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Academic-Related Services of Laguna State Polytechnic University With Sentiment Analysis and Data Analytics Using Multinomial Naïve Bayes Algorithm

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Abstract

Sentiment is a term that refers to a topic that is both subjective and objective, as well as a factual or non-factual topic that is neither positive nor negative. Sentiment analysis is a type of investigation based on spreading rumors or gossip. This study intended to investigate the college students' feedback in the three academic-related services to sentiment analysis utilizing the multinomial Naïve Bayes algorithm. The respondents of this study included College Students enrolled in the College of Computer Studies at Laguna State Polytechnic University - Santa Cruz Campus. Data was gathered using Google Forms for historical data and software testing with ISO 25010 and data analytics mobile application software to analyze and evaluate based on the students' sentiments. The researcher used descriptive and developmental research designs. The agile model was used in the development methodology.

The researcher employed diverse methods for collecting data to identify the necessary elements with the developed mobile application with Flutter Framework and Dart Programming. Based on the results and findings of the three academic-related services,

namely Admission and Enrollment (4.52), Classroom Management (4.289), and Research (4.356), all areas have reflected positive sentiments but analysis showed that its good performance should be continuous. Lastly, it is recommended to develop an additional module that automatically generates the topic model based on the evaluation procedure such as perplexity and coherence.

Keywords: Sentiment analysis, academic-related services, Multinomial Naïve Bayes Algorithm, and Agile Development Methodology

With today's rapid advancements in the realm of Information Technology (IT), the educational sector should not be left behind in its efforts to keep up with the current trends and advancements. New IT trends are unstoppable in their discovery and application. These continue to expose individuals to the world, thanks to technological advancements, anything and everything can happen at any time. In light of every educational institution's responsibility to help students level up to meet society's demands and become competitive, the school plays an important role in exposing students to the real world, as well as its demands in terms of skill development and the use of modern information technologies.

In the overview of ICT in the management of academic programs offered by various educational institutions, a shift in the application of teaching methodologies occurs, with the teacher becoming a facilitator or coach rather than a conventional "spoon feeder" of ideas. Sentiment is a term that refers to a topic that is both subjective and objective, as well as a factual or non-factual topic that is neither positive nor negative. Sentiment analysis is a type of investigation based on spreading rumors or gossip. The method of analyzing a text using an analytical methodology is called sentiment analysis.

The goal of this sentiment analysis is to figure out how subjective an opinion is, whether it is from a review or a tweet. Opinions from someone can be divided into numerous groups based on data size and document type using sentiment analysis.

The researcher conducted a study in a university setting to evaluate the students' sentiment analysis feedback on the delivery of academic-related services using the Multinomial Naïve Bayes Algorithm with Data Analytics. The researcher gathered data and information from the Laguna State Polytechnic University Main Campus - Santa Cruz, Laguna. The academic-related services are Admission and Enrollment, Classroom Management, and Research. The LSPU Academic Calendar year was adjusted last 2022 due to changes during the pandemic. It was a challenging time for the LSPU system to cater to the needs of the students in their admission processes, as well as the encoding of grades in the portal. There was a concurrent flow of admission processes and grade processing, causing delays. Students were facing difficulties while waiting for the system and often encountered errors when accessing the system link. Much of the feedback on the LSPU portal from stakeholders included long overdue responses, limited accessibility only at midnight, and the inability of the system to handle the high volume of transactions.

In terms of classroom management, the Associate Dean and Program Coordinators conducted the faculty members' classroom observations in different modalities. They conducted flexible learning implementations, Outcome-Based Teaching and Learning (OBTL) Plans, monitored attendance, students' responses, and all classroom management transactions, especially since the current setup utilized the hybrid learning modality for LSPU during the 2nd Semester of A.Y. 2022-2023. There were more than 50% onsite classes, and the rest were online classes.

Lastly, the Research and Development Unit provided the college with yearly targets for the university. They also checked the status of the Turnitin account, action plan, and other accrediting body institutions, as well as the payment process. Each college handled transactions related to student payments. Thus, feedback gathering will help improve the collection of

manuscripts and streamline all transactions within the Research and Development Unit.

To address all these concerns, the proponent conducted this study to assist in developing a system that would gather all student feedback. This system would help the management of LSPU. The initial plan was to conduct the preliminary implementation in the College of Computer Studies (CCS). In terms of Admission and Enrollment, there would be evaluations of student inquiries, enlistments, submission of requirements, interviews, and the payment process. This initiative aimed to enhance LSPU services in the three academic-related areas for all stakeholders.

To put the plan into action, sentiment analysis was chosen as an approach to understand better the feedback of the students. This is a task that focuses on polarity detection and the recognition of emotion toward an entity, which could be an individual, topic, and or event. In general, sentiment analysis finds users' opinions, identifies the sentiments they express, and then classifies their polarity into positive, negative, and neutral categories. Nowadays, sentiment analysis using deep learning models has gained good performance.

This study is expected to be beneficial to Laguna State Polytechnic University Santa Cruz Campus which is why the study was done to serve as basis for strategic planning, providing guidance, and promoting a mindset that acknowledges the importance of precision and accuracy in the developed student feedback sentiment categorization system. The study can also be a valuable tool for improving the quality of work and efficiently managing the growing number of documents handled by the institutions. Benefit could also accrue to the administrative officials, who are aware of the significance and status of the delivery of academic-related services particularly in terms of their planning on putting IT infrastructure which is a very important part of the institution's effort to provide competitive services among its stakeholders. Faculty members are also given the opportunity to improve their teaching methodologies. Utilization of suitable online platforms will enable the faculty members to

effectively perform their role as facilitators or mentors rather than just merely sources of knowledge during the pandemic time. The administrative staff perform their tasks of delivering support services more efficiently. Students have the knowledge about technology and facilities that are more suitable to an ideal learning approach and environment in these new normal settings.

Finally, for other academic institutions and future researchers, the study would serve as a reference in their initiative to assess their status in terms of the delivery of academic-related services. This will also serve as their reference in conducting research of a similar nature.

The institution was originally established as a provincial high school known as Baybay Provincial High School, the first public high school established in the shoreline (Baybay) district of Laguna de Bay and the second in the whole Province of Laguna. Then in 1957, by virtue of Republic Act No. 1807, in June 1957, the Baybay Provincial High School was converted into Baybay National Agricultural and Vocational School (BNAVS).

Meanwhile, Laguna State Polytechnic University Santa Cruz - Main Campus has an existing LSPU Santa Cruz Campus Online Teacher and Student Portal. This web portal was implemented in 2020 during the uncertain times of the COVID-19 pandemic. However, there is a need to implement a web-based system for encoding student grades during the online quarantine period. At that time, the University utilized a LAN-based system on campus, where faculty members encoded their grades in the Pulse Digital Networking Corp. (PDNC) area of the University.

Then, the Information and Communications Technology Services Office (ICTS) devised a solution to transition the LAN-based encoding of grades to an online platform. The present study is believed to be a significant response to the challenge of adopting new methods for evaluating the students' grading system through

the LSPU - Online Web Portal. This platform is expected to serve as another medium to enhance the processes involved in the students' grading system, including grade encoding and other features of the web-based teacher and student portals. During the pandemic, the faculty members followed the process and implementation approved by the LSPU Board of Regents (BOR) for flexible learning. They utilized platforms such as Google Classroom, Meet, and Zoom to conduct online classes and student research.

Admission and Enrollment

Based on SEM works' "Enrollment Management: A Systems Approach," the discussion focuses on organizational systems, which consist of individual components and involve relationships between these components. In the context of an enrollment management system, the components are managed. One of the best practices for enrollment management organizations is to offer actionable intelligence concerning the factors that influence student decisions to enroll initially or persist once enrolled.

The framework utilized in the development of an automated enrollment system, as mentioned in SEM Works, is Visual Basic.NET 2010. The objective was to create a user-friendly system that is easy to operate. The Computerized Enrollment System aims to provide an automated and hassle-free enrollment process. This software will be utilized to streamline and expedite the enrollment procedures, ensuring accuracy and efficiency. Additionally, it is crucial to assess the variations in academic preparation across different universities. Institutions must address these disparities, particularly in their admission and enrollment systems, to bridge the gap and ensure smooth processes.

The Enrollment Management Systems Archetype also alludes to institutional outputs: (1) desired outcomes, (2) enduring effect, and (3) enduring behavior. Desired outcomes in this system mostly reference psychological stages of future, present, and past students' experiences as they migrate into and through an institution.

Classroom Management

The theoretical framework for classroom management delves into the perceptions of lecturers regarding the concept of classroom management in higher learning institutions. The framework aims to address two sub-objectives that arise from the identified gaps within the four factors of classroom management. It seeks to determine the lecturers' perceptions of classroom management issues in higher learning institutions.

This research framework empirically investigated the four components of the perception of classroom management in the context of both private and government higher learning institutions in Malaysia. These four variables are quantified using a test instrument comprising a set of questions adapted from past studies and literature reviews.

Meanwhile, the Blended Learning Framework is a method to address the lack of teachers in continuing education at North China University of Science and Technology. At the very beginning of each term, teachers upload all the teaching materials (including the teaching syllabus, teaching schedule, and teaching video). The adult students are required to study the subjects on the platform and discuss what they have learned with their classmates through a forum using the learning platform. The research framework incorporates the following four primary blended learning elements: classroom, teachers, technology, and students.

Research

An operational research framework is divided into three phases. Each phase's output is an input to the next phase. Phase 1 is based on dataset processing and feature extraction. Phase 2 is based on evaluating individual reference classifiers that involve training and testing using precision, recall, accuracy, and F1-score. Phase 3a is aimed to evaluate the ensemble of all the classifiers using precision, recall, accuracy, and F1-score. Phase

3b compares the result from the two techniques (individual and ensemble) in highlighting the better technique for phishing website detection based on the output of precision, recall, accuracy, and F1-score. In the university, some gaps need to be addressed, such as the lack of clear directions and processes in student research. The operational framework serves as a tool to enhance each step involved in the institution's research process.

The researcher aimed to perform sentiment analysis on student feedback in the education domain. To gather this feedback, sets of interviews and surveys were conducted to obtain students' opinions on various aspects of academic-related services, including admission and enrollment, classroom management, and research activities at the Laguna State Polytechnic University-Main Campus in Santa Cruz, Laguna. The classification of student sentiments was done using the Naïve Bayes Algorithm in web sentiment analysis, categorizing them accordingly.

The sentiment analysis focused on key aspects of student feedback related to the three academic services. The Multinomial Naïve Bayes algorithm was employed for this analysis, leading to the proposition of data analytics. The researcher developed a module that encompasses three types of data analytics: Descriptive, Predictive, and Prescriptive.

Lastly, the study summarized the feedback and assessed the precision and accuracy of the categorization system. This evaluation aids institutions in assessing their academic-related services. The software was measured using ISO 25010, considering the following criteria: Functionality, Reliability, Usability, Efficiency, Maintainability, and Portability.

The study aimed to analyze the Academic Related Services of Laguna State Polytechnic University using Sentiment Analysis and Data Analytics, employing the Multinomial Naïve Bayes Algorithm.

Specifically, it sought to answer the following questions:

1. How can a model be generated to improve the three academic-related services of Laguna State Polytechnic University, specifically in the following areas:
    1.1 Admission and Enrollment;
    1.2 Classroom Management; and
    1.3 Research?
2. How can sentiment analysis using the Multinomial Naive Bayes algorithm be used to gauge key aspects of student feedback on the three academic-related services, leading to the proposition of data analytics?
3. How can a module be developed to reflect the three types of data analytics, specifically:
    3.1 Descriptive;
    3.2 Predictive; and
    3.3 Prescriptive?
4. How can software testing quality be measured using the ISO 25010 standard, in terms of the following:
    4.1 Functionality Suitability;
    4.2 Reliability;
    4.3 Usability;
    4.4 Performance Efficiency;
    4.5 Maintainability;
    4.6 Portability;
    4.7 Compatibility; and
    4.8 Security?

The scope of this study was focused on improving three (3) academic-related services at LSPU (Main Campus) Santa Cruz, Laguna, specifically targeting students from the College of

Computer Studies, particularly those enrolled in BS Information Technology (BSIT) and BS Computer Science (BSCS) programs. This research aligned with Sustainable Development Goal number four (4), which aims to transform the world and enhance processes at LSPU, specifically in the areas of admission and enrollment, classroom management, and research.

Furthermore, the study aimed to classify student feedback, opinions, or comments based on sentiment analysis in the field of education, focusing on the three academic-related services. Thus, the researcher examined the current utilization of computer resources and technology in academic-related services, classroom management, and research, utilizing the Multinomial Naïve Bayes algorithm.

The study was conducted during the 1st and 2nd semesters of A.Y. 2022-2023. At that time, the university was implementing the Hybrid Learning Modality, where classes were conducted 50% Onsite and the remaining portion was conducted through Online classes. The researcher utilized the mobile application MEGA, a cloud storage platform that allows users to host or access files using hyperlinks, to distribute materials to the students. Gmail was used by the researcher to collect student data from the application since the mobile application only had a local database.

The respondents were required to have their own mobile device running on the Android operating system (OS) to install the developed mobile application, which was built using Flutter and Dart programming. Additionally, a stable internet connection was necessary for them to answer the set of questions through their mobile devices, particularly in the comments section intended for the sentiments of college students.

When utilizing a specific type of software, such as the approach for developing reading techniques, it is essential to examine the underlying assumptions regarding the various specific tasks for which the document will be used. Understanding the aspects of the software is crucial in supporting those tasks, as well as considering the environmental factors that may impact

tasks when using the software. Moreover, the mobile application was equipped to handle profanity words and translate them into the word cloud.

The importance of this study was to improve the academic-related services for the continuous processes of the University, benefiting all its students. It was crucial to recognize the need for improvement to enhance the quality of education. The study was developed using mobile technologies, specifically the Flutter Framework and Dart Programming. The application operated solely on a local database. However, the study did not encompass the implementation plan and roadmap of the developed system, leaving it open for further research. Additionally, the mobile application was designed to handle sentiments expressed in English words only, and it was unable to interpret sentiments expressed in Filipino words.

This research has potential limitations. There might be an unintentional use of data analysis particularly on the sample size because the questionnaires were only facilitated to the respondents at the College of Computer Studies. The data might have issues and compromises addressing the sample size that require a reassessment of the collected data from the college students. There are also several limitations in using sentiment analysis in interpreting the data like accuracy and bias, handling sarcasm and ambiguity, as well as the imbalance issues. The next phase of this study is to use another algorithm that handles language terms in the variation of syntax, vocabulary, syntax, and pragmatics style in language expressions in different ways.

The research results suggested that interventions on the analysis feedback from the college students in the three (3) academic-related services in the admission and enrollment, classroom management, and research, the University can be able to identify the areas of improvement of these mentioned academic-related services. The management can clarify the areas of corrective actions that can enhance the process and processes of

handling these areas in the university. Based on the results and in each model, the faculty members have an understanding of a course that needs improvement and on their teaching methods. These will also boost student engagement and satisfaction which are gauged in the various academic programs. The administrators also the trends and concerns from the students which can lead to better services to its stakeholders and the community.

Review of Literature

Evaluation of University Academic Services

Information about different aspects of sentiment analysis was viewed in the research presented. With rapidly changing technology and increasing emphasis on managing information properly, the impact of the current internet development is that it is easy to get very large amounts of data. They can use the data to be analyzed to produce useful information. The related kinds of literature were based on the development of this study. There are several studies on generated Models to improve the academic-related services of Laguna State Polytechnic University in Admission and Enrollment, Classroom Management, and Research, there are a series of framework model that discusses on the aspect of sentiment analysis such as the study of Lalata, Gerardo and Medina (2019) that it helps to improve machine learning results producing better predictions compared to a single model. recall and F-measure values of up to 92.06, 93, and 92.52%, respectively.

Sentiment Analysis Used in a University Setting

The main contribution of the proposed model is that it determines the most effective strategy for improving teaching based on students' opinions. Pong-inwong and Songpan (2018) that according to the literature mentioned, based on the Sentiment analysis in teaching, there are studies that help in the improvement of the current process of academic-related services with the usage of these models wherein the researcher had an insight into the output of this type of study to aid in the enhancement of the University's three academic-related services.

A sentiment analysis using the Multinomial Naïve Bayes Algorithm discusses the usage of sentiment analysis in various processing domains using the data that was acquired. Naive Bayes approach was used in forecasting the class and comparing it to other algorithms such as SVM and KNN. The researchers classify classes as either positive or negative. Results of the experiment show that the Naïve Bayes method has a better accuracy level that is carried out in this text processing and collection of data. It is most important that respondents determine the academic quality and learning outcomes of the three colleges and universities in an organization. By having the same study on classifying the student's feedback and sentiment analysis on the aspects of education, other organizations having difficulty in their area on the aspects of education services will be able to bridge the gap between the different methods presented and be knowledgeable about the classification their sentiments and education services. There are new services included for input in classroom management which has been the priority for educators.

This leads to the development of prescriptions and data analytics of the created mobile application. The best outcome is achieved using optimization techniques in prescriptive analytics that identify the uncertainties in making the decisions better. Predictive analytics comprises several statistical and analytical techniques for developing novel strategies for the future possibilities of prediction. Predictive analytics, therefore, becomes vital when an essential quantity of highly sensitive data has to be handled. Based on the perceived events, future probabilities and measures are predicted. With the aid of available data mining techniques, predictive analytics predicts events in the future and can make recommendations called prescriptive analytics. These analytics led to the development of the mobile application with the use of Flutter and Dart programming with the sentiment analyzer that helps to analyze the feedback of the students to lead on the prescriptions and development of the three academic-related services.

Methods of Sentiment Analysis

Based on the literature and studies presented on the use and quality of software testing using ISO 25010, the evaluated precision accuracy in an organization is based on the student's feedback categorization system. This study is expected to reflect the three types of algorithms module that will analyze and provide solutions based on the students' sentiments. The different areas of admission and enrollment, classroom management, and research, need to establish and maintain the learning environments level of the sentiment analysis which are unique and have similar rules according to their interventions and maintaining a conducive environment to learning. The research evaluated and measured the quality of software testing with the ISO 25010.

Overall, synthesis in academic delivery stimulates the integration of knowledge from several disciplines, fosters critical thinking and analytical skills, and cultivates a deeper grasp of complicated subjects leading to the proposal of the model, analytics with the use of multinomial Naïve Bayes algorithm that can enable the improvement of the three academic relates services. College students and researchers go beyond simple comprehension and form a more thorough and nuanced viewpoint on the subjects they are studying. It helps to improve the learning results producing better predictions and analysis model extracts the responses and comments from discussions that are posted in evaluation of the system of the system.

Software Development Framework

Figure 1
Project Development/ Software Engineering Model

Agile Development Methodology (Java point, 2011)

Figure 1 illustrates the phases of the agile model used in the agile development methodology. These phases include requirements gathering, in which the researcher defines the needs. Working with stakeholders to define needs is an essential part of the requirements design process. In construction, it establishes the prerequisites and the beginning of work. The

testing verified and evaluated the software's functionality—phase of deployment, during which an output is produced for the user's working environment. Feedback is the last item on the list. The software uses feedback for improvement.

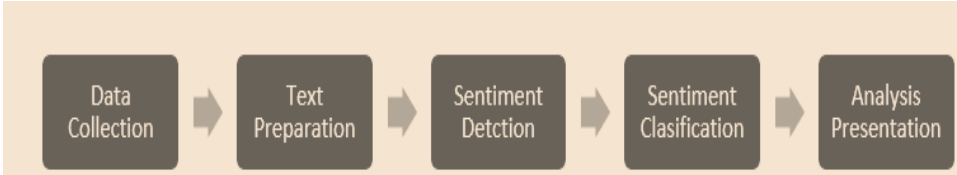
Methodology/Research Design

The study developed a sentiment analysis application for the analysis of academic delivery services using the Dart programming language. The Naive Bayes algorithm was used to identify social classes or degrees of sentiment in the multinomial naive Bayes algorithm. Sentiment analysis was used to determine the level of students or opinions on students' sentiment analysis feedback on the delivery of academic-related services. The sentiment analysis figured out how subjective an opinion is, whether it is from a review or an answer on the Google form survey for historical data. Opinions from someone are divided into numerous groups based on data size and document type using sentiment analysis.

Developmental research is "the systematic study of designing, developing, and evaluating instructional programs, processes, and products that must meet the criteria of internal consistency and effectiveness (Richey, 2019). The research design utilized by the researcher examined the behavior of the population of the study toward the developed system, the consistency and effectiveness of the study, and the time used in conceptualizing and structuring the intended outcome or system.

The main goal of this research analyzes students' feedback in the aspects of education domain to sentiment analysis. The historical data was collected from the Google form surveys from the college students randomly. The software generated a module that reflects the Data Analytics namely: Descriptive, Predictive; and Prescriptive decided whether it is suitable to analyzed through English words that were available as of writing the study was scored and checked. Figure 2 shows a graphical description of the processes involved in sentiment analysis.

Figure 2
Sentiment Analysis Process (Edureka Blog, 2014)



Sentiment analysis is an AI-powered approach for companies and institutions about their consumers' feelings whether it is good or bad comments in Figure 2. It might be through TikTok or Facebook videos, Twitter or Xing comments, polls, emails, and any other platforms. Step 1 is the Data Collection, which is one of the most crucial elements in the sentiment analysis process.

Everything will depend on the quality of the data obtained and how it has been annotated or labeled from here on. Step 2, Text preparation, involves cleaning and preparing the retrieved data for subsequent examination. Irrelevant material, such as noise, non-contextual content, metadata, and stop words, is recognized and eliminated for efficient processing.

Step 3, Sentiment Detection includes filtering the data further for efficient analysis is required before moving on to the next phase. All of the textual phrases in the dataset are subjectively checked throughout this procedure. Only the phrases that include subjective terms are kept in the data set for future

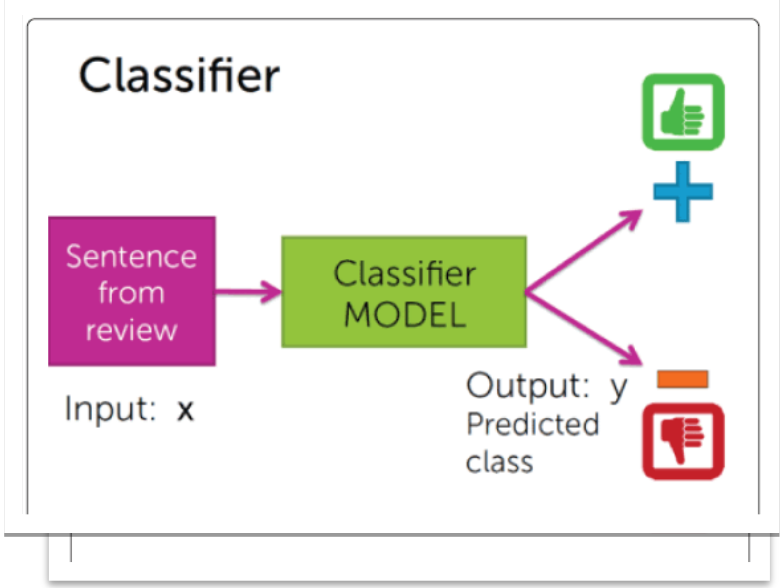
analysis, while the remainder is eliminated. Step 4, Sentiment Classification, is when the subjective text data is categorized into multiple sentiment classifiers during this step. The polarity of the sentiment is recognized after sentiment categorization, and it is decided whether the text communicates positive, negative, or neutral feelings.

Sentiment categorization methods are divided into three categories. Lastly in Step 5, in Analysis Presentation, the findings of the analysis are released as separate papers and graphics. However, with the advancement of technology, interactive dashboards with sophisticated data visualization features are now being utilized to handle enormous amounts of data in real time.

The framework on Student Efficiencies and its concepts on active learning and cooperation in the classroom, its implementation, and theoretical proposed guideline in designing an environment class focused on the student characteristics in classroom environments with flexibility.

Figure 3

Sentiment Analysis Process Classifier (Www.slideshare.net, 2023)



The process of predicting the sentiment is shown in Figure 3, where a sentence comes from a review and the classifier classifies the document whether positive or negative sentiment. Most universities provide surveys to students to develop goals and strategies, evaluate programs, and create a positive public image. There is always an open-ended question to describe their comments. Unfortunately, students' comments are not analyzed properly because they are written in natural language. The software proposed method is to use the datasets (students' responses) accumulated previously to build the classifier.

Research Design

The study used descriptive research and developmental research design. A descriptive research design can use a wide variety of research methods to investigate one or more variables. A developmental research design was also utilized by the researcher to obtain necessary data and identify the specific requirements needed in the development of the software solution. The main goal of the research was to analyze the students' feedback in the aspects of education domain to sentiment analysis. The historical data was collected from the Google form surveys from the college students randomly. The software generated a module that reflects the Data Analytics namely: Descriptive, Predictive; and Prescriptive to decide whether it is suitable to be analyzed through English words that were available as of writing the study were scored and will be checked.

Research Locale

The participants in this study were from Laguna State Polytechnic University – Santa Cruz Main Campus, College of Computer Studies. It was intended for BS Information Technology

(BSIT) and BS Computer Science (BSCS). The Bachelor of Science in Information Technology, as part of its educational objective, applies knowledge for solving computing problems employing design and development solutions for business-driven applications, installation, processes, operation, maintenance, and administration of IT hardware and software.

The Bachelor of Science in Computer Science communicates effectively and recognizes the legal, ethical, and professional issues governing the utilization of computer technology and engages in independent learning development as a computing professional. It also undertakes research and extension services and provide progressive leadership in its areas of specialization. The LSPU – College of Computer Studies college students have an overall population of 959.

Description of Respondents

The respondents of the study are the college students of Laguna State Polytechnic University (Main Campus) Santa Cruz, Laguna in the College of students of Computer Studies who are currently enrolled in the current academic year. Particularly the Bachelor of Science in Information Technology (BSIT) and Bachelor of Science in Computer Science (BSCS) answered the created mobile application with their sentiments and the Google form survey of the ISO 25010. The data applications include a comprehensive dataset of positive and negative reviews written in English text for the Preliminary Data Analysis. The historical data were collected via Google Form Survey of College students, on the 1st and 2nd Semester A.Y. 2022-2023.

The researcher utilized questionnaires that evaluate the current situation of the three academic-related services and identify the gaps in the student's feedback in the aspects of education domain to sentiment analysis. The students were given survey questionnaires online through Google Forms which was the basis for the use of the data analytics software.

Sample Size and Sampling Technique

Slovin's formula was used for sampling the population of the study. It is the formula that applies the sample size needed to attain a specific confidence interval while sampling a population is determined. It was used in interpreting the result of the evaluation of the system. Slovin's formula is used in statistics and determine the smallest sample size required to predict a statistic with a reasonable margin of error. Using an approach based on probability theory, the samples were selected from a broader population using the probability sampling methodology. A participant must be chosen at random for him to be taken into account as a probability sample. By using this statistical technique, a sample is chosen from a population such that each person has a known, non-zero chance of being chosen. The most important prerequisite for probability sampling is that each member of the population has an equal and known chance of being chosen.

Probability sampling is the process of selecting a small sample of people at random from a large population and then predicting that all of their responses are representative of the entire population. The researcher made use of a stratified sampling technique to ensure a sample size obtained from the population. Stratified sampling was applied after using Slovin's formula to get the sampling size of the population.

Table 1
Total Population of the Study

RESPONDENTS	POPULATION	SAMPLE
Bachelor of Science in Information Technology	693	254
Bachelor of Science in Computer Science	233	147

Total	401

Table 1, presented the category per program of the respondents involved in the study. For the samples among the respondents, the LSPU – College of Computer Studies college students has an overall population of 959. Through Slovin's formula, the researcher used 0.05% margin of error and the total number. It ensured the representation from respondents that reduce sampling bias.

The Table 2, Likert Scale below has a range of 5 to 1 with 5 being the highest and 1 being the lowest.

Table 2
Likert Scale

SCALE	RANGE	DESCRIPTIVE RATING
5	5.0	Very Satisfied
4	4.0	Satisfied
3	3.0	Moderately Satisfied
2	2.0	Somewhat In Satisfied
1	1.0	Dissatisfied

Data-Gathering Procedure

The students answered and shared their sentiments in the sentiment analysis software in a Mobile development and the student responses were collected and translated via Gmail into the multinomial Naïve Bayes algorithms. The college students evaluated and assessed the three academic-related services based on their sentiments and feedback from the University particularly in the College of Students. This study classifies the student's feedback, opinions, or comments based on sentiment analysis of

the aspects of education particularly in the three academic-related services. Generally, the researcher examined the current use of computer resources and technology available in terms of academic-related services, classroom management, and research with the multinomial Naïve Bayes algorithm.

The researcher utilized the mobile application using MEGA, a cloud storage that lets the user host or get other's files with the use of hyperlinks, to distribute to the students. Gmail was used to gather the student's data from the application since the mobile application only has a local database.

The respondents needed to have their mobile device in an Android operating system (OS) to install the developed mobile application which is made from Flutter and Dart programming. Stable internet connectivity was also needed to answer the set of questions through their mobile device especially the comments sections intended for the sentiments of the college students.

In using a specific kind of software, the approach for developing reading techniques checks the underlying assumptions about different specific tasks for which the document will be used. The aspects of the software must be understood to support those tasks and aspects of the environment affecting tasks using the software. The mobile application can also handle profanity words and translate them into the word cloud.

The Sentiment analyzer process involved a feature extraction in a format required by machine learning algorithms from the datasets which consists of formats in words. Both train and test data were subjected to feature extraction. The multinomial naïve Bayes algorithm helped examine the extracted sentiments of the college students. A multinomial distribution is useful to model feature vectors where each value represents, for example, the number of occurrences of a term or its relative frequency. If the feature vectors have n elements and each of them can assume k different values with probability pk, then:

$$(x_1 + x_2 + \cdots + x_k)^n = \sum_{n_1, n_2, \ldots, n_k \geq 0} \frac{n!}{n_1! n_2! \cdots n_k!} x_1^{n_1} x_2^{n_2} \cdots x_k^{n_k},$$

In the Evaluation of the test data (2), showing the formula quantity one of the multinomial distribution model, it could be said that evaluation is the process of collecting and analyzing data, where the result can be used to determine whether an organization is effectively carrying out the planned activity. This corresponds to the final evaluation that the model goes through after the training phase has been completed. The researcher used the data Analytics software using Dart programming in the Flutter mobile application for the three data analytics, Descriptive; Predictive; and Prescriptive. Graphical representation Data visualization is the presentation of data in a graphical format.

Presentation and Discussion of Results

Statement of the Problem 1: How can a model be generated to improve the three academic-related services of Laguna State Polytechnic University, specifically in the following areas:

1.1 Admission and Enrollment;

1.2 Classroom Management; and

1.3 Research?

To achieve the first statement of the problem, to achieve a model generated to improve the three academic-related services of Laguna State Polytechnic University: Admission and enrollment, Classroom Management, and Research, the researcher created an Operational Model based on the created mobile application. It employed diverse methods for collecting data in order to identify the necessary elements for mobile development. The researcher used Dart programming language with its multinomial naive Bayes analytics library to analyze the performance of the three areas of study. A preliminary investigation was also conducted.

The researcher exhibited a Face-to-face and Online interview session at the College of Computer Studies.

> Statement of the Problem 2: How can sentiment analysis using the Multinomial Naive Bayes algorithm be used to gauge key aspects of student feedback on the three academic-related services, leading to the proposition of data analytics?

To answer the second problem, the researcher using the Multinomial distribution showed that more than the possibility of counts or frequency, multinomial was used in text classification. The features are the words and value of its features. It works on a particular sentiment if it is good or bad. Sentiment analysis is a classification that has five (5) reviews on the dataset. Generally given the features with is to predict if it is positive or negative on a single word given in a given data set. There is a need to have a document matrix populated with values, and the frequency in the document id written. The comment matrix will display the total number of words from the document features.

Table 3
Multinomial Features

Document	**Review**	**Class**
1	capable, enrolling, online, **convenient**, **unfortunate**, **proper**, device, **knowledge**, online, enrollment, hard, cope, online, enrollment, process, online, enrollment, **advantage**, **convenience**, **ease**	Positive (+)
2	online, enrollment, tool, **lessen**, time, enrollment, promote, **efficiency**, **problem**, encountered, online, enrollment, support, mass, enrollment, crashes, **wait**, people,	Negative (-)

	disconnect	
3	online, **lessen**, time, enroll, **problem**, queue, student, **wait**	Negative (-)
4	**proper**, classroom, management, **convenience**, attendance, **ease**, **problem**	Positive (+)
5	research, student, search, library, **knowledge**, **advantage**, research, topics, **proper**, documentation	Positive (+)

Table 3 shows the Multinomial features with the summary of the sentiments of the students. It is an overall sentiment from the three academic-related services, based on the Multinomial which is a commonly used model in Natural Language Processing. Multinomial is the creation of vocabulary that contains the collection of different words, and each word is associated with a count of how it occurs. Later, the class in the table includes whether it's positive or negative. There are a series of document reviews of the sentiments of three (3) academic-related services of the University. The review of the documents shows the words that are classified in the multinomial classification of words and the researcher conducted a hand calculation on each sentiment based on their words encoded on the developed mobile application. It interprets and justifies the used words based on the sentiment analysis if it is positive, neutral, or negative.

Table 4

Term Document Matrix

Document/ Features	**Document 1**	**Document 2**	**Document 3**	**Document 4**	**Document 5**
convenient	1	0	0	0	0
unfortunate	1	0	0	0	0

proper	1	0	0	1	1
knowledge	1	0	0	0	1
advantage	1	0	0	0	1
convenience	1	0	0	1	0
ease	1	0	0	1	0
lessen	0	1	1	0	0
efficiency	0	1	0	0	0
problem	0	1	1	1	0
wait	0	1	1	0	0
disconnect	0	1	0	0	0

Table 4 shows the tokenized words and stop words from the sentiments as document features. It breaks down the process of meaningful text into individual units and removing common words that may not contribute to the analysis and simplify the textual data efficiently on the multinomial algorithm. The stop of words transcribes the informative words and removed the documents.

Table 5
Classification Model

P(Y=+) = 0.6		
P(Y=-) = 0.4		
Feature	***P(Feature|+)***	***P(Feature|-)***
convenient	0.0714	0
unfortunate	0.0714	0

proper	0.2142	0
knowledge	0.1428	0
advantage	0.1428	0
convenience	0.1428	0
ease	0.1428	0
lessen	0	0.25
efficiency	0	0.125
problem	0.0714	0.25
wait	0	0.25
disconnect	0	0.125

Table 5 shows the classification model with the use of Naïve Bayes algorithm computed to classify each sentiment with Laplace smoothing on Table 5. It displays the documents from one (1) to five (5) with the set of features.

Table 6
Classification Model with Laplace Smoothing

P(Y=+) = 0.6		
P(Y=-) = 0.4		
Feature	***P(Feature|+)***	***P(Feature|-)***
convenient	0.1428	0.125
unfortunate	0.1428	0.125
proper	0.2856	0.125
knowledge	0.2142	0.125

advantage	0.2142	0.125
convenience	0.2142	0.125
ease	0.2142	0.125
lessen	0.0714	0.375
efficiency	0.0714	0.25
problem	0.1428	0.375
wait	0.0714	0.375
disconnect	0.0714	0.25

Table 6 shows the classification model with the use of Naïve Bayes algorithm computed to classify each sentiment with Laplace smoothing.

Statement of the problem 3: How can a module be developed to reflect the three types of data analytics, specifically:

3.1 Descriptive;

3.2 Predictive; and

3.3 Prescriptive?

To address the third problem, the researcher created a mobile application that reflects the three (3) different forms of data analytics (Descriptive, Predictive, and Prescriptive): the module's objective and the sorts of analytics it will conduct are assessed to answer the statement of the problem three (3). The information was gathered from databases and the students' constructed sentiment software. To make sure the data is clear, full, and

pertinent, preprocessing was done which entailed eliminating any duplicates or missing data and transforming the data into a format appropriate for the three (3) different types of data analytics. Based from the application, the three (3) data analytics such as: descriptive, predictive and prescriptive were applied to the model and generated for its remarks.

Descriptive analytics, which involves analyzing data to describe the past, was carried out by the descriptive analytics module. Visualizations and summary statistics like mean, median, and mode might be produced with the module. Predictive analytics is the practice of predicting potential future events using statistical algorithms and machine learning models. To achieve this, the models must first be trained using previous data before being applied to fresh data. Predictive analytics is the practice of predicting potential future events using statistical algorithms and machine learning models. To achieve this, the models must first be trained using previous data before being applied to fresh data.

To find patterns or significance in data, descriptive methods were employed to look for and summarize the information to answer the Descriptive analytics of the study. This reflective examination of learner data aimed to shed light on past patterns of performance and behavior in online learning environments. Descriptive analytics uses two methods to find historical data: data aggregation and data mining. To make the datasets easier to manage, the researcher's data was first collected and classified by data aggregation. The following stage of analysis is known as data mining, and it entails searching the data for patterns and significance. The specific ways that learners interacted with the learning content and the learning environment are uncovered through analysis of the identified patterns.

Figure 4

Word cloud sentiments of the three academic-related services

The word cloud calculated the percentage of each student's feedback word and displays in Figure 4. The state of the student's sentiment feedback in the mobile application. Based on the student sentiment analysis most of the words are positive such as “goods, good and satisfied”.

Figure 5
Word cloud percentage of the three academic-related services

Figure 5, shows the Word cloud computation of each word feedback. These are the words generated from the system based on the college students' sentiments on the academic-related services wherein most of the words are positive. Predictive analysis, also known as predictive modeling, refers to the process of using historical data to make predictions or forecasts about future events or outcomes. Through its use, the researcher answered the 3.2 Predictive with the use of Naive Bayes a popular

machine learning algorithm commonly used for predictive analysis tasks, particularly in text classification and spam filtering. In the context of the Naive Bayes algorithm, predictive analysis involves using the algorithm to predict the class or category of a new instance based on its feature values. The algorithm calculates the conditional probabilities of each class given the observed feature values and then selects the class with the highest probability as the predicted class for the new instance.

Statement of the Problem 4: How can software testing quality be measured using the ISO 25010 standard, in terms of the following:

4.1 Functionality Suitability;

4.2 Reliability;

4.3 Usability;

4.4 Performance Efficiency;

4.5 Maintainability;

4.6 Portability;

4.7 Compatibility; and

4.8 Security?

The standard defines six quality characteristics that can be used to measure the quality of software. These characteristics include functionality, reliability, usability, efficiency, maintainability, and portability. The ISO 25010 standard offers a framework for evaluating the functionality, dependability, usability, efficiency, maintainability, and portability of software. Program testers and developers can find areas for improvement and make sure their program satisfies user needs by measuring software quality against these attributes. The researcher validated

the questionnaire with a licensed statistician and descriptively evaluated the results.

Conclusions

Based on the feedback of the system testing and survey results, the study showed that the developed system was fully functional and proven effective for the intended users and they are also satisfied by utilizing it. The academic-related services are beneficial and important in assisting students in their educational endeavors. These services include a variety of tools and support toward a student's overall academic performance. The use of these services leads to the conclusion that they have a considerable impact on improving the learning outcomes and experiences of students. Based on the gathered evaluation, the following area garnered the following: Admission and Enrollment (4.52), Classroom management (4.289) and Research (4.356).

LSPU can put in place a methodology that makes use of automated processes and sophisticated data analytics to improve the admission and enrollment process. The following elements could be part of this model: online application system which should eb created to enable candidates to submit their applications digitally. The system should be able to handle high application volume efficiently. It is important to integrate an automated system that can authenticate and validate the papers that applicants have submitted. Positive feelings have been expressed in every region, but analysis suggests that good performance should continue. After the researcher's data collection through face-to-face and online consultation from Objective 1 to 4 the researcher concluded that the current teaching and learning will be improved. It is deemed important to implement a thorough LMS that offers a central platform for instructors and students to access course materials, submit assignments, and communicate. This will help LSPU manage technology and data-driven approaches to optimize learning environments. It is important to analyze student performance using data analytics by keeping a close eye on them. For Smart Classroom Technology, the university should provide interactive

whiteboards, audio-visual equipment, and collaborative learning software in the classrooms.

A model that encourages collaboration, financing possibilities, and information dissemination can be created by improving the research activities at LSPU. Using a Platform for Research Collaboration, the university can create an online network for LSPU researchers to collaborate with outside organizations. This platform can make it easier to communicate, share resources, and collaborate on research projects. The university should implement a system to manage money provided and streamline the application process for research grants. This approach should make funding opportunities accessible to researchers and streamline administrative tasks. The developed mobile application was able to provide the LSPU – College of Computer Studies basis to improve the way they manage the three Academic Related Services. The developed mobile application was also able to provide additional tools to consolidate and analyze the opinions and sentiments of college students. In terms of the Sentiment Analysis module, it can be concluded that the Dart Programming sentiment analysis model was accurate, and the accuracy score on the test data set and the harmonic mean between the precision. The developed system was also successfully tested and evaluated and can be used in the deployment in the LSPU – College of Computer Studies. Having a support service for college students is a crucial role that will enable develop their skills and different disciplines.

In conclusion, it takes careful consideration of a variety of factors to build a module that reflects the three forms of data analytics—descriptive, predictive, and prescriptive. Understanding historical data and offering insights into the past are the main goals of descriptive analytics. The researcher implemented descriptive analytics by integrating a data collection module that gathered pertinent data from diverse sources and ensured its accuracy and completeness. The researcher calculated

essential statistics when applying Multinomial Naive Bayes to the three data analytics.

Predictive analytics, which utilized patterns in historical data to forecast future results, involved selecting important traits or variables likely to impact the outcome. The researcher employed proper prediction techniques and considered both the student's feedback and previous data. Predictive analytics focuses on offering suggestions or actions to improve results based on projections and predetermined goals. The researcher included appropriate techniques, such as data exploration and visualization for descriptive analytics, predictive modeling for predictive analytics, and optimizing for optimization, in developing a module that reflects the three types of data analytics. These techniques were used to clearly define the objectives and constraints of the problem by the application of the Nave Bayes algorithms, which determine the best course of action that maximizes or minimizes a specific objective.

For future research related to this study, inferential statistics play a crucial role, particularly in the field of computer studies. This is particularly relevant in the realms of sentiment analysis and game-based development using technologies such as Flutter, Dart, and R Programming. It would be beneficial to extend data collection to other colleges, aiming to gather diverse sentiments regarding the three academic-related services. This approach will enable future researchers to make inferences or predictions about a broader population based on a sample of data from that population.

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