the consent of the university president where the study was conducted. A total of two thousand one hundred thirty two (2132) examinees were included in the analysis. Only those who took the pre-licensure examination were included in the study. Teacher education graduates who did not take the Pre-Licensure examination were removed from the sample. Then, normal distribution analysis was done to determine if the distribution is normal or not.

Finally, triangulation of the result was done by interviewing the dean and associate deans of the teacher education institution. Using the Kolmogorov-Smirnov (KS) test for normality, than the set alpha value of 0.05. Likewise, using the same normality test, it can be seen from the there is sufficient evidence to say that the pre-licensure examination percentile ranks of the teacher education graduates follow a non-normal distribution graph as seen on the probability value of <0.010 which is significantly lesser than the set alpha value of 0.05. Likewise, using the same normality test, it can be seen from the figure that the licensure examination percentile ranks of the teacher education graduates are not

normally distributed. For these reasons, there is insufficiency of using the variance-based statistics. Hence, the use of fractal dimension to analyze the pre-and licensure examination performance of teacher education graduates is done.



(Fig.2) Normality plot of the Pre-Licensure Examination performances of Teacher Education Graduates



(Fig.3)Normality plot of the actual Licensure Examination performances of Teacher Education Graduates

Based on the data presented in the table, it is found that the fractal dimension of teacher education performance in the pre-LET was 1.14813 which Campus C served as a primary contributor in the variations of the performance while the performance of teacher education graduates from Campus B found to be the least contributor in the total performance variations. In terms of year graduated, the least F_D was found in 2010 implying close relations among the graduates' performances in the pre-licensure examination which associated to high performance of teacher education graduates.

The performance of BSEd graduates had the least fractal dimension among other teacher education courses implying small variations among the graduates' performances. On the other hand, the highest fractal dimension was found in 2011 on BSFEd graduates performances showing fluctuations on the BSFEd graduates' performances.

In addition, graduates inclined with Arch draft showed the highest fractal dimension. Conversely, graduates inclined with Food Technology got the least F_D. As to number of examination taken, teacher education graduates who took once showed least fractal dimension of 1.13369 which after looking deeply was found that in 2013, the F_D of teacher education graduates was in its lowest point. On the contrary, those who took the examination more than three times got the highest fractal dimension.

RESULTS AND DISCUSSION

Table 1.*Fractal Dimension of the Performance of Teacher Education Graduates from 2009–2013 in the Pre-Licensure Examination for Teachers*

Variables	Year Graduated					
Campuses	2009	2010	2011	2012	2013	Mean
A	1.15230	1.14286	1.15230	1.13714	1.15307	1.14753
B	1.16856	1.12257	1.12346	1.15459	1.15535	1.14491
C	1.15611	1.14446	1.15459	1.15383	1.15686	1.15317
D	1.15535	1.12609	1.14446	1.14998	1.15868	1.14691
Weighted Mean	1.15808	1.13400	1.14370	1.14889	1.15599	1.14813
Course Taken	2009	2010	2011	2012	2013	Mean
BEEd	1.14605	1.16206	1.15761	1.16497	1.12870	1.15188
BSAgEd	1.14124	1.17760	1.15761	1.15757	1.15383	1.15757
BSEd	1.15836	1.12522	1.14842	1.15230	1.12870	1.14260
BSFEd	1.15969	1.15969	1.16785	1.15969	1.15153	1.15969
BSIE	1.15611	1.16059	1.15153	1.11808	1.14998	1.14726
CTP	1.14446	1.15836	1.15911	1.16206	1.15383	1.15556
Weighted Mean	1.14924	1.15544	1.15702	1.14935	1.14443	1.15110
Number of Take	2009	2010	2011	2012	2013	Mean
1	1.12783	1.13714	1.12696	1.15307	1.12346	1.13369
2	1.15761	1.15153	1.15911	1.16352	1.15794	1.15794
3	1.15153	1.14684	1.16713	1.14124	1.15169	1.15169
4	1.15230	1.15836	1.14920	1.15329	1.15329	1.15329
5	1.14763	1.14998	1.14881	1.14881	1.14881	1.14881
6	1.15535	1.18030	1.16783	1.16783	1.16783	1.16783
Weighted Mean	1.15019	1.15403	1.1506	1.15261	1.12346	1.14618
Field of Specialization	2009	2010	2011	2012	2013	Mean
Agri and Fish Arts Ed.	1.16300	1.16405	1.16196	1.14920	1.16613	1.15780
Animal/Crop Science	1.14842	1.15221	1.15153	1.15383	1.15145	1.15126
Architectural Drafting	1.16395	1.16564	1.16564	1.16059	1.17068	1.16564
Biological Sciences	1.16352	1.16425	1.15535	1.15307	1.15911	1.15906
Content Courses	1.15075	1.16570	1.15535	1.16497	1.15611	1.15858
Drafting Technology	1.15611	1.15465	1.15476	1.14205	1.16713	1.15510
English	1.14920	1.16352	1.15836	1.14842	1.15383	1.15467
Filipino	1.16713	1.15383	1.16059	1.15459	1.15836	1.15890
Food Technology	1.14366	1.14366	1.14366	1.14366	1.14366	1.14366
MAPEH	1.19890	1.17068	1.16497	1.12522	1.16713	1.16538
Mathematics	1.15836	1.15761	1.14526	1.15535	1.14763	1.15284
Physical Science	1.15383	1.15383	1.15383	1.13381	1.16570	1.15220
Pre-Elem	1.16151	1.16206	1.16096	1.15985	1.16107	1.16096
Social Science	1.15230	1.16133	1.15985	1.15153	1.14763	1.15453
Special Education	1.14523	1.14336	1.14710	1.13961	1.15459	1.14710
TLE	1.15761	1.15307	1.13296	1.13961	1.15911	1.14847
Weighted Mean	1.15965	1.16059	1.15381	1.14846	1.15925	1.15635

Results of LET Fractal Dimension

The LET result of Bachelor of Science in Fishery Education graduates was shown to have the highest fractal dimension compared to others. On the other hand, the least fractal dimension can be found in the performance of CTP graduates.

Table also shows that the average fractal dimension in the licensure examination for teachers of teacher education graduates is 1.14223. Specifically, it can be seen that the graduates of Campus D got the lowest fractal dimension during the licensure examinations as revealed by the F_D value of 1.13974 which means that the performance of teacher education graduates from Campus D has the lowest variability among other campuses. This low variability implies that that the performances of teacher education graduates from 2009–2013 of Campus D are almost the same for every licensure examination taken. On the other hand, the performance of teacher education graduates from Campus A has a fractal dimension of

1.14402 which is also the highest F_D among the four campuses. This denotes that the performance of teacher education graduates from the said campus is more variable than the other campuses.

Table 2. *Fractal Dimension of the Performance of Teacher Education Graduates of from 2009 – 2013 in the Licensure Examination for Teachers*

Campuses	Year Graduated					Mean
	2009	2010	2011	2012	2013	
A	1.15985	1.13212	1.13631	1.15383	1.13797	1.14402
B	1.14124	1.14763	1.14124	1.14205	1.14205	1.14284
C	1.14124	1.14684	1.14763	1.13631	1.13961	1.14233
D	1.14684	1.14763	1.14256	1.12956	1.13212	1.13974
Weighted Mean	1.14729	1.14356	1.14194	1.14044	1.13794	1.14223
Course Taken	Year Graduated					Mean
	2009	2010	2011	2012	2013	
BEEd	1.15230	1.14920	1.13879	1.14526	1.15459	1.14803
BSAgEd	1.14526	1.16858	1.13961	1.14786	1.13797	1.14786
BSEd	1.13381	1.14684	1.13961	1.13961	1.15075	1.14212
BSFEd	1.15632	1.15882	1.15383	1.16381	1.16713	1.16048
BSIE	1.14124	1.14842	1.14124	1.13296	1.14205	1.14118
CTP	1.13879	1.11898	1.18495	1.11717	1.12522	1.13702
Weighted Mean	1.14228	1.14640	1.14967	1.13375	1.14629	1.14368
Number of Take	Year Graduated					Mean
	2009	2010	2011	2012	2013	
1	1.14842	1.14124	1.14286	1.12783	1.15075	1.14222
2	1.15535	1.14763	1.14684	1.12696	1.14420	1.14420
3	1.13797	1.14684	1.12696	1.14763	1.13985	1.13985
4	1.13041	1.14205	1.12783	1.13343	1.13343	1.13343
5	1.15153	1.14446	1.14800	1.14800	1.14800	1.14800
6	1.15075	1.15761	1.15418	1.15418	1.15418	1.15418
Weighted Mean	1.14650	1.14664	1.13612	1.13414	1.15075	1.15420
Field of Specialization	Year Graduated					Mean
	2009	2010	2011	2012	2013	
Agri and Fish Arts/Ed.	1.14426	1.14499	1.14354	1.13631	1.14645	1.14062
Animal/Crop Science	1.14684	1.14298	1.15383	1.13212	1.14394	1.14426
Architectural Drafting	1.16056	1.16167	1.16167	1.15836	1.16497	1.16167
Biological Science	1.13961	1.13296	1.13464	1.14684	1.14763	1.14034
Content Courses	1.16279	1.14763	1.14043	1.14205	1.16133	1.15085
Drafting Technology	1.13961	1.14428	1.14392	1.14446	1.14446	1.14284
English	1.14920	1.13961	1.13464	1.13879	1.13797	1.14004
Filipino	1.14763	1.13041	1.12609	1.13296	1.12522	1.13246
Food Tech	1.14842	1.15524	1.15524	1.16206	1.15524	1.15524
MAPEH	1.14998	1.17623	1.13714	1.15153	1.09907	1.14279
Mathematics	1.15153	1.13041	1.14286	1.13797	1.15075	1.14270
Physical Science	1.13381	1.14763	1.16570	1.15459	1.13041	1.14643
Pre-Elem	1.13747	1.13879	1.13714	1.13631	1.13755	1.13755
Social Science	1.13879	1.13961	1.13548	1.14124	1.13631	1.13829
Special Education	1.14604	1.14604	1.14604	1.15911	1.13296	1.14604
TLE	1.14526	1.14366	1.14286	1.14366	1.14124	1.14334
Weighted Mean	1.14612	1.14269	1.14137	1.14490	1.13969	1.14295

Relationship between the FDs of Pre-LET and LET

There is no significant relationships existed between the F_D performance of teacher education graduates during the pre-licensure and

the actual licensure examination which signified the independency among variations in the two licensure exams across campuses. Based also on the data given in the table, there were significant relationships existed between the F_D performance of teacher education graduates in the pre-and actual licensure examination which showed negative (for BSEd) and positive results (for BSIEd) while no significant relationship was found on the performance of teacher education graduates in other teacher education courses. Likewise, there were no significant relationships found on the variations in the performance of teacher education graduates when classified according to field of specialization as revealed by the pre- and actual licensure exam performance of the graduates who took once the examination. There is no significant relationship also in the fractal dimension of the performances of teacher education graduates in the pre-LET and the actual LET when classified according to year graduated. The findings signify that the ten consecutive licensure examinations taken by the teacher education graduates of four campuses of the university showed that the performances of teacher education graduates in the licensure examination for teachers are less variable compared to pre-LET results. Although it showed no significant relationship, the variations are explained deeply when analyzing the program/course taken and number of attempts in the taking the licensure examination. The significant negative relationship between variations on pre-and actual LET performances of BSEd provides an implication that calls institution to provide focus on consistency. Since found significant, large variations in the pre-LET is associated to more consistent LET result. Hence, variations on the results of BSEd LET performance can be explained by the variations in pre-LET results.

Table 3

. *Relationship between the Fractal Dimensions of Pre-Licensure Examination Performances and the Actual Licensure Examination Performances of Teacher Education Graduates when Classified According to Program Taken/Course Enrolled*

Campuses	Average FD		r-value	r^2	p-value	Relationship
	Pre-LET	LET				
A	1.14753	1.14402	-0.12	1.42%	0.849	Not Significant
B	1.14491	1.14284	-0.56	31.70%	0.323	Not Significant
C	1.15317	1.14233	-0.51	25.60%	0.385	Not Significant
D	1.14691	1.13974	-0.54	28.94%	0.349	Not Significant
Program/Course Taken	Average FD		r-value	r^2	p-value	Relationship
	Pre-LET	LET				
BEEd	1.15188	1.14803	-0.687	47.20%	0.200	Not Significant
BSAgEd	1.15757	1.14786	0.771	59.44%	0.229	Not Significant
BSEd	1.1426	1.14212	-0.943	88.92%	0.016	Significant
BSIEd	1.14726	1.14118	0.918	84.27%	0.028	Significant
CTP	1.15556	1.13702	-0.011	0.01%	0.986	Not Significant
Field of Specialization	Average FD		r-value	r^2	p-value	Relationship
	Pre-LET	LET				
Animal/Crop Science	1.15120	1.14426	-0.365	13.32%	0.762	Not Significant
Biological Science	1.15906	1.14034	-0.687	47.20%	0.200	Not Significant
Content Courses	1.15858	1.15085	-0.638	40.70%	0.247	Not Significant
Drafting Technology	1.1551	1.14284	0.483	23.33%	0.679	Not Significant
English	1.15467	1.14004	-0.76	57.76%	0.136	Not Significant
Filipino	1.1589	1.13246	-0.503	25.30%	0.387	Not Significant
MAPEH	1.16538	1.14279	0.364	13.25%	0.547	Not Significant
Mathematics	1.15284	1.1427	-0.27	7.29%	0.361	Not Significant
Physical Science	1.1522	1.14643	-0.479	22.94%	0.414	Not Significant

Social Science	1.15453	1.13829	-0.68	46.24%	0.206	Not Significant
THE/TLE	1.14847	1.14334	0.266	7.08%	0.665	Not Significant
Number of Licensure Examination Taken	Average FD		r-value	r^2	p-value	Relationship
	Pre-LET	LET				
1	1.13369	1.14222	-0.959	91.97%	0.010	Significant
2	1.15794	1.1442	-0.082	0.67%	0.918	Not Significant
3	1.15169	1.13985	-0.975	95.06%	0.025	Significant
more than 3	1.15726	1.14659	0.809	65.45%	0.400	Not Significant

CONCLUSION AND RECOMMENDATION

The primary purpose of this study was to analyze the Fractal Dimensions of pre-and licensure examination results of teacher education graduates of one state university as basis of curricular enrichment program. Since low performance in the licensure results have been observed in State Universities and Colleges, studying deeply the factors associated is imperative. Based on the foregoing result, this study noted that there is an inverse variation in the pre-licensure and actual licensure examination results of Bachelor of Secondary Education graduates in the State University where the study was conducted which denotes that high variations in the pre-licensure examination results to low variations in the actual Licensure Examination performances. On the other hand, the variation in the performances of Bachelor of Industrial Education graduates during pre-LET is positively correlated to the variations in the actual Licensure Examination. In terms of number of licensure examination taken, both 1 and 3 have shown negative relationship signifying that large variations in the pre-LET is associated to small variations in the actual LET. Variations on the pre-licensure and actual licensure examinations were associated by the personnel interviewed on the continuous innovation done by the university on increasing the LET performances of its graduates. Likewise, one of the campuses involved in the study has been awarded as Center of Development in Teacher Education in which one of the measurements is the licensure examination for teachers' high performance.

While the study tried to get the up to date data on the pre-and actual licensure examination results, only the included data have shown consistent reliable results (with no data gaps) in terms of pre-Licensure Examination. Hence, it is recommended to maintain this initiative which could be a very good source of data for analyzing the performances in the Licensure examination. Also this study attempted to link fractals to education by analyzing the variations in the pre-LET and actual LET results of the teacher education graduates. Discussions focused only on the variations on the performances not the performances relative to some average-based measures.

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