University Support System Program Placement Using Predictive Decision Tree Data Model

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Abstract: ***This research used the quantitative approach utilizing a descriptive-developmental research design and survey questionnaire technique to efficiently gather data and establish a systematic way of designing and evaluating University Support System Program Placement using a Predictive Decision Tree Data Model employing a Rapid Application Development (RAD) in the development. The researcher used a standardized set of questions based on the constructs of ISO/IEC 25010 to measure the user acceptability of the system. The survey forms were distributed after finishing the testing phase of the proposed system were held to obtain data from ten (10) information technology experts as alpha evaluators, six (6) BulSU - Bustos admin council as beta evaluators, and four (4) admission clerk as gamma evaluators are chosen using purposive sampling. Results show that University Support System Program Placement using Decision Tree Data Model is excellent in terms of functional suitability (M=4.72), performance efficiency (M=4.78), compatibility (M=4.72), usability (M=4.80), reliability (M=4.67), security (M=4.58), maintainability (M=4.73), portability (M=4.77) recording a grand mean of 4.72 interpreted as excellent. It means that the system satisfies both software quality standards and end-user requirements. Thus, it is ready for adoption. Along with its implementation, it is recommended to gather feedback regularly and conduct an impact analysis of the effectiveness of using the university support system program placement using a decision tree data model.***

Indexed Terms: ***Decision Tree, Datamining, Program Placement, Decision Support System, RAD***

I. INTRODUCTION

Education plays a vital role in the lives of students and society. Therefore, the Department of Education implemented the Enhanced Basic Education Curriculum, which led to creating the Senior High School Program in 2013. This K-12 curriculum introduced a new model of systems for the Philippine education sector. A school's managing system and grading systems are now evaluated to develop an effective curriculum to deliver responsive people for society.

The senior high school implementation is designed to give the students the skills and knowledge they require to prepare and plan better for the chosen path in higher education for their possible courses like information technology, engineering, education, entrepreneurship, or employment for their future. The addition of two more grade levels or two more years better equips and prepare the student's knowledge and values with the necessary skills needed to succeed in their fields or courses in the future. Nowadays, students' academic performance is becoming more vital, particularly in higher learning institutions. Expanding student's performance in learning is the main goal of all educational institutions.

An early detection of identifying students' risk, along with preventive measures, can significantly improve their success. In educational institutions, student success is crucial because it's frequently utilized as a performance indicator. Machine learning techniques have been widely used for prediction purposes nowadays.

Academic Analytics is an emerging area of data mining focusing on extracting useful patterns from student databases. One of the major problems in academic analytics is student retention. Addressing this problem is very crucial as all academic institutions

aim to increase student retention rates as a long-term goal. The consequences of student attrition are significant for students, academic and administrative staff (Ishitani, 2006)

Students enrolled in the first year are the most vulnerable to low student retention. Freshman students have the greatest risk of dropping out or having academic learning difficulties. The research gap motivates the researcher to focus on this area to provide timely help.

Addressing the problem is crucial as students with learning difficulties have a higher percentage of dropping out or transfer to another university or college. This scenario can lead to loss of fees and removal of manpower, particularly faculty members. With this, the researcher aims to utilize enrolment and admission data in making a predictive model using a decision tree algorithm to model or to establish a university admission decision-making model in the early identification of possible students who need necessary academic and counseling interventions. The study aims to develop decision support systems (DSS) that use a classification algorithm to embed the predictive models extracted. A DSS is a computerized information system that aids organizational and business decision-making. It is an interactive software-based system that identifies students prone to academic difficulty early (Segal, T., 2021).

This study aims to focus on the prediction feature in course selection of the students that can determine significant attributes to identify students on their learning difficulties. The application of the decision tree model in predicting students with learning difficulty. In addition, a data model can be developed using the defined algorithm system predictions that generate student academic performance that provide valuable information for educational authorities, which offers diverse decision-making opportunities and assists the students to achieve excellent performance in their studies. Also, recommendations/actions can be implemented based on the mapping analysis. effective the system in terms of ISO metrics.

II. OBJECTIVE OF THE STUDY

This study aimed to design and develop a University Support System Program Placement using Predictive Decision Tree Data Model.

Specific objectives included are the salient features and significant attributes that can be used to identify program placement of the students which can give recommendations of different programs to the students using the University Program Support System Using Predictive Decision Tree Data Model and then evaluating the app using International Organization for Standardization/International Electro-technical Commission standards. (ISO/IEC 25010, 2011) functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability.

A. Conceptual Framework

Figure 1 is the University Program Support System using the IPO model. The proponents first gathered adequate data for the app's construction, after which the data was processed, and the design, coding, and testing phases began. The study's outcome is a fully functional University Program Placement that gives recommendations to the students. Feedback was incorporated into the system to help it improve.

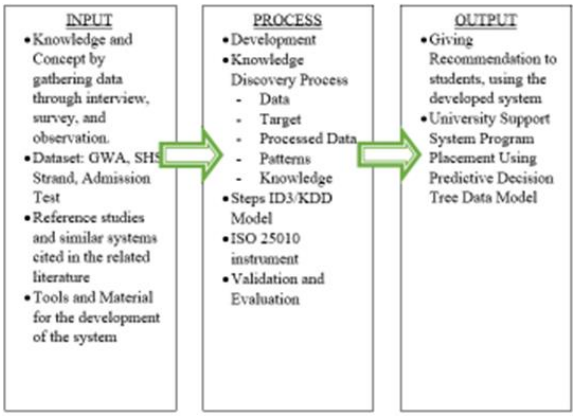

Figure 1. IPO model for the development of University Support Program Placement (Ken Feldman, 2018)

B. Scope and Delimitation of the Study

The study focuses on the student's admission data, senior high school track, math and English average grade, and GWA records of the incoming freshman students. The study is for incoming freshman students. It focuses only on incoming freshman students. The confidentiality of student's data will be protected by deleting personal information of the data from data sources.

Historical data was used and divided into two parts: training and test data. The training data will be used to generate data and cluster models. The predictive model will be evaluated using the testing data by calculating the accuracy results using the confusion matrix test. The models are derived from rule sets from decision tree algorithms. The model will be embedded in software that predicts student academic standing in terms of learning difficulty. The data will be prepared in a format that a data mining tool can be recognized.

III. METHODOLOGY

A. Research Design

This research used the quantitative approach utilizing a descriptive-developmental research design and survey questionnaire technique to efficiently gather data and establish a systematic way of developing a university support system program placement.

The quantitative approach refers to a research methodology that emphasizes the use of measurable and numerical data to systematically investigate a phenomenon or research question. In this study, the quantitative approach allows for the systematic integration of quantitative data from various sources to enable a more comprehensive and synergistic analysis than what could be achieved through a survey.

The descriptive method focused on University Support System Program Placement. Using a Predictive Decision Tree Data Model, the descriptive approach would be used to identify and describe the features of the program placement process. This would involve collecting and analyzing numerical data related to the factors that influence program placement decisions, such as student performance data, program requirements, and resource availability. By using the descriptive approach, researchers can provide a comprehensive and detailed understanding of how program placement decisions are made and what factors are most influential in the process. As Akhtar (2016) noted, the descriptive approach can be useful in collecting accurate data and providing a clear understanding of the project being studied

The researcher used this method to gather data from its client through questionnaires and document analysis. This enabled them to understand the important content of the university support system program placement.

The developmental method is one in which the object of the study is not merely knowledge but the knowledge that practitioners can use. The researcher created a system utilizing data mining techniques and software development methodology to systematically plan all aspects of this study. Specifically the development phase of the University Support System Program Placement using the Decision Tree Data Model.

Knowledge Discovery in Databases is used as a methodology for creating predictive models to early predict program placement for students using admission and early subjects as variables. The main steps of KDD involve data preprocessing, modeling, and evaluation.

Decision Tree Algorithm produces a tree-based classification which is one of the successful classification algorithms used by experts and converted them into powerful classification rules. The splitting technique is based on the calculation of entropy and information gain. Information gain theory in machine learning refers to the value of information gained about a random variable or signal from observing another variable. It consists of nodes and creates a tree-like structure which is called a decision node. This algorithm is the simplest and most easy to understand algorithm as output is being converted into a powerful IF – THEN – ELSE structure.

Entropy $H(S)$ is a measure of the amount of uncertainty in the (data) set S (i.e. entropy characterizes the (data) set S).

$$H(S) = \sum_{x \in X} -p(x)\, log_2\, p(x)$$

Equation 1. Entropy Formula

Information Gain *IG(A)* is the measure of the difference in entropy from before to after the set *S* is split on an attribute. To compute the information gain, the formula was used.

$$\boldsymbol{IG(A,S) = H(S) - \sum_{t \in T} p(t)H(t)}$$

Equation 2. Information Gain Formula

B. System Development Procedure

Rapid Application Development (RAD) was used in developing the system. This strategy utilized different techniques and strategies to rapidly create negligible arranging for quick prototyping.

As expressed by Goh, Cullen et al. (2015), Rapid Application Development delivers high caliber and speedier advancement of items. Its standard is prototyping, for example, producing predefined systems, developments, and strategies to rapidly create programming models. Figure 2 shows the four stages of the rapid application development model.

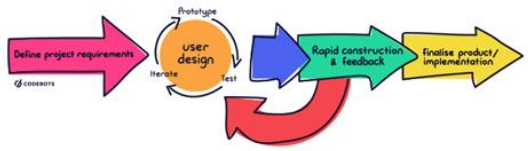

Figure 2. RAD Model (Christine Chien, 2020)

Through Rapid Application Development Model, the researcher was able to do the following phases:

Requirements Planning Phase. It is the initial step wherein the client and the researcher agree and settle on the project needs, degree, and framework necessities. It built up a general comprehension of the business issues in the setting of its development and processes to end up with familiarity with the existing system, and to recognize the techniques that were upheld by the proposed system.

User Design Phase. It is the working model of the system that was a consistent, intuitive process and empowered the clients to alter, comprehend and support with a specific end goal to meet the necessities.

Construction Phase. It concentrated on the development of the program and application improvement, like, programming and application advancement, coding, unit integration, system testing, and debugging. This comes with the guarantee that the system will not be affected by possible changes or improvements in the future.

Cutover Phase. It is also called the deployment phase; it is similar to the final task in the System Development Life Cycle implementation phase, together with the testing, data conversion, and changes over to the new system. As compared to the traditional methods, the whole process is compressed as a result and built a new system, delivered and placed in operation.

C. Organizational Assessment

This includes the released guidelines of the university admission, work environment, and authority structure system flow and content of the University Support Program Placement with the consultation of the local campus dean and admission officer. The classified assessment procedure oversees the development of the University Support System Program Placement that aims to assist the researchers in meeting its objectives.

D. Participants of the study

Bulacan State University (BulSU), Bustos Campus, is the locale of the study. These University Support Program Placement respondents include Information Technology experts (Alpha evaluators), Local Administrative Council (Beta evaluators), and admission officers (Gamma evaluators). The evaluators were chosen using a non-probability, purposeful sampling technique. This sampling technique required the researcher to exercise judgment in selecting the most helpful sample for the study. Table 1 shows the respondents of the study.

TABLE I. RESPONDENTS OF THE STUDY

Respondents	No. of Respondent	Description
Information Technology Experts	10	IT professionals who are involved in systems development projects
Local Administrative Council	6	are in charge of creating, putting into effect, and assessing the systems and policies of the district and the schools.
Admission Officer	4	Assists students with the admission process. Assists with student record keeping, scanning of records, and registration
TOTAL	20	

E. Research Instruments

The main instrument for gathering data will be the questionnaire. This is adapted from ISO/IEC 9126-1:25010: 2011. ISO/IEC 9126-1:25010: 2011 consists of quality standards, namely: Functional Suitability, Performance efficiency, Compatibility, Usability, Reliability, Security, Maintainability, and Portability. Permission was asked from the prior researcher who utilized the instrument and was subsequently granted.

F. Data Gathering

The results and data for this study were collected using the survey form via electronic means. The respondents would give a standardized set of questions based on the constructs of ISO/IEC 25010 to measure the user acceptability of the system. Confidentiality of the survey sheets shall be assured since the respondents are not known by the researcher. The survey forms were distributed after finishing the testing phase of the proposed system.

The respondents were selected as information technology experts (programmers), BulSU Bustos local administrative council, and admission officers.

In gathering the data, the researcher carried out the following procedure:

1. A letter was sent to the Dean to ask permission to conduct the proposed study.
2. With the approval of the Dean, the researcher distributed the questionnaire via electronic means to the respondents personally.
3. The researcher collected the questionnaires from the respondents and checked whether all the questions were answered.

IV. RESULTS AND DISCUSSION

A. Salient Features of the Proposed University Program Support System Using Predictive Decision Tree Data Model

The salient feature of this University Support System is the product of collaboration between stakeholders and IT professionals. It is customized to fit the university's colors, logo, and other distinguishing features with its Login page, Forget Password, File Uploading, and Generate Reports which gives Program Recommendations and Visual Graph Reports.

B. Significant attributes that can be used to identify program placement of the students in the University.

This study's different attributes or datasets were carefully collected and evaluated properly using entropy and information gain. The analysis of the data is done based on the strand taken in SHS GWA and Track; GWA, Track and Admission Test; GWA, Track, Admission Test, and Final Grade. These attributes were used to identify the program placement of the students entering BulSU Bustos Campus.

This research was based on the Bulacan State University's enhanced guidelines on grade requirements for college freshman admission.

C. The decision tree data model was useful in predicting students' program placement.

Decision tree models have been used in education to predict student performance and program placement. For example, a study by Huang and his colleagues (2019) used a decision tree model to predict student success in an online learning environment. The model used variables such as the student's prior knowledge, motivation, and learning strategies to predict the likelihood of success.

Overall, decision tree data models are useful in predicting program placement because they provide a systematic approach to analyzing complex data and identifying the most important factors that influence program placement decisions. These models can be customized to the specific needs of different fields and can be updated over time to improve accuracy and effectiveness.

D. The data model predicts and gives a recommendation to the student program placement.

The dataset was fed to the Python code. The python will do the following:

First, Python will filter the dataset into two groups, the features (X dataset) and the class (Y dataset). X dataset (GWA, TRACK, TEST SCORES) are the features that are used to predict the Y dataset (Predicted program/course) of a record.

After grouping the datasets. They will be fed inside the Decision Tree Classifier algorithm to create a model. This is the part where machine learning happens; the algorithm will create a model that will learn to predict the course of the students based on the datasets. The more datasets it reads and learns , the more options it could make in predicting.

After processing the X and Y dataset, the system saves the file to "joblib.dump(model, 'thea-decision-tree-GWA-TRACK-feature.joblib')," which saves the machine learning file. This file will be the heart of the system.

The system checks if the CSV file uploaded in a system contains the right data; if not, it will return an error. (PHP code is involved). If data is current, it will now pass the data to the Python code that initializes the decision tree model.

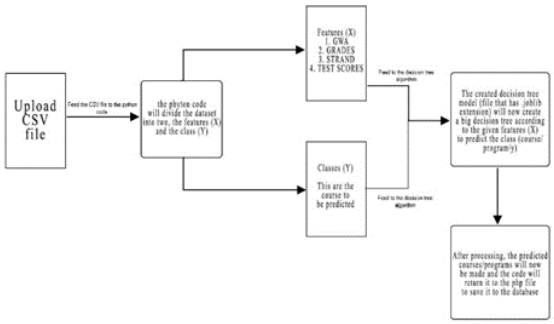

Figure 3. University Support System Program Placement System Flow

E. Results of the system evaluation with the designed survey questionnaire adapted from ISO/IEC 25010

This section presents the evaluative results of the University Support System Program Placement. The order of presentation of findings is arranged according to the evaluation results from the three groups: IT Experts, Local Administrative Council, and Admission Officer of the ISO/IEC 9126-1:25010: 2011.

TABLE II. SUMMARY OF IT EXPERTS EVALUATION (ALPHA EVALUATORS)

Indicators	WM	Verbal Interpretation
Functional Suitability		
Functional Completeness	4.63	Excellent
Functional Correctness	4.70	Excellent
Functional Appropriateness	4.65	Excellent
Average Mean	4.66	Excellent
Performance Efficiency		
Time Behaviour	4.70	Excellent
Resource Utilization	4.63	Excellent
Capacity	4.71	Excellent
Average Mean	4.68	Excellent
Compatibility		
Co-Existence	4.70	Excellent
Interoperability	4.63	Excellent

Average Mean	4.67	Excellent
Usability		
Appropriateness recognizability	4.77	Excellent
Learnability	4.81	Excellent
Operability	4.79	Excellent
User-error protection	4.61	Excellent
User-interface aesthetics	4.67	Excellent
Accessibility	4.79	Excellent
Average Mean	4.74	Excellent
Reliability		
Maturity	4.42	Excellent
Availability	4.84	Excellent
Fault tolerance	4.14	Excellent
Recoverability	4.67	Excellent
Average Mean	4.51	Excellent
Security		
Integrity	4.12	Excellent
Non-repudiation	4.24	Excellent
Accountability	4.61	Excellent
Authenticity	4.82	Excellent
Average Mean	4.44	Excellent
Maintainability		
Modularity	4.74	Excellent
Reusability	4.65	Excellent
Analyzability	4.72	Excellent
Modifiability	4.72	Excellent
Testability	4.79	Excellent
Average Mean	4.72	Excellent
Portability		
Adaptability	4.67	Excellent
Installability	4.79	Excellent
Replaceability	4.53	Excellent
Conformance	4.63	Excellent
Average Mean	4.65	Excellent
Grant Mean	4.63	Excellent

Table 2 shows the alpha evaluation of the University Support System Program Placement. It got a grand mean of 4.63, interpreted as excellent.

Following the BulSU Information Technology, Administrators' evaluation, and Admission Officer who comprise the Beta group of evaluators, were consulted to ensure adherence to quality standards of Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability, Security, Maintainability, and Portability, as shown in Table 3.

TABLE III. SUMMARY OF LOCAL ADMINISTRATIVE COUNCIL EVALUATION (BETA EVALUATORS)

Indicators	WM	Verbal Interpretation
Functional Suitability		
Functional Completeness	4.80	Excellent
Functional Correctness	4.73	Excellent
Functional Appropriateness	4.73	Excellent
Average Mean	4.75	Excellent
Performance Efficiency		
Time Behaviour	4.80	Excellent
Resource Utilization	4.73	Excellent
Capacity	4.73	Excellent
Average Mean	4.75	Excellent
Compatibility		
Co-Existence	4.63	Excellent
Interoperability	4.80	Excellent
Average Mean	4.71	Excellent
Usability		
Appropriateness recognizability	4.93	Excellent
Learnability	4.80	Excellent
Operability	4.80	Excellent
User-error protection	4.60	Excellent
User-interface aesthetics	4.89	Excellent
Accessibility	4.72	Excellent
Average Mean	4.79	Excellent
Reliability		
Maturity	4.53	Excellent
Availability	4.93	Excellent
Fault tolerance	4.84	Excellent
Recoverability	4.89	Excellent
Average Mean	4.79	Excellent
Security		
Integrity	4.83	Excellent
Non-repudiation	4.91	Excellent
Accountability	4.56	Excellent
Authenticity	4.62	Excellent
Average Mean	4.73	Excellent
Maintainability		
Modularity	4.80	Excellent

Reusability	4.62	Excellent
Analyzability	4.53	Excellent
Modifiability	4.53	Excellent
Testability	4.73	Excellent
Average Mean	4.64	Excellent
Portability		
Adaptability	4.93	Excellent
Installability	4.73	Excellent
Replaceability	4.87	Excellent
Conformance	4.73	Excellent
Average Mean	4.81	Excellent
Grant Mean	4.74	Excellent

Table 3 summarizes the Local Administrative Council evaluation using ISO/IEC 9126-1:25010: 2011 quality standards. The overall rating for the mobile application is excellent *(M = 4.74)*.

Finally, Admission Officer is Gamma Evaluator. This is to verify that end-user needs are met. Each indicator received an outstanding rating. All latent variables were rated excellent, with an overall mean score of 4.63, as shown in Table 4.

TABLE IV. SUMMARY OF ADMISSION OFFICER EVALUATION (GAMMA EVALUATORS)

Indicators	WM	Verbal Interpretation
Functional Suitability		
Functional Completeness	4.75	Excellent
Functional Correctness	4.83	Excellent
Functional Appropriateness	4.67	Excellent
Average Mean	4.75	Excellent
Performance Efficiency		
Time Behaviour	4.92	Excellent
Resource Utilization	5.00	Excellent
Capacity	4.83	Excellent
Average Mean	4.92	Excellent
Compatibility		
Co-Existence	4.83	Excellent
Interoperability	4.75	Excellent
Average Mean	4.79	Excellent
Usability		
Appropriateness recognizability	4.83	Excellent
Learnability	4.83	Excellent
Operability	5.00	Excellent
User-error protection	4.75	Excellent
User-interface aesthetics	4.83	Excellent
Accessibility	5.00	Excellent
Average Mean	4.87	Excellent
Reliability		
Maturity	4.74	Excellent
Availability	4.68	Excellent
Fault tolerance	4.58	Excellent
Recoverability	4.87	Excellent
Average Mean	4.71	Excellent
Security		
Integrity	4.50	Excellent
Non-repudiation	4.48	Excellent
Accountability	4.68	Excellent
Authenticity	4.67	Excellent
Average Mean	4.58	Excellent
Maintainability		
Modularity	4.92	Excellent
Reusability	4.84	Excellent
Analyzability	4.92	Excellent
Modifiability	4.67	Excellent
Testability	4.92	Excellent
Average Mean	4.85	Excellent
Portability		
Adaptability	5.00	Excellent
Installability	4.83	Excellent
Replaceability	4.75	Excellent
Conformance	4.83	Excellent
Average Mean	4.85	Excellent
Grant Mean	4.79	Excellent

It is evident in Table 4 that integrity got the lowest mean score of 4.58. As a security indicator, this study corroborates the literature's assertion that web system vulnerability is at an all-time high in today's digital age.

Table 5 presents the overall ratings of IT experts, Local Administrators, and Admission Officers using ISO/IEC 9126-1:25010: 2011 quality standards. It was revealed that the average weighted mean was excellent (4.72). All indicators evaluated in terms of Functional Suitability, Performance efficiency, Compatibility, Usability, Reliability, Security, Maintainability, and Portability were rated excellent.

TABLE V. SUMMARY OF IT EXPERTS, BUISU ADMINISTRATORS, AND ADMISSION OFFICER EVALUATION USING ISO/IEC 9126-1:25010:2011 QUALITY STANDARDS

Indicators	WM	Verbal Interpretation
Functional Suitability	4.72	Excellent
Performance Efficiency	4.78	Excellent
Compatibility	4.72	Excellent
Usability	4.80	Excellent
Reliability	4.67	Excellent
Security	4.58	Excellent
Maintainability	4.73	Excellent
Portability	4.77	Excellent
Grant Mean	4.72	Excellent

Aside from the instrument using ISO/IEC 9126-1:25010: 2011 quality standards, the researchers identified comments and suggestions from the respondents to improve the mobile application before the actual implementation. The followings are the comments and suggestions of IT experts, Bulacan State University Local Administrative Council, and Admission Officer.

The related word cloud list summarizes the most frequently occurring response, which is the application is useful to students.

CONCLUSION

The developed system is suitable for a web platform that helps to support the program administrators can more accurately predict program placements, which ensure that students are enrolled in appropriate programs that are well-suited to their individual needs and interests. The design and development of the system were developed with the functional requirements.

The system can now be accessed through the internet with the use of any platform. Based on the evaluation results yielded, the system has successfully met and achieved all the desired functionalities required of a decision support system program placement. The results of the evaluation suggest the possibility of using the University Support System Program Placement using the decision Tree Data Model as a tool for program placement prediction of incoming freshman students of BulSU Bustos.

RECOMMENDATION

Upgrade bandwidth to prevent network congestion and bottlenecks, which can cause latency problems, packet loss, and sluggish response times. Include employees in the process of learning new skills, acquiring new knowledge, and training. Training employees means showing them how to do a certain task or method to help them do their jobs better. Consider recommendations and gather feedback regularly. Create program placement that satisfies customers by prioritizing the features that the majority of users were employed based on their input.

REFERENCES

[1] Affecting First Year Undergraduate Students Academic Performance, - *Scholars Journal of Economics, Business and Management*, pp. 54-60, 2015.

[2] Alyahyan, E., Düştegör D. (2020). Predicting academic success in higher education: literature review and best practices. *International Journal of Educational Technology in Higher Education Article number: 3 (2020)*. Retrieved from: https://educationaltechnologyjournal.springeropen.com/articles/10.1186/s41239-020-0177-7

[3] Analysis through educational data mining. 694-699. 10.1109/ICISC.2018.8398887.

[4] Baker, S., & Inventado, P. S. (2016). Educational data mining and learning analytics: Potentials and possibilities for online education. In G. Veletsianos (Ed.), Emergence and Innovation in Digital Learning (83–98). doi:10.15215/aupress/9781771991490.01

[5] Buenaño-Fernández, D. & Luján-Mora, S. (2019). Application of machine learning in predicting performance for computer engineering students: a case study. Sustainability.

[6] D. Raju and R. Schumacker, (2015). Exploring Student Characteristics of Retention that Lead to

Graduation in Higher Education Using Data Mining Models,‖ Journal of College Student Retention: Research, Theory & Practice, 16(4), pp. 563–591, 2018, doi: 10.2190/cs.16.4.e.

[7] Hegde, Vinayak & P.P, Prageeth. (2018). Higher education student dropout prediction and

[8] Kovacic, Z (2010). Early prediction of student success: Mining students' enrolment data.., repository.openpolytechnic.ac.nz,https://repository.openpolytechnic.ac.nz/handle/11072/646

[9] Lead to graduation in higher education using data mining models. J. College Student Retention, Vol. 16(4) 563-591. Retrieved from: https://journals.sagepub.com/doi/abs/10.2190/CS.16.4.e

[10] Students at Risk of Failing in the Early Stage of Tertiary Education,‖ Journal of Learning Analytics, 3(2), pp. 330–372, 2016, doi:10.18608/jla.2016.32.20.

[11] Pal, AK, & Pal, S (2013). Classification model of prediction for placement of students. International Journal of Modern Education and …, mecs-press.net, http://www.mecs-press.net/ijmecs/ijmecs-v5-n11/IJMECS-V5-N11-7.pdf

[12] Ramesh, V, Parkavi, P, & Yasodha, P (2011). Performance analysis of data mining techniques for placement chance prediction. International Journal of …, researchgate.net, https://www.researchgate.net/profile/VamananRamesh/publication/254558569_Performance_Analysis_of_Data_Mining_Techniques_for_Placement_Chance_Prediction/links/0c96051fcbaa67d852000000/Performance-Analysis-of-Data-Mining-Techniques-for-Placement-Chance-Prediction.pdf

[13] Retrieved from: https://ched.gov.ph/wp-content/uploads/2018/01/CMO-No.-105-s.-2017-Policy-on-the-Admission-of-Senior-High-School-Graduates-to-the-Higher-Education-Institutions-Effective-Academic-Year-2018-2019.pdf

[14] Ricketts, J, Jones, K, O'Neill, P, & Oxley, E (2022). Using an assessment decision tree to align students' reading needs to support in school., osf.io, https://osf.io/tm5cg/download

[15] S. Fong, Y. -W. Si and R. P. Biuk-Aghai, "Applying a hybrid model of neural network and decision tree classifier for predicting university admission," 2009 7th International Conference on Information, Communications and Signal Processing (ICICS), Macau, China, 2009, pp. 1-5, doi: 10.1109/ICICS.2009.5397665.

[16] Student Support System, International Journal of Emerging Technologies and Innovative Students According to their Academic Performance: A Predictive Modeling Approach,‖ Decision Support System, 2018, doi:10.1016/j.dss.2018.09.001.

[17] Yu Liang, Xuliang Duan, Yuanjun Ding, Xifeng Kou, and Jingcheng Huang. 2019. Data Mining of Students' Course Selection Based on Currency Rules and Decision Tree. In Proceedings of the 4th International Conference on Big Data and Computing (ICBDC '19). Association for Computing Machinery, New York, NY, USA, 247–252. https://doi.org/10.1145/3335484.3335541

[18] Zhifei Zhang, Zijian Zhao, Doo-Seoung Yeom, "Decision Tree Algorithm-Based Model and Computer Simulation for Evaluating the Effectiveness of Physical Education in Universities", Complexity, vol. 2020, Article ID 8868793, 11 pages, 2020. https://doi.org/10.1155/2020/8868793