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Predictors of Licensure Examination for Teachers: A Comparative Analysis of Multiple Linear Regression and Artificial Neural Network

Randy P. Acoba
College of Education, Isabela State University – Echague Campus, 3309, Philippines
randy.p.acoba@isu.edu.ph

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ABSTRACT

The growing demand for high-quality education underscores the vital role of Teacher Education Institutions (TEIs) in shaping future educators who can meet the challenges of a dynamic society. Among the key indicators of a TEI's effectiveness is the success of its graduates in the Licensure Examination for Teachers (LET), a critical benchmark for professional readiness and teaching competence in the Philippines. As such, it is imperative to identify the predictors of board examination performance to help TEIs refine their academic programs, enhance their graduates' preparedness, and improve success rates in LET. Hence, this study aimed to identify the best predictors of LET among graduates of Bachelor of Secondary Education (BSE) program at Isabela State University-Echague Campus. To achieve this goal, the study uses advanced statistical models, namely, Multiple Linear Regression (MLR) and Artificial Neural Network (ANN), to analyze data on the academic performance of Batch 2019 graduates who immediately took the LET after graduation. The study found a significant positive correlation between academic performance and LET performance among BSE graduates. The study also compared the predictive abilities of MLR and ANN models using Mean Absolute Percentage Error. Results revealed that the ANN model had a lower forecast error compared to the MLR model for the General Education component of LET in the

BSE program. However, the MLR model had a lower forecast error for the Professional Education component of LET in the same program. Moreover, the predictive abilities of the two models vary across the six major courses of the LET. While the data used courses in the old curriculum, it is recommended that the same study be conducted using data from the graduates of the new curriculum.

Keywords: *Multiple Regression Analysis, Artificial Neural Network, Licensure Examination for Teachers, Teacher Education, prediction*

Introduction

Teaching has long been regarded as one of the most noble professions, as teachers' contributions to the development of other professions are indispensable. Teachers play a vital role in human development and catalyze change in society, modifying the behavior of individuals as learners. Republic Act No. 7836, also known as the Philippine Teachers Professionalism Act of 1994, states that no person shall practice or offer to practice the teaching profession in the Philippines or be appointed as a teacher to any position requiring a teaching position without first obtaining from the Commission a valid certificate of registration and a valid professional license.

The performance on board examinations is one of the indicators of a program's quality. If the passing rate on the first attempt is high, this is an excellent indicator of program excellence (Professional Regulation Commission CHED, 2004). Takers who finished BSE are evaluated on three components: General Education courses, which are considered the core subjects such as Filipino, Mathematics, Science, and Social Sciences; Professional Education subjects, which are classified into theory/concept courses, methods/strategies courses, field study courses, and special topics courses; and Field of Specialization.

On the other hand, the performance in the board examination has been considered a Key Performance Indicator in State Universities and Colleges (SUCs) Levelling (DBM-CHED Joint Circular No. 1, s. 2016). Additionally, CHED uses LET as one of the criteria for designating SUC curricular programs as Centers of Excellence (COE) or Centers of Development (COD). Likewise, accrediting bodies such as the AACCUP regard board examination as one criterion in the evaluation of the SUCs program offerings.

Basaen et al. (2005) mentioned in their study that the performance of the graduates in the licensure examinations measures the kind of students, quality, and standard of education a particular school provides, and mirrors the kind of teaching competence and quality of instruction they provide to the students. This underscores the importance of understanding the factors that contribute to successful LET outcomes. Noting the importance of the board examination performance in SUCs, it should be stressed that quality education and meaningful learning be delivered to the stakeholders of the University.

However, the Philippine Business Education (PBEd), an organization that has conducted research on the LET Performance of Higher Education Institutions (HEIs) throughout the country, has concluded that the average passing rate has been 31% since 2009. Additionally, PBEd's study found that at least half of HEIs' performance falls short of the national passing rate. According to a similar study conducted by Baylan (2018), a greater number of HEIs struggled to meet the national passing standard of at least 60% from 2008 to 2017.

The number of first takers and repeaters has also statistically affected the passing rate of Teacher Education Institutions in Central Luzon from 2009 to 2016 (Nool & Ladia, 2017). It revealed in their study that the number of first takers of the board examination had positively correlated with board examination performance while the number of repeaters in the examination had negatively correlated with the said examination. This implies that a smaller number of repeaters in the board examination resulted to a higher passing percentage. This finding emphasizes the importance of improving the preparation and retention of first-time takers.

Moreover, Guzman (2020) conducted a study on the board examination performance of graduates of Isabela State University, Echague, Isabela, Philippines, and found that the performance of BSE has improved from 2010 to 2017, noting a slight decline in 2014 for BSE. Furthermore, he found that the BSE passing rate has consistently been at least 39% higher than the national passing rate. However, despite these improvements, variations in passing rates over time suggest that other factors may be influencing LET outcomes, which warrants further investigation.

Say, for instance, the study of Quiambao et al. (2015) revealed that students' intelligence quotient and students' academic performance, among others, statistically and significantly predicted the passing of the graduates in the licensure examination for teachers. Moreover, in a similar study conducted in Cagayan Valley, it was confirmed that there was a significant and strong correlation between the performance of the graduates in college and board examination (Amanonce & Maramag, 2020). This further suggests that the assessment procedure of the universities involved in the study is effective as it concurs with the graduates' performance in the said examination. This highlights the value of academic performance as a predictor of LET success. Additionally, Macalinao et al. (2024) mentioned that the LET performance of graduates in a certain University in Zambales, Philippines, revealed an overall decline from 2021 to 2024, with BSE graduates exhibiting a more variable performance.

In addition, Ferrer et al. (2015) and Hena et al. (2014) also examined the interplay of academic performance and board examination performance and concluded that these two variables are highly and positively correlated with each other. Refugio (2017) also delved into the predictors of LET and found out that the respondents' academic achievements in professional education and major courses are significantly and positively correlated with their board examination performance; however, the academic performance of these respondents in general education courses did not significantly relate to their LET performance.

Meanwhile, there is a weak correlation between the graduates' General Weighted Average (GWA) and their board examination performance in General Education and Professional Education subjects (Antonio et al., 2016). However, the study of Apare et al. (2018) revealed that the GWA of BSE graduates is not significantly correlated to their LET performance, particularly in their field of specialization. These conflicting results

suggest that other variables influence LET performance, which may vary depending on the context of the institution or region.

Furthermore, LET performance is influenced by performance in academics and admission tests (Dagdag et al., 2017). Similarly, Montebon (2005) conducted a study on the factors affecting the LET performance of BSE graduates at Tagum College and discovered a significant correlation between academic achievement and practicum and the board examination. This demonstrates how critical academic preparation and experiential learning are for students during their college years. He recommended that teachers incorporate built-in reviews into their professional education classes. Similarly, to improve LET performance, syllabi and review materials should be updated to conform to the CHED Memorandum Order on curriculum and to align with the National Competency-based Teachers Standards (NCBTS) and Professional Regulation Commission (Visco, 2015).

Additionally, the PRC is mandated to monitor schools' performance on the licensure examination, as specified in Section 7 of Republic Act No. 8981, also known as the Professional Regulation Commission Modernization Act of 2000. Regular monitoring of higher education institutions' performance on board examinations provides critical information to various stakeholders. This will assist HEIs in making policies and decisions to improve their performance in board examinations.

Given these premises, it becomes essential to conduct a deeper investigation into the various factors influencing board examination performance. Specifically, building predictive models can provide valuable insights to faculty members in Teacher Education programs. These models can help identify which courses or components of the curriculum have the most significant impact on graduates' success in the board examination. Such findings would enable educators to refine their teaching strategies and curriculum design, to ultimately enhance the quality of instruction and the performance of future graduates.

Methods

The study employed the descriptive method of data analysis to determine the LET performance and the academic performance of the respondents while the inferential method of data analysis was used to determine the linear relationship between the variables being tested.

Respondents of the Study

The respondents of this study were the Batch 2019 BSE graduates of Isabela State University-Echague Campus who immediately took the September 2019 Board Examination after graduation. Eighty-three percent of the graduates of the College of Education at Isabela State University, Echague Campus, immediately took the Licensure Examination for Teachers in September 2019. Among these 161 LET takers, 102 samples were drawn using systematic random sampling. This number of samples was determined using Cochran's Formula with a 95% confidence level while systematic random sampling was used among these graduates to determine the specific respondents of the study. Data was retrieved from the LET results issued by the PRC through the Vocational Placement Unit of Isabela State University. Other data needed were taken from the Office of the Registrar.

Statistical Treatment of Data

Pearson Product Moment Correlation Coefficient was used to find the linear relationship between the performance of the respondents in the Licensure Examination for Teachers and their academic performance in college. Likewise, MLR and ANN were employed to generate models that will predict the performance of ISU-Echague in the Licensure Examination for Teachers in terms of their academic performance in General Education, Professional Education, and Major/Content courses. These two models were compared to determine which predictive model may be more accurate in determining the predictors of board examination.

Predictive Modeling Using Multiple Linear Regression

Multiple linear regression is a statistical technique that tries to explain the outcome value (i.e., LET) as the weighted sum of influences from multiple independent variables (Smalheiser, 2017). In this study, the goal was to identify key factors that influence the performance in LET. To do this, Stepwise Regression was considered to help select the most important predictors from a set of variables to ensure that the model is both efficient and effective at predicting the outcome.

Predictive Modeling Using Artificial Neural Network

Artificial Neural Networks (ANNs) are inspired by the way the human brain works. They are computational models that can learn and make predictions by processing information in layers, similar to how brain processes thoughts (Maind & Wanker, 2014). ANNs are especially good at understanding complex patterns and relationships in data that might be too difficult for traditional models to detect. In this study, a specific type of ANN called a Multilayer Perceptron, which includes multiple layers of nodes (like neurons in the brain), was used to make more accurate predictions. The predictors used in this model were chosen based on their importance, which was determined by how strongly they influenced the outcome in earlier stages of the analysis.

Validation and Comparison of the Models

The accuracy of the models generated by the MLR and ANN was assessed using the Mean Absolute Percentage Error (MAPE). This measure tells us how close the predicted values are to the actual values. A lower MAPE means the model is more accurate, while a higher MAPE suggests a significant deviation between the predicted and actual values.

Ethical Considerations

Prior to the gathering of necessary data, a notice to proceed with the study was granted by the Office of the Research and Development. This measure is done to ensure that all research activities are carried out in accordance with the rules and ethical guidelines for conducting research. Prior to the collection of data, approval of the request to access PRC data and scholastic records is sought from the Office of Student Affairs and Services. All data collected were treated with utmost confidentiality and were used solely in this study.

Results and Discussion

Relationship Between Academic Performance and LET Performance of BSE Graduates

Table 1 presents the relationship between the academic performance and board examination performance of Bachelor of Secondary Education graduates.

As gleaned from the table, the General Education performance of BSE graduates in college is significantly and positively correlated with their performance in the General Education component of LET. This is supported by a p-value of 0.01 and an r-value of 0.47, implying that when the respondents excel in General Education courses in college, their performance in the General Education component of LET also increases.

Furthermore, the table reveals a significant and positive association between the performance of BSE graduates in Professional Education courses in college and their performance in the Professional Education component of LET. This observation is evidenced by a p-value of 0.01 and an r-value of 0.45, suggesting a direct relationship between the two variables. This implies that as the respondents' performance in Professional Education courses in college increases, their performance in the Professional Education component of LET also increases.

Meanwhile, the major courses of the BSE graduates have a direct and significant relationship with their performance in major courses of LET. The p-value of 0.01 and an r-value of 0.25 suggest that there is a higher chance of getting a higher mark in the major courses of LET when the respondents excel in major subjects in college.

The overall performance of the BSE graduates in college is significantly and positively correlated with their overall performance in the Licensure Examination for Teachers. The observation is supported by the p-value of 0.01 and an r-value of 0.50 which imply that the BSE graduates have a higher chance of passing the board examination when they excel academically in college.

The findings of the study align with several studies (Amanonce & Maramag, 2020; Ferrer et al., 2019; Hena et al., 2014; and Refugio, 2017) which examined the association between LET performance and academic performance and revealed that these two variables are significantly and positively correlated with each other.

However, Antonio et al. (2016) found a weak correlation between the General Weighted Average (GWA) of the graduates and their performance in LET. Furthermore, Apare et al. (2018) found in their study that the GWA of BSE graduates is not significantly correlated with their LET performance.

Table 1. Relationship between Academic Performance and LET Performance of the BSE Graduates

	Academic Performance							
	General Education		**Professional Education**		**Major Courses**		**General Weighted Average**	
LET Performance	**r-value**	**p-value**	**r-value**	**p-value**	**r-value**	**p-value**	**r-value**	**p-value**
General Education	0.47	0.01						

Professional Education	0.45	0.01				
Major Courses			0.25	0.01		
Overall LET Performance					**0.50**	**0.01**

Predictors of Performance in the Licensure Examination for Teachers for BSE Program and Comparison between Multiple Linear Regression and Artificial Neural Network

General Education and Professional Education Components of LET in the BSE Program

Table 2 presents the predictors of the performance of BSE graduates in the Licensure Examination for Teachers using Multiple Linear Regression and Artificial Neural Network.

Table 2. Comparison Between the Predictors of General Education and Professional Education Components of LET under the BSE Program

Courses	**Methods**	
	Multiple Linear Regression (MLR)	**Artificial Neural Network (ANN)**
General Education Courses	• Computer Education Including Software Application • Study and Thinking Skills	• Computer Education Including Software Application • General Biology • College Algebra • Plane Trigonometry • Writing in the Discipline
R-Square Value	0.26	0.24
Mean Absolute Percentage Error	4.60%	4.54%
Professional Education Courses	• The Teaching Profession • Assessment in Learning 2 • Child and Adolescent Development	• The Teaching Profession • Special Topic in Peace Education • Curriculum Development • Field Study 5 • Principles of Teaching 1
R-Square Value	0.37	0.10
Mean Absolute Percentage Error	5.49%	6.09%

In terms of general education courses, the MLR generates two predictors of the general education performance in LET. However, only 26% variation in the performance in the general education component of LET is accounted for from these two predictors. On the other hand, ANN generated five predictors of general education performance in LET. As observed in the table, only a 24% variation in the performance in the general education component of LET is accounted for from these five predictors. In comparing their accuracy in predicting performance in the general education component of LET, the MLR method generated a Mean Absolute Percentage Error (MAPE) of 4.60% while the ANN method had a MAPE of 4.54%. This implies that a greater chance of forecast error may be committed when using the MLR model than the ANN model.

Meanwhile, the MLR generates three predictors of professional education performance in LET. As shown in the table, only 26% variation in the performance in the professional education component of LET is accounted for from these predictors. On the other hand, the ANN model suggests five predictors of professional education performance in LET. However, a minimal 10% variation in the performance in the professional education component of LET is accounted for by these predictors. In comparing the two models for predicting the professional education performance in LET, the MLR model generated a MAPE of 5.49% while the ANN model generated a MAPE of 6.09%.

Major Component of LET in the BSE Program

English Major. In the English major courses, MLR generated only one predictor of the major component performance in LET as shown in Table 3. The result also revealed at least 47% variation in the performance in the English major course component of LET that is accounted for by these predictors.

On the other hand, the ANN generated three predictors of performance in the English major component of LET. The model also revealed that 42% of the variation in the performance in the English major course component of LET is accounted for by the predictors using the ANN method. In comparison to their accuracy, the MLR model has a Mean Absolute Percentage Error of 3.84%, while the ANN model has a MAPE of 3.81%. This suggests that when using the model, a forecast error may be committed more from MLR than from the ANN.

Table 3. Predictors of English Major Component of LET in the BSE Program

	Methods	
	Multiple Linear Regression	**Artificial Neural Network**
English Major Course	• Language and Literature Assessment	• Literary Criticism • English and American Literature • Language and Literature Assessment
R-Square Value	0.47	0.42
Mean Absolute Percentage Error	3.84%	3.81%

Mathematics Major. In the Mathematics major courses, the MLR model generated two predictors of performance in Mathematics major course component of LET as revealed in Table 4. The result also revealed 57% variation in the performance in Mathematics major component of LET that is accounted for by these predictors.

On the other hand, the ANN model generated three predictors of performance in Mathematics major component of LET. Furthermore, a 35% variation in the performance in Mathematics major course component of LET is accounted for by these predictors. In comparison to their accuracy, the MLR model has a Mean Absolute Percentage Error of 5.42%, while the ANN model has a MAPE of 5.92%. This suggests that when using the model, a greater forecast error may be committed from the ANN model than in the MLR model.

Table 4. Predictors of Mathematics Major Component of LET in the BSE Program

	Methods	
	Multiple Linear Regression	**Artificial Neural Network**
Mathematics Major Courses	• Seminar in Technology in Mathematics • Abstract Algebra	• Plane Geometry • History of Mathematics • Seminar in Technology in Mathematics
R-Square Value	0.57	0.35
Mean Absolute Percentage Error	5.42%	5.92%

Filipino Major. In the Filipino Major courses, the MLR generated three predictors of performance in the Filipino major component of LET as gleaned from Table 5. The result also revealed 89% variation in the performance in the Filipino major course component of LET that is accounted for from these predictors.

On the other hand, ANN generated six predictors of performance in Filipino major component of LET. The model also revealed that 89% variation in the performance in the Filipino major course component of LET is accounted for from the predictors using the ANN method. While the ANN model suggested more predictors than the MLR model, the former model revealed a lower Mean Absolute Percentage Error than the latter model. This implies that when using the model, a greater forecast error may be committed from the ANN model than in the MLR model.

Table 5. Predictors of Filipino Major Component of LET in the BSE Program

	Methods	
	Multiple Linear Regression	**Artificial Neural Network**
Filipino Major Courses	• Pagtuturo at Pagtataya sa Pagbasa at Pagsulat • Kulturang Popular • Panulaang Filipino	• Introduksyon sa Pag-aaral ng Wika • Panimulang Lingguistika • Pagtuturo at Pagtataya sa Pakikinig at Pagsasalita • Introduksyon sa Pamamahayag • Panitikan ng Rehiyon • Pananaliksik sa Wika at Panitikan
R-Square Value	0.89	0.83
Mean Absolute Percentage Error	0.87%	1.16%

Social Sciences Major. Table 6 reveals one predictor of performance in the Social Sciences major component of LET when using the MLR model. However, only 49% variation in the performance in the Social Sciences major component of LET is accounted for from the predictor. Likewise, only one predictor of performance in the Social Sciences major component of LET was generated when using the ANN model. The table also revealed a 47% variation in the performance in the Social Sciences major component of LET that is accounted for by the predictor.

In comparison, the ANN model revealed a greater Mean Absolute Percentage Error than the MLR model. This suggests that the ANN model may have a greater forecast error than the MLR model.

Table 6. Predictor of Social Science Major Component of LET in the BSE Program

	Methods	
	Multiple Linear Regression	**Artificial Neural Network**
Social Sciences Major Courses	• Asian Studies	• World History and Civilization 2
R-Square Value	0.49	0.47
Mean Absolute Percentage Error	2.48%	3.02%

Technology and Livelihood Education Major. As gleaned from Table 7, two predictors of performance in the Technology and Livelihood Education (TLE) major

component of LET were generated using the MLR model. Also, 63% variation in the performance in the TLE major component of LET is accounted for from these predictors.

Likewise, two predictors of performance in the TLE major component of LET were generated by the ANN model. Furthermore, the table revealed a 71% variation in the performance in the TLE major course component of LET that is accounted for by these predictors. In comparison, the MLR model revealed a greater Mean Absolute Percentage Error than the ANN model which suggests that the MLR model may have a greater forecast error than the ANN model.

Table 7. Predictor of Technology and Livelihood Education Major Component of LET in the BSE Program

	Methods	
	Multiple Linear Regression	**Artificial Neural Network**
Technology and Livelihood Education	• Entrepreneurship • Fishery Arts	• Entrepreneurship • Basic Electronics • Tailoring
R-Square Value	0.63	0.71
Mean Absolute Percentage Error	6.73%	5.80%

Physical Education Major. As revealed in Table 8, none of the major courses of Physical Education (PE) can statistically predict performance in the PE major component of LET when using the MLR method.

Table 8. Predictor of Physical Education Major component of LET in the BSE Program

	Methods	
	Multiple Linear Regression	**Artificial Neural Network**
Physical Education Major Course	• None	• Aquatics (Swimming and Other Underwater Activities) • International Folkdance and Other Dance Forms • Music Literature (Western Music)
R-Square Value		0.32
Mean Absolute Percentage Error		1.93%

Interestingly, three predictors of performance in the PE major component of LET were generated when using the ANN model. Nevertheless, only a 32% variation in the performance in the PE major course component of LET is accounted for from the predictor using the ANN method. In terms of its accuracy, the ANN model has a Mean Absolute Percentage Error of 1.93%.

Conclusion and Future Works

Based on the findings of the study, the following conclusions were derived:

1. Eighty-three percent of the Batch 2019 graduates of the BSE Program immediately took the September 2019 Licensure Examination for Teachers. This high participation rate underscores the preparedness and motivation of the graduates to obtain licensure.
2. Higher performance in LET is moderately associated with higher performance in college. This highlights the importance of academic rigor and performance during college as a foundation for LET success.
3. The MLR model identified fewer but more specific predictors (e.g., computer-related courses and Study Thinking Skills) of the general education component of LET; whereas the ANN model highlighted a broader set of predictors, including courses in Biology, mathematics, and writing-related subjects. This suggests that while the ANN model provides a more comprehensive view of influencing factors, the MLR model offers a more focused and interpretable framework for prediction.
4. For the professional education component, the MLR model emphasized core pedagogical courses such as The Teaching Profession, Assessment in Learning 2, and Child and Adolescent Development, while the ANN model incorporated additional specialized courses like Special Topics in Peace Education and Field Study 5. This implies that the ANN model may account for a wider range of teaching competencies but introduces greater complexity.
5. The MLR model suggests that proficiency in Language and Literature Assessment plays a significant role in predicting performance in the English Major course. Meanwhile, the ANN model added Literary Criticism and English and American Literature as predictors of English major component of LET.
6. While the MLR model targets key advanced topics in mathematics (i.e., Abstract Algebra and Seminar in Technology in Mathematics) that directly impact a student's performance in LET, the ANN model provides a more diverse range of predictors, that includes both historical and practical elements of mathematics (Plane Geometry, History of Mathematics, and Seminar in Technology in Mathematics).
7. While the MLR model emphasizes key foundational courses related to reading, writing, and Filipino poetry, the ANN model highlights a more extensive range of subjects, including linguistic, journalistic, and regional literature, pointing to a more holistic and multifaceted approach to academic success in the Filipino Major.
8. The MLR model focuses on region-specific knowledge (in this case, Asian Studies), and the ANN model broadens the scope to include global historical perspectives, which reflects the diversity of topics that can influence success in the Social Sciences major course.

9. The MLR model suggests that entrepreneurial skills and specific vocational knowledge in fishery arts significantly influence the performance of TLE major graduates in LET, while the ANN model recognizes a broader set of vocational disciplines that includes electronics and tailoring for success in the board examination.
10. The MLR model did not identify any predictors for the PE major; however, the ANN model suggests that the diverse skill sets and disciplines involved in physical education that span physical activities, cultural appreciation, and artistic expression may significantly influence performance in the PE major component of LET.
11. While the curriculum of the BSE program has already changed, it is recommended that the same study be conducted for the new graduates of the K-to-12 curriculum.

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Conflict of Interest

The author declares that there are no conflicts of interest regarding the publication of this paper.