Isabela State University Linker:
Journal of Education, Social Sciences, and Allied Health
Volume 1, Issue 1
ISSN (Print): 3082-3692 ISSN (Online): 3082-3706
DOI: https://doi.org/10.65141/jessah.v1i1.n5

Relationship of Grades in Electronic Subjects to Electronic Board Exam Performance

Clyde A. Ogayon[1], **Edwin R. Arboleda**[2], **Migui A. Obsina**[3], **Thomas Gabriel A. Reyes**[4]
Department of Computer and Electronics Engineering, Cavite State University, Indang, Cavite, Philippines[1,2,3,4]
edwin.r.arboleda@cvsu.edu.ph

RESEARCH ARTICLE INFORMATION	ABSTRACT
Received: May 26, 2023 **Reviewed:** June 22, 2024 **Accepted:** June 05, 2024 **Published:** June 28, 2024 	This research involved the use of educational data mining methodologies to forecast and find relationships between electronic subjects and BSECE electronic board examination. Experiments based on real-world data from Cavite State University were presented in this paper. Based on earlier academic performance data, machine learning models were used to assess the ranking of topics that are crucial for electronic students to pass. WEKA, a modeling technique, was employed in this study. Furthermore, electronic grades had a significant impact on the academic achievement of undergraduate electronic communication students. This study contributes to the ongoing discussion on the relationship between essential BS electronics subjects and the Electronic Licensure Examination by evaluating the proposition of this research. During the data creation and manipulation process, challenges cannot be avoided, but they were filtered out until the data were suitable for processing. Overall, the study is beneficial since its findings can be applied in the future, and the model can be utilized as a reference and source of information for students and participants.

Keywords: *board exams, electronics communications, electronic communication students, grades, machine learning, WEKA*

Introduction

Engineering has altered the world, yet it is a conservative and slow-moving profession (Bokova, 2010). Electronic and communications engineering strive to bring two distinct engineering fields together to fulfill the demands of today's electronics and the computer industry (Dekho, 2018). Electronics and Communication Engineering is concerned with electronic devices, circuits, and communication equipment such as transmitters and receivers, as well as integrated circuits (IC). Basic electronics, analog and digital data transmission and reception, audio and video, microprocessors, satellite communication, microwave engineering, antennae, and wave progression were also covered. Its goal was to broaden students' understanding and skills in fundamental concepts and theories, preparing them for professional work involving analysis, system implementation, operation, production, and maintenance of numerous applications in the field of Electronics and Communications Engineering.

Electronics and Communication Engineering provides students with excellent job opportunities. Students can readily find work in manufacturing sectors and service organizations such as broadcasting, consulting, data communication, entertainment, research and development, and system support after completing the degree (Singh, 2016). For students as starters in the program of Electronics and Communication Engineering, those who have passed in physics, chemistry, and mathematics are eligible to enroll in the four-year bachelor's degree program in Electronics and Communication Engineering (Guduru, n.d). Upon finishing the four-year bachelor's degree comes the ECE Licensure Examination which is the basis of the study. The ECE board exam, which is also known as the Electronics Engineering Licensure Examination, is a biannual written licensure examination for electronics engineering graduates and is governed by the R.A. 9292 or known as the Electronics Engineering Law of 2004. This licensure examination occurs and is held every month of April and October by the board of Electronics Engineering under the Professional Regulation Commission (PRC) (Inhinyero, 2020). Several students strive to pass this licensure examination, and the most recent one occurred last April 2022. According to the Professional Regulation Commission (PRC), 897 out of 1,925 takers passed the Electronics Engineer Licensure Examination (Professional Regulation Commission, n.d).

In addition, based on the most recent electronics licensure examination, 46.5974% were passers, as the remaining percentage had failed. For most college schools, it is still way hard for them to predict which individual student may pass or fail the exam. The use of educational data mining tools made it possible to investigate the elements that influence students' academic performance and contribute to their failure and dropout prediction (Thomas, 2015). This paper would suggest the classification of electronics subject grades obtained by the students to their licensure examination results and evaluate its relationship to each.

WEKA was created with the intention of digesting agricultural data. However, the workbench's machine learning methodologies and data engineering capability have advanced so rapidly and dramatically that it is now widely employed in all types of data mining applications. WEKA includes a large number of relevant algorithms for a wide range of data mining jobs. These include data engineering tools, attribute selection methods, clustering algorithms, association rule learning algorithms, classification and regression algorithms, and more (Frank, et al., 2010)

Moreover, engineering and scientific workforce education is a crucial factor for economic development and technical competitiveness, according to the leading countries that generated engineering graduates (Gereffi, 2008,). Engineering has a significant impact on the physical, social, economic, and even digital aspects of the world. Educating people in this field to become facilitators of sustainable development in physical, social, economic, and technological transformations is currently the greatest challenge in this profession (Ferrer, 2015). Electronics Engineering is a branch of engineering that integrates available and emerging technologies with knowledge of mathematics, natural, social, and applied sciences to conceptualize, design, and implement new, improved, or innovative electronic, computer, and communication systems, devices, goods, services, and processes (CHED, 2018).

Before anyone else can undertake engineering in the Philippines, they must first get a certificate of registration and a professional license from the Professional Regulation Commission (Ferrer, 2015). The Commission is responsible for the administeration, implementation, and enforcement of the national government's regulatory laws on the regulation and licensing of numerous professions in the country (Republic of the Philippines - Professional Regulation Commission, n.d.). The licensure examination is required of all applicants for registration to practice engineering. The first difficulty for engineering graduates after receiving their baccalaureate degree is to meet the Commission's requirements (Ferrer, 2015).

Methods

Research Design

The study followed a quantitative design, and is quasi-experimental in nature which classified and interpreted the grades to board exam results of the students. Quasi-experimental research designs examine whether there is a causal relationship between independent and dependent variables. Quantitative emphasizes the collection of scores which is a measure to distinguish attributes of individuals as numerical data and evaluate using statistical approaches (Fischler, n.d). After the collection of grades of the Electronic and Communications students from 2012-2019, this study determined the significant relationship between passing the licensure examination to the students' grades in electronic subjects.

Research Participants

The participants of the study were the BS Electronics Communications Engineering students of the College of Engineering and Information Technology located in Cavite State University in Cavite Province, Philippines. The students involved in the study were graduates of the said degree and had taken the ECE Licensure Examination and completed electronic subjects that belonged to the attributes of the study. Overall, there were 70 students taken as a sample for the study.

Data Description

The data used for the study was obtained from the Department of College of Engineering and Information Technology, Cavite State University, Cavite, Philippines. The data were used for the classification and for the said model. The overall data gathered were composed of 22 electronic subject grades of 70 ECE students between the years 2012-2019. These electronic subjects were believed to pose a great significance in relation to their licensure examination results. The data obtained was filtered and cleaned since some students did not take some of the subjects included within the scope of the study and some discontinued. After that, the data were prepared for the data mining process. The data were entered into WEKA for processing. WEKA is a collection of data mining machine learning techniques. It has data pre-processing, classification, regression, clustering, association rules, and visualization capabilities (Witten, 2016).

Research Procedures

The research procedure entails the goal of the data collection, starting from the collection of data made possible with the permission of the academic department. Along with the administrators in charge of the handling of the student's data, complying with the proper procedures were followed in obtaining student records which was then handled by the co-author for the distribution and use of data for the study. Once the data were ready for classification, these were visualized and entered through WEKA.

Data Analysis

WEKA is an open-source software that offers tools for data preprocessing and algorithm implementation (Tutorialspoint, n.d.). It was used for classification and to identify potential connections between passing the 22 electronic subjects taken during the undergraduate course (attributes) and the licensure examination results (class).

Ethical Considerations

Throughout this research, safeguarding the privacy and confidentiality of the participants was of utmost importance, reflecting a strong ethical commitment. The researchers meticulously followed a well-defined process, which involved conducting personal consultations with each participant.

During these consultations, Electronics Communications students were provided with a thorough overview of the study's objectives and scope, ensuring their complete comprehension before giving their consent. Throughout these interactions, the researchers actively attended to any inquiries or apprehensions raised by the students, fostering an environment of transparent and open communication.

To ensure privacy, the researchers employed meticulous strategies, such as anonymization and de-identification methods, to eliminate any personally identifiable details from the gathered data. This stringent approach guaranteed the confidentiality of the students' identities and upheld the most rigorous privacy standards. Furthermore, the researchers took extensive precautions in securely handling the data, employing encryption and password protection to restrict access to authorized personnel only.

The participants' autonomy was respected by the researchers, who clearly informed them that they could opt out of the research and have their data excluded. Adhering to these ethical procedures allowed the researchers to uphold the fundamental principles of privacy and confidentiality.

Results and Discussion

PRC Results

The data below includes the total summation of samples, classified into two classes: passed and failed. A total of 70 students participated in the study: 44 passed the licensure examination, while 26 failed.

Table 1. Class Values

Class	***No. of Students***
Passed	*4* *4*
Failed	*2* *6*

Inclusion of Subjects BS Electronics and Communications Engineering

The dataset was composed of 22 subjects as input attributes. The researchers collected the students' grades for each of these 22 subjects, which served as the attributes and were referred to as the independent variables. These independent variables were significant for the study as they were used to correlate with the output, the dependent variable, which was the class. Each student, based on their performance in each electronic subject, was classified as either having passed or failed. These grades for each subject played a crucial role in determining the likelihood of passing or failing the PRC licensure examination, highlighting their significance in the classification process. Table 2 contains the individual list of the input variables and their data description.

Table 2. Attributes and Data Description

Attributes	**Description**
ECEN105A	Numerical Grade (Ranges from 1 to 5)
ECEN 106	Numerical Grade (Ranges from 1 to 5)
ECEN 111	Numerical Grade (Ranges from 1 to 5)
ECEN 116	Numerical Grade (Ranges from 1 to 5)
ECEN 196	Numerical Grade (Ranges from 1 to 5)
ECEN 197	Numerical Grade (Ranges from 1 to 5)
ECEN 198	Numerical Grade (Ranges from 1 to 5)
ECEN 199	Numerical Grade (Ranges from 1 to 5)
ECEN 200	Numerical Grade (Ranges from 1 to 5)
ECEN 55A	Numerical Grade (Ranges from 1 to 5)
ECEN 60A	Numerical Grade (Ranges from 1 to 5)

ECEN 70	Numerical Grade (Ranges from 1 to 5)
ECEN 75A	Numerical Grade (Ranges from 1 to 5)
ECEN 85	Numerical Grade (Ranges from 1 to 5)
ECEN 95A	Numerical Grade (Ranges from 1 to 5)
ECEN100	Numerical Grade (Ranges from 1 to 5)
ECEN101	Numerical Grade (Ranges from 1 to 5)
ECEN190	Numerical Grade (Ranges from 1 to 5)
ECEN50	Numerical Grade (Ranges from 1 to 5)
ECEN65	Numerical Grade (Ranges from 1 to 5)
ECEN80	Numerical Grade (Ranges from 1 to 5)
ECEN90	Numerical Grade (Ranges from 1 to 5)

Processed Data in WEKA

The most appropriate classifier for the provided data set was the Decision Stump Classifier. In machine learning, a classifier is an algorithm that automatically orders or categorizes data into one or more of a set of "classes" (Abro et al., 2022). Machine learning algorithms are useful for automating jobs that were previously done manually (Mesevage, 2020). The data used within the study went through five-fold cross-validation. Cross-validation is a data resampling technique for determining the generalization capabilities of prediction models and avoiding overfitting (Berrar, 2019). A decision stump is a decision tree that splits based in only one attribute. This often signifies that the tree only has one internal node for discrete properties, and the root has only left as successor nodes. The tree may be more complex if the attribute is numerical (Fürnkranz, 2016).

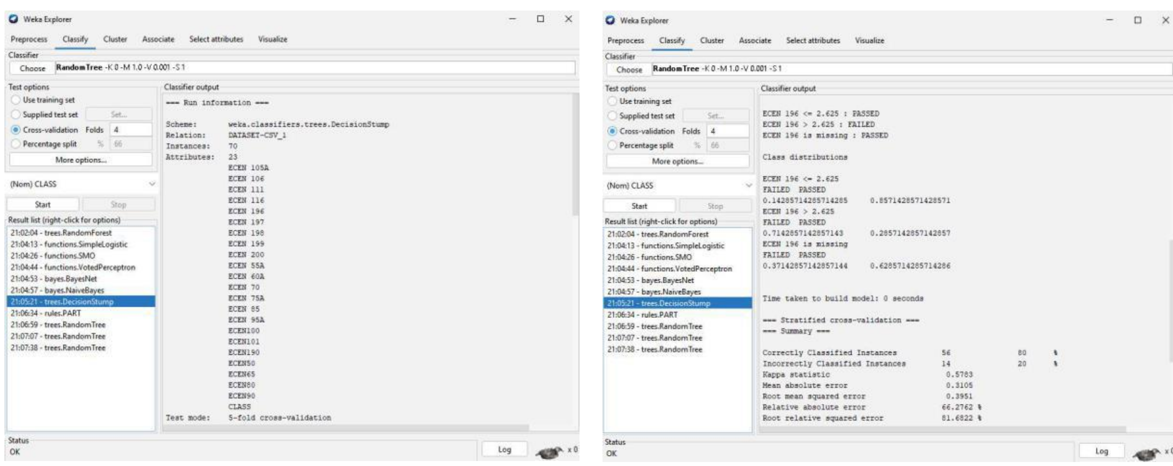

Figure 1. *Data Processing Through WEKA*

Graphical Representation of Attributes

The data entered within the WEKA application were analyzed using data mining techniques. The processed data were represented with visualization. Visualization refers to the process of presenting facts in a graphical or pictorial manner that makes it easier to comprehend. It aids in the explanation of facts and the selection of courses of action (Shadare et al., 2016). As shown in Figure 24, the subject with the highest rank when it comes to given attributes is the ECEN196, followed by ECEN80, ECEN100, ECEN198, and ECEN60A, and so on.

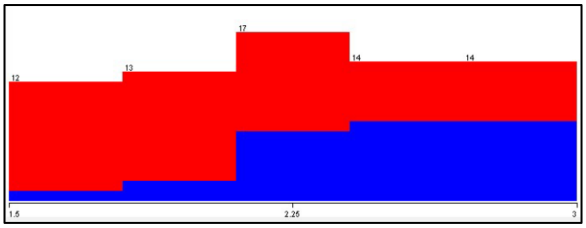

Figure 1. *Graphical Visualization of ECEN10*

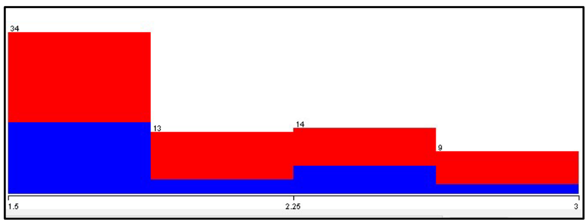

Figure 2. *Graphical Visualization of ECEN106*

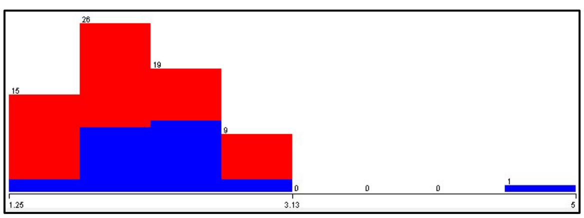

Figure 3. *Graphical Visualization of ECEN111*

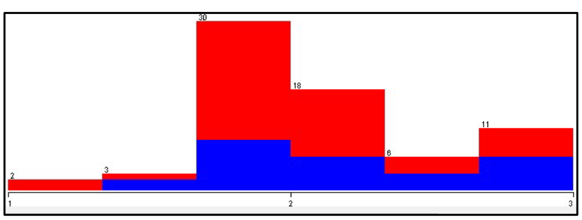

Figure 4. *Graphical Visualization of ECEN116*

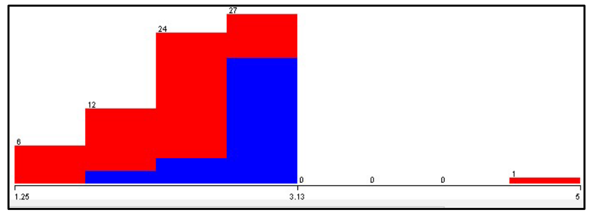

Figure 5. *Graphical Visualization of ECEN196*

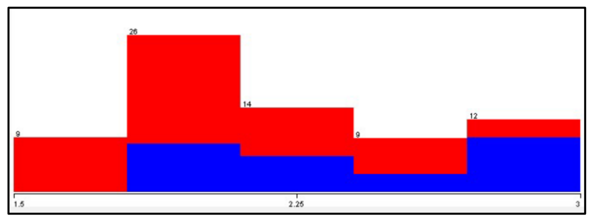

Figure 6. *Graphical Visualization of ECEN197*

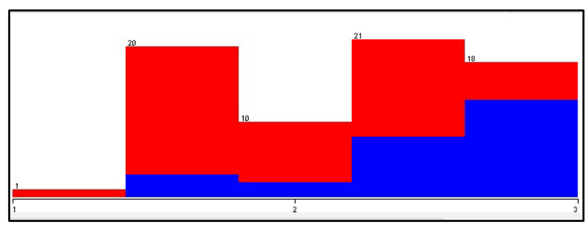

Figure 7. *Graphical Visualization of ECEN198*

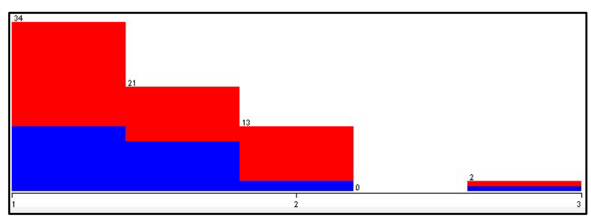

Figure 8. *Graphical Visualization of ECEN 199*

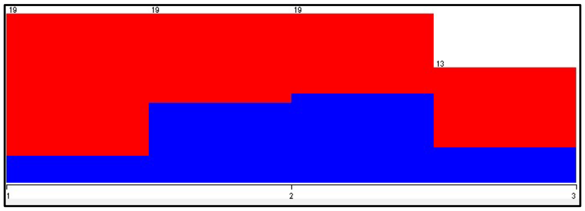

Figure 9. *Graphical Visualization of ECEN200*

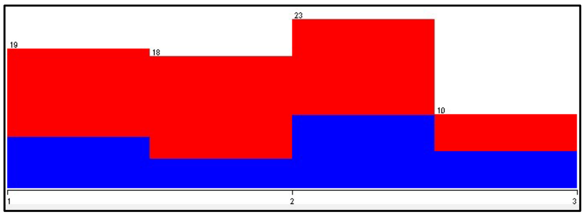

Figure 10. *Graphical Visualization of ECEN55A*

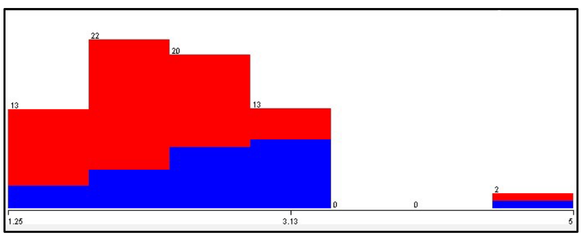

Figure 11. *Graphical Visualization of ECEN60A*

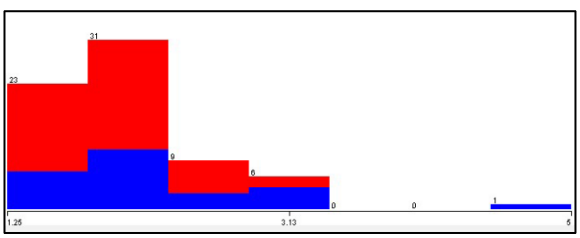

Figure 12. *Graphical Visualization of ECEN70*

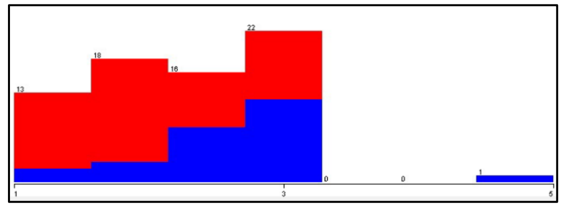

Figure 13. *Graphical Visualization of ECEN75A*

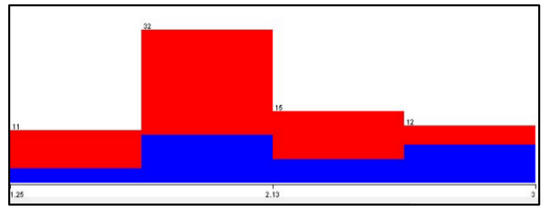

Figure 14. *Graphical Visualization of ECEN85*

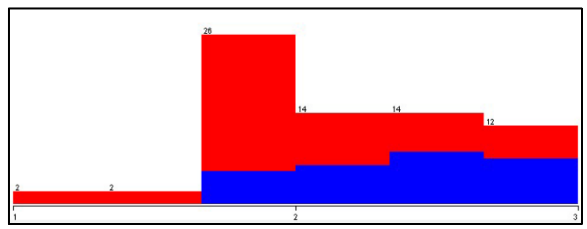

Figure 15. *Graphical Visualization of ECEN95A*

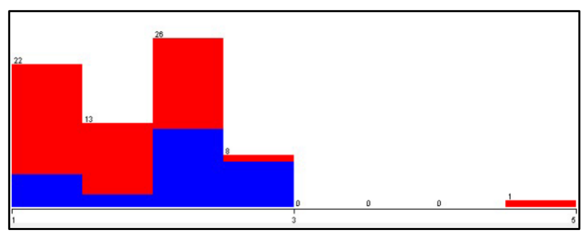

Figure 16. *Graphical Visualization of ECEN100*

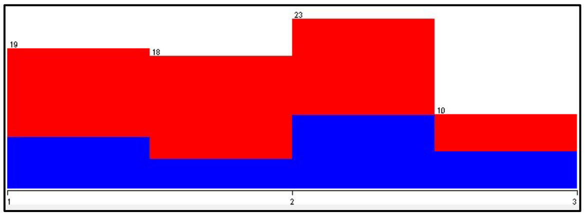

Figure 17. *Graphical Visualization of ECEN101*

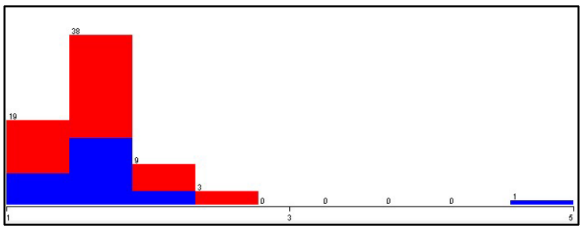

Figure 18. *Graphical Visualization of ECEN190*

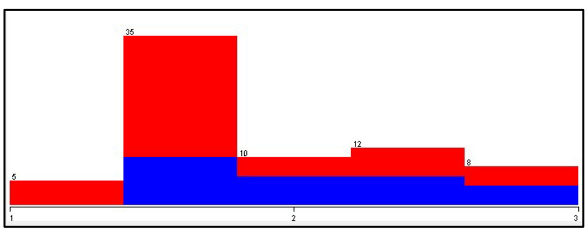

Figure 19. *Graphical Visualization of ECEN50*

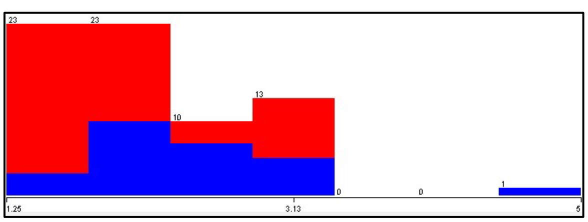

Figure 20. *Graphical Visualization of ECEN65*

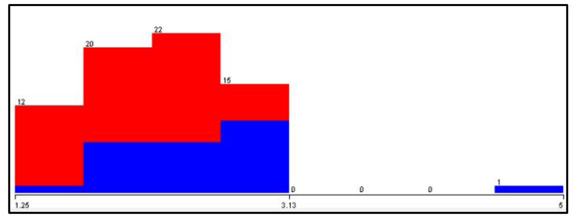

Figure 21. *Graphical Visualization of ECEN80*

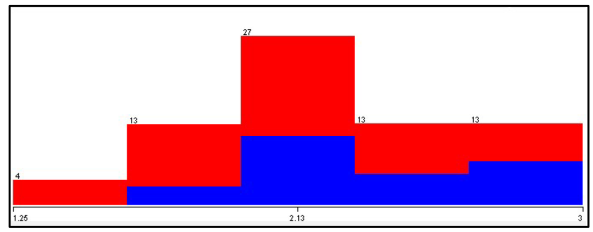

Figure 22. *Graphical Visualization of ECEN90*

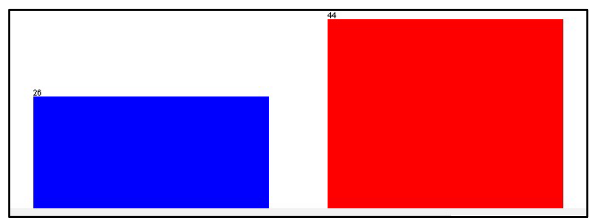

Figure 23. *Graphical Visualization of the Class*

```
average merit      average rank  attribute
 0.154 +- 0.022     1.2 +- 0.4      5 ECEN 196
 0.143 +- 0.011     1.8 +- 0.4     21 ECEN80
 0.101 +- 0.02      3.6 +- 0.8     16 ECEN100
 0.046 +- 0.047     6.2 +- 2.48     7 ECEN 198
 0.024 +- 0.043     7.2 +- 2.93    11 ECEN 60A
 0.035 +- 0.043     8   +- 5.25    13 ECEN 75A
 0.011 +- 0.02      9.4 +- 2.94     6 ECEN 197
 0.004 +- 0.047     9.8 +- 6.14    17 ECEN101
-0.011 +- 0.009    12.2 +- 2.32     8 ECEN 199
-0.007 +- 0.014    12.2 +- 4.12    18 ECEN190
-0.014 +- 0.021    12.4 +- 4.59     3 ECEN 111
-0.01  +- 0.044    12.4 +- 7.91    14 ECEN 85
-0.015 +- 0.041    14   +- 6.23     1 ECEN 105A
-0.025 +- 0.031    14.6 +- 4.96    20 ECEN65
-0.027 +- 0.021    15   +- 4.56     9 ECEN 200
-0.024 +- 0.015    15   +- 2.97    22 ECEN90
-0.026 +- 0.024    15.4 +- 4.5      2 ECEN 106
-0.03  +- 0.018    15.6 +- 3.44    19 ECEN50
-0.032 +- 0.035    15.6 +- 4.72    12 ECEN 70
-0.032 +- 0.012    15.8 +- 2.32    10 ECEN 55A
-0.038 +- 0.015    17.8 +- 2.48     4 ECEN 116
-0.039 +- 0.018    17.8 +- 3.54    15 ECEN 95A
```

Figure 24. *Attribute Rankin*

Classifications and Class Distributions

Only one rule governs decision stumps, and it is based on only one attribute. Decision trees allow multiple feature-based split sequences (Mining, 2017). A class distribution is a dictionary with the class value (e.g. 0 or 1) as the key and the number of randomly generated samples to include in the dataset as the value (Brownlee, 2019). The figure below depicts the classification and the class distribution of the study. The results indicate that having a grade of 2.625 or lower in ECEN196 significantly increases the likelihood of passing the licensure examination, with an approximate probability of 0.8571428571428571. On the other hand, a numerical grade of greater value than 2.625 has a higher possibility of failing the board examination.

```
Classifications

ECEN 196 <= 2.625 : PASSED
ECEN 196 > 2.625 : FAILED
ECEN 196 is missing : PASSED

Class distributions

ECEN 196 <= 2.625
FAILED  PASSED
0.14285714285714285     0.8571428571428571
ECEN 196 > 2.625
FAILED  PASSED
0.7142857142857143      0.2857142857142857
ECEN 196 is missing
FAILED  PASSED
0.37142857142857144     0.6285714285714286
```

Figure 25. *Classification and Class Distribution*

Conclusion and Future Works

The study's participants were BS Electronics and Communications Engineering students from Cavite State University's College of Engineering and Information Technology in Cavite Province, Philippines. This paper presented experimental research based on real-world data from Cavite State University's BSECE classes. The relevance of subjects for engineering students to pass was calculated using machine learning methods. Electronic subjects, particularly ECEN196, had a huge impact on academic progress and relationships when it comes to passing or failing the Electronic Board Examination.

Moreover, machine learning using WEKA can have far-reaching implications in diverse areas of study. As a potential avenue for future research, one could explore the impact of various learning styles and strategies on the academic performance and outcomes of electronic communication students by correlating their grades in electronic subjects with their licensure examination results. This investigation may utilize WEKA to categorize students based on their preferred modes of learning, such as visual, auditory, and kinesthetic, among others. Subsequently, an analysis can be conducted to ascertain the variations in grades, retention rates, and exam scores among these distinct groups. Another prospective area of inquiry involves broadening the scope of the study to encompass other disciplines and professions that necessitate licensure examinations, including engineering, medicine, and law. By comparing outcomes across different domains and contexts, valuable insights can be gained into the shared and unique factors influencing students' success in various professional fields. This comprehensive approach has the potential to enhance the quality and relevance of education by identifying key areas for improvement.

References

[1] Abro, A. A., Khan, A. A., Sajjad, M., Talpur, H., Kayijuka, I., & Yaşar, E. (2022). *Machine learning classifiers: A brief primer.*

[2] Bokova, I. G. (2010). *Engineering: Issues, challenges and opportunities for development.* UNESCO report. [Online]. Available: https://unesdoc.unesco.org/ark:/48223/pf0000189753.

[3] Commission on Higher Education. (2008). CHED Memorandum Order (CMO), No. 24, Series of 2008. Available: https://dokumen.tips/documents/ched-cmo-number-24- for-bsece.html.

[4] Dekho, C. (2018). *Career as an electronics and computer engineer.* College Dekho.

[5] Ferrer, F. P. (2015). *Performance in the engineer licensure examinations: Philippines, 2011-2015.*

[6] Frank, E., Hall, M. A., Holmes, G., Kirkby, R., & Witten, I. H. (2010). *WEKA: A machine learning workbench for data mining.* https://doi.org/10.1007/978-0-387-09823-4.

[7] Workbench. Fischler, A. S. (n.d.). *Quantitative research methods.* Available: https://education.nova.edu/Resources/uploads/app/35/fil es/arc_doc/quantitative_research_methods.pdf.

[8] Gereffi, G. (2008). *Getting the numbers right: International engineering education in the United States, China, and India.*

[9] Guduru, A. (n.d.). What is the eligibility criteria to be a electronics & communication engineer?.pdf. Available: https://www.careerguide.com/ask/t/what-is-the- eligibility-criteria-to-be-a-electronics-communication- engineer#:~:text=The four years bachelor's degree, tests i.e. JEE main %26 advanced.

[10] Inhinyero. (2020). *Electronics engineering board exam coverage.* Available: h ttps://www.inhenyero.com/2020/04/ece-board-exam- coverage.html.

[11] PRC. (2022). *Electronics engineer licensure examination results released in four (4) working days.* Republic of the Philippines - Professional Regulation Commission. Available:https://www.prc.gov.ph/article/april-2022- electronics-engineer-licensure-examination-results- released-four-4-working-days.

[12] Singh, M. (2016). Role of electronics and communication engineering (ECE) in technological revolution. *Gian Jyoti E-Journal, 6*(3), 1– 7.

[13] Tutorialspoint. (n.d.). *What is WEKA?* Available: https://www.tutorialspoint.com/weka/what_is_weka.ht

[14] University of the Philippines. (n.d.). *Bachelor of Science in Electronics Engineering (BSECE): Program description, program educational objectives, and student outcomes.*

Acknowledgment

The researchers express their gratitude to Cavite State University for granting them the opportunity to conduct this research. Special acknowledgment is extended to their research mentor, Dr. Edwin R. Arboleda, for his enthusiastic support, patience, and extensive expertise, which greatly contributed to the successful completion of the study. The Registrar of Cavite State University is also recognized for his generous provision of the underlying data utilized in this research.