Formative Assessment Based Students' Recruitment Estimation: Neural Network Approach

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Abstract. Even though there is a strong focus on achieving the objectives of the education system, it is undoubtedly dependent on the knowledge, skills, and, most notably, the methodology of how teachers use qualitative and quantitative assessment techniques to assist learners. Teachers use formative assessment to monitor students' progress, their level of knowledge, and their ability to self-assess. One of the critical outcomes following completion of a degree program is the ability of the student to obtain employment. More specifically, it focuses on acquiring knowledge, skills, and capacities that are then applied to real-life contexts. This paper presents a neural network approach to predicting students' job placement based on formative assessment. The approach aids Higher Education Institutions in determining the progress of individual students and areas for improvement during the graduation process, increasing the likelihood of students finding employment after graduation. The paper illustrates important parameters for campus placement selection, how embedding formative assessment and neural network modelling facilitate enhancing students' knowledge, skills, and performance at the institute and fulfil its objectives of gaining meaningful employment.

Keywords: Formative Assessment · Job Placement · eLearning · Machine Learning · Neural Network

1 Introduction

There is no doubt that the use of soft computing technologies, specifically neural network modeling, is playing an increasingly important role in assessing student performance in the education sector. This method improves transparency and accuracy of assessment across a multitude of features with more excellent reliability, thereby ensuring the efficacy of education [1]. The assessment of student learning and skills within an outcomes-based education system, however, plays an essential role in determining the

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degree to which students have acquired understandings, knowledge, and skills. A lot of the changes that are being implemented in education are suggested by these assessments and evaluations. It is important for institutes of higher learning to be aware of these assessments so that they can strategize their teaching methods. This is especially important with possible changes in the future, as these assessments provide an overview of our current knowledge. Furthermore, this makes it possible for the future of education to be improved and effective.

In the context of teaching and learning, formative and summative assessment constitute two of the most popular methods of assessment. Formative assessment is well known to be essential for identifying learners' needs in terms of their learning process [10]. Nevertheless, it is hardly ever used in order to predict the job placement of students. In the present paper, we discuss the former method of assessment, which assists students in learning and practicing subject content throughout a school year. As a result of identifying and supporting specific student needs, it motivates the student to perform at their best.

On the other hand, the latter involves a cumulative evaluation of students' knowledge at the end of the course. Such assessment provides evidence of students' knowledge, skills, and proficiency. In outcome-based education, formative assessment provides quantitative and qualitative evidence of teaching practices employed by a teacher to meet the diverse learning needs of students. This is key to improving the learner's skill and knowledge level for lifelong learning, a crucial attribute for a successful career when the student enters the workplace.

Furthermore, formative assessment is shown to positively impact students' self-perception, motivation, and achievement among average learners. It is a continuous method of evaluating a student's performance. During the assessment, teachers engage learners in different activities and strategies for their development [8]. The incorporation of such evidence-based teaching-learning methods, innovative practices, ICTs, and scientific teaching strategies enhances teachers' professional development. According to cognitive psychology research, active participation in teaching-learning-evaluation activities improves students' knowledge. As mentioned earlier, formative assessment concerning both the attributes motivates participation in an active learning strategy, learner encouragement, and long-term knowledge retention students [2] and develops confidence among.

Given the significance of formative assessment in teaching-learning, this paper examines whether comprehensive post formative assessments can accurately predict student academic achievement on job placement indicators as determined by standardized criterion-referenced tests. Explicitly, the analysis would help improve the criterion [1], which would result in better job placement for the graduates following graduation. The paper is divided into several sections. Upon introducing the theme, the subsequent section describes the importance of campus recruitments, skills required for campus recruitment. This is followed by the literature review focusing on other researchers working on a similar theme and thereby identifying the gaps in the literature. After the formative screening of the students, a feed-forward neural network model is applied to the data set. A discussion of the usefulness of this model follows in the final section of the paper.

2 Importance of Campus Recruitment

Campus recruitment is important not only because it shows potential employers that the institute have strong students and a high number of students who are attending and graduating, but also because it helps the institute to recruit their own students. An institute's career center is in charge of campus recruitment [11]. It always place advertisements on newspapers, websites, and flyers for prospective students to attend their open days or for current students to look for jobs or internships on campus. Campus recruitment serves as a brand building exercise for the institute. From the perspective of student, doing a campus interview is an excellent way to have a face-to-face opportunity to speak with prospective students and answer their questions. Recruiting prospective students on college campuses is one of the most impactful ways to connect with prospective students and close enrollment gaps. Campus visits also make important contributions to student success efforts by giving current students an opportunity to interact with future roommates, classmates and mentors through activities such as guest lectures, peer mentoring groups, or career events [12]. The likelihood that these interactions will lead to a successful match between current and future students is increased by holding formal recruitment events.

The vital role that campus recruiting plays to the success of the recruitment efforts cannot be overstated. Using campus recruiting as a main strategy can help to meet the institute enrollment goals and increase the yield depending on which months the events occur in or during concurrent enrollment periods, the outreach activities must be both effective and consistent. The overall goal of enrolling more students can easily be missed if the institute does not focus on consistently bringing in qualified students and supporting them to enroll, especially during the target enrollment periods.

3 Skills for Campus Recruitment

Campus recruitment can be a great way for employers to find the next best talent for their workforce. It can also help the students to kickstart their career with the prospective company. One thing is clear: it is in the best interest of the student to be able to negotiate with potential employers, just like it would during any other interview process. This means that the concerned student needs certain skills that make him/her stand out from the pack and give them the edge over others who may want the same position as much as they do. In addition, having the right campus recruitment skills can help the students in other aspects of your life. They will be able to stand out from the crowd, have a "savvy" personality, or simply just be better able to advance their career [10]. Thus, it can even help them in both personal and professional life.

A formative and summative assessment helps to identify student knowledge and skill in particular domain. Knowledge is the understanding of particular concept, method, problem or scenario. It is theoretical or practical based on understanding actual subject. The knowledge can be categorized as factual, cognitive, procedural or conceptual. Skill is different from knowledge. It is ability to gain something from practice and professionally implement in real world [13, 14]. The skills can be enhanced through practice and hard work. Summative assessment motivate learners for acquire knowledge while

formative assessment promotes for skill development. Skill assessment framework plays vital role for student's holistic development in higher education. This framework focus on defining skills as per their education domain, analysis of study content, analysis of study methods and evaluate the skill acquired. Skills consist of problem understanding, problem solving, decision making, team work, critical thinking, stress management, emotional intelligence [7]. Outcome based study content is necessary to cope up current industry needs. Blooms taxonomy helps to design study content that can fulfill course and program outcome efficiently. Lectures, group discussions, case studies, role playing, activity based learning, library, laboratory work, practical exercises etc. [11] motivates the learners and helps to bridge gap between syllabus content and industry expectations.

4 Literature Review

Campus recruitment is one of the major parameter for measuring status of professional institutions. Today institutes are taking lot of efforts to attract the multinational companies (MNC's) for domestic, international and academics collaborations to improve their reputation. Students of final year programme mostly considered for Campus selection process. According to NASSCOM report IT and BPO are the major employment generation sectors in India. As per the TimesJobs.com average 70 to 80 percent recruitment in professional institutes is done through the campus recruitment. During recruitment process gap between existing curriculum and industry requirements, recruitment calendar or schedule, entry level salary expectations, training period these are major challenges for corporate as well as higher education(HE's) institutes [14, 17]. In order to improve learning and achievement for students, formative assessment is the cornerstone of educational policy. Data-based decision making (DBDM) and assessment for learning (AfL) are two fundamental approaches to formative assessment. These approaches help minimize the gap between actual and expected performance levels for students. The formative assessment stimulates student-teacher interaction and helps learners identify their learning preferences. For formative assessment to impact the quality of the teaching-learning process [13], teachers' knowledge and skill must be factored in, as are psychological and social factors.

Now days every institute has its own placement cell to improve industry- institute interaction, industry experts are involved in curriculum designing, admission process, training and recruitment activities. Students considered various factors while selecting institute for higher education and future career such as institute ranking and recognition, alumni reference, industry collaboration, students-teachers participation in events, admission criteria, brand image, experience, and localization [10]. Hybrid pedagogies are widely adopted in this context, based on Bloom's taxonomy revised through cognitive learning, flipped classrooms, and asynchronous learning for improved teaching-learning strategies. In order to identify student interests, depth of knowledge, and comprehension, classroom discussion question and answer session is an essential part of formative assessment. The combination of a self-assessment strategy and formative assessment provides immediate feedback regarding performance against established criteria and standards [1], allowing students to determine what they learn and improve their performance for better learning outcomes.

According to the literature, neural networks (NN) can predict students' academic progress and engagement in class. NN is a system of artificial neurons that similarly perform tasks to the geometry neurons in the human brain. A significant enhancement of output performance can be achieved through learning, training, and continuous improvement [5]. With regards to tutoring and assessing learners, soft computing, specifically artificial intelligence (AI), machine learning, and neural network-based techniques, have become increasingly important. They have proven to be the most effective formative evaluation methods, customized learning, ontologies, adaptive learning, self-assessment, and automation in students' grading systems [12]. AI-based pedagogical decision-making motivates the learner-centric approach by systematically assessing the student's understanding and learning interest [16]. The use of techniques such as artificial intelligence (AI) and Neural Networks promotes student assessment related to their learning behaviors, sentiments, and achievements. Through the soft computing approaches, behavior analysis identifies the learner's understanding level, and sentiment analysis identifies their emotions, attitudes, and perceptions. MCQ tests, project work, presentations, and case studies are all ways to assess students' achievement [9]. Students' learning behavior can be evaluated by embedding the above-said techniques based on their academic performance, learning methods, ability to listen and read, and memorization. Such preference-based personalized learning systems encourage learners to learn at their own pace. The same will also facilitate appropriate ICT tools and teaching methods for outcome-based education. There is also literature reporting slight variation of these techniques in the form of Fuzzy rule-based systems, which help determine whether students are slow or fast learners.

Other Adaptive Neuro-Fuzzy System helps predict student knowledge level by predicting learners' domain knowledge. Additionally, it motivates learners to select the most appropriate learning path to get the best learning experience [4]. In conjunction with formative assessment, natural language processing is one of the most effective formative and summative assessment methods. Students are motivated to solve exercises through automatic grade assignment applications, which reduce the possibility of errors and shorten the correction time [9, 12]. As far as recruitment and job placement are concerned, Artificial Intelligence has a significant impact on the recruitment process; it provides automation in constructing uniform profiles [6], matching the required profile and skillset for an industry, hiring quality candidates, addressing queries, and so on.

According to the literature review both students and institutional factors impact on campus placement recruitment. Cognitive skills, domain specific knowledge, attitude, confidence, learnability and communication skill of student's accountable for campus selection. Institute levels factors such as brand image, industry-institute collaboration, curriculum, formative assessment methods, summative assessment methods and alumni association highly impact on success rate of student's recruitment. Figure 1 depicts the prominent factors for campus recruitment.

However, the literature review results indicate that the outcome of formative assessment is ignored concerning job recruitment for students. In this case, we have utilized the data as an essential asset for predicting the likelihood of individual students being selected for campus job placement using a neural network approach. This study illustrates the important parameters for campus placement selection [15, 16]. In the light

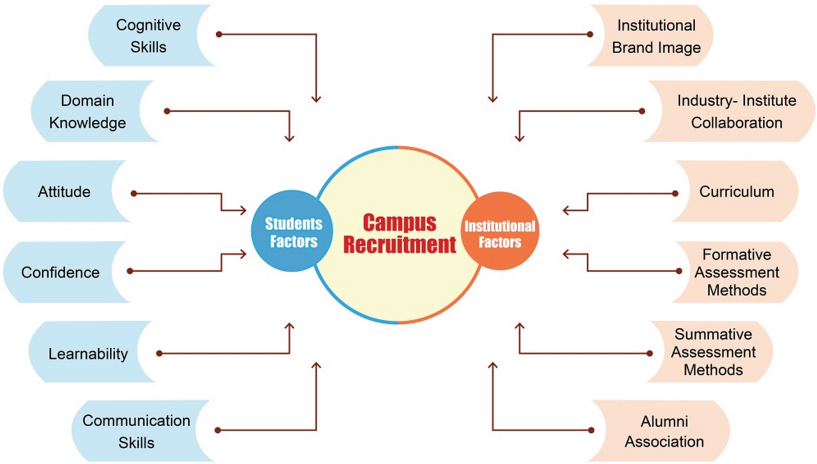

Fig. 1. Prominent Factors for Campus Recruitment

of this, the present paper proposes to establish the connection between the formative assessment and job placement of the students to strategize their holistic development during their graduation journey.

5 Methodology

This dataset was compiled from a set of job recruitment selection records of consecutive five-year placements made by the computer science department of one of the author's institutes. There are various activities that are used to assess students on a qualitative level during each semester. It consists of assignments, eLearning activities, projects, multiple choice questions, presentations, and unit tests as shown in Eq. (1). The average marks of each activity are calculated as part of the quantitative research process. In order to determine whether the student is eligible for selection, the placement department collects the student's employment history in order to determine their eligibility. As part of the preparation of the dataset, the placement status of each student is taken into account in addition to the quantitative assessment data. We have considered 1360 students for the study. We have observed that 72.54% of those students are getting campus placements (Fig. 2).

Bar chart (Fig. 3) depicts that the students who get campus placement has highest score in project work, presentations, MCQ test and eLearning activities.

6 Model Development

A Three-Layer Feed Forward Neural Network (FFNN) and a Sigmoid Activation function are used in this proposed model. With this model, the neural network is formed by three layers: input, hidden and output. The first layer is where the system receives information from input dataset. The second layer contains a group of neurons (hubs).

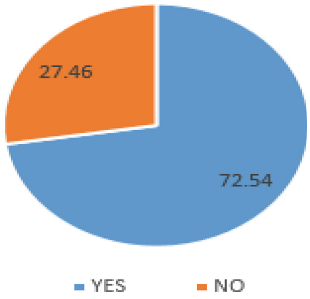

Fig. 2. Campus Placement Selection

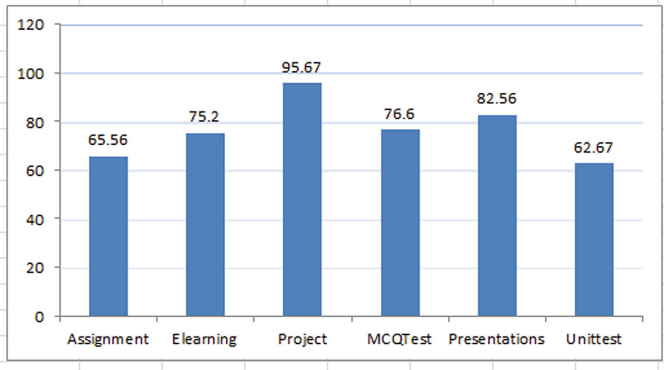

Fig. 3. Qualitative Assessment for Placement Selection

These hubs are responsible for receiving information from the first layer and passing it to the third-layer. In this layer, individual neurons are activated by this data to make predictions about what can be found in a given area in time period t + 1. The output of this layer is the information that has been predicted to be in the given area in time period t + 1. The final layer is fed from the output of the second and third layers and contains a group of neurons that are responsible for predicting future events in order to help maintain predictability and stability.

The Neural Network uses an input layer where it consists of many sensors (where each sensor provides information about a certain condition or feature). The next layer is the hidden layer. This layer divides information among the hubs (central neurons) of its neurons. This layer is responsible for providing information to the output layer (which then makes decisions based on this information). The output layer contains one neuron for each candidate variable and predicts future values of each variable.

In this investigation, it is taken into consideration that the FFNN model is better fit to the property of Time Series Data such as placement records. It is assumed that the FFNN model makes prediction of records in a specific time frame. The initial value of input variable is constant and it is not updated during the process of execution. The output value of FFNN model is assigned a value between 0 and 1 by using Sigmoid Activation

function for each new record observation. The sigmoid activation function is used in the hidden layer.

The multilayer perceptrons model is considered as a common feed forward neural network. The three layers of FFNN are connected to each other by using the activation function. The output value of FFNN is stored in a single element of a vector before it has passed to the activation function, where it is then transcribed as a single element after being modified by the activation function inside hidden layer.

The following Equations shows the input data, output data and activation function of FFNN.

$$\text{inputs} = \left[\text{Assignments},\ \text{e} - \text{learning},\ \text{MCQ Tests},\ \text{presentations},\ \text{Unit Tests}\right]; \quad (1)$$

$$\text{output} = \text{activation(inputs)}; \quad (2)$$

$$\text{Activation function (hidden layer)} = \text{g(z)}; \quad (3)$$

If the model is trained using a training set S which contains patterns that are predicted by the model with their corresponding actual values y_i, A pattern will be chosen at random from S to form a test set T. The output value y_i of the test set T is checked for accuracy. If the pattern y is correctly predicted, we will say that we have correctly classified it. If the model does not correctly predict the pattern, then it is called an incorrect prediction.

7 Training and Testing Datasets

Training and Testing Datasets for neural network models is key to their successful application. Neural networks are a type of computer software that can be used for pattern recognition, prediction and classification. The algorithms of neural networks learn from experience to improve their performance over time. However, an important step in this type of algorithm training process requires large amounts of data with meaningful labels such as images/videos or text information. This is because it is necessary to fully explore the model space before restricting the training to a few specific locations. A good data set can be important for example in order to identify which of the input variables are related with a certain output variable. The better models will be able to use more data to accelerate the training process and achieve higher accuracy. However, there is an important difference between the amount of data required for training and testing at the initial time of model building and later on in the actual deployment process. During the initial training process, a large amount of data must be obtained in order to check all possible combinations of inputs and output variables to prevent over-fitting and bad models. The results will be used afterward to make adjustments and fine-tune the neural networks model. On the other hand, once a neural network model has been obtained it is used repeatedly as a prediction or classification algorithm. Therefore, the amount of data needed for training and testing must match the amount of input data and parameters needed to validate the model's predictions.

Table 1. Structure of Neural Network

Content	Values
Number Input Neurons	6
Nodes of Input Layers	Assignment, E-learning, Project, MCQ Test, Presentation, Unit Test
Number of Hidden Neurons	4
Number of Output Neurons	2
Nodes of Output Layer	Yes, No
Weight	84
Accuracy	96.29%

In the present study, the Students' data is divided into training and testing datasets through a random sampling method. To build the Neural Network model, 70% training and 30% testing data have been considered. The Neural Network model is trained during experimentation by changing the number of hidden layers, the number of nodes in the hidden layer, and their respective weights. Neural network weight decay 0.2 is used to resolve the over-fitting issue. The learning rate and Root Mean Square Error (RMSE) were observed in each iteration. It reveals that the model trained with one hidden layer and four hidden neurons gives 96.29% accuracy with an RMSE of 0.0685 in 25796 iterations. Table 1 depicts the structure of the Neural Network.

8 Algorithm Development and Programming Paradigm

In R studio, algorithm for student's placement prediction is developed by using neuralnet package. RStudio is an Integrated Development Environment for statistical computing and graphics. With RStudio, you can create a variety of plots and charts through which you can do statistical analysis. RStudio was designed specifically for the needs of modern data science: data management, exploration, visualization and manipulation, modeling, simulation and analysis. It is very useful for scripting the algorithms.

R is an open source programming Language which is designed by R Development Core Team at The R Foundation for Statistical Computing. R has a very large collection of libraries that provide specialized statistical methods such as nonlinear regression analysis, time-series analysis and classical test procedures (i.e., chi-square tests). R Studio is an Integrated Development Environment as well as a web-based IDE (Integrated Development Environment) for R users. It provides a lot of functionality to the user like code completion, syntax highlighting, plotting, GUI building etc. This package is used to model the neural networks architecture. This package has got a variety of functions which identify the input nodes, hidden nodes, output nodes and weights. The user can set these models according to their choice and train them to find the optimal weights.

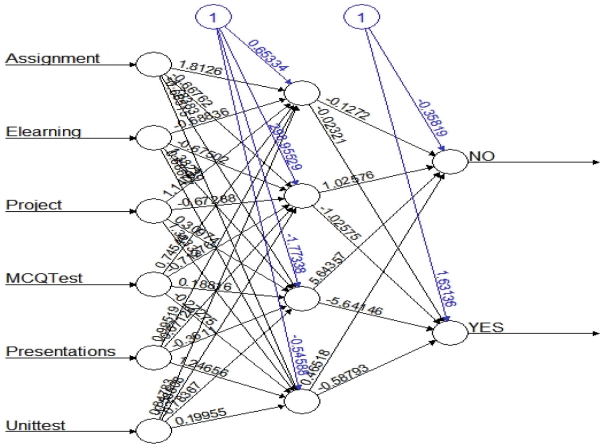

Fig. 4. Three Layer Feed-Forward Neural Network

Neural networks are becoming more and more popular in computing. This package is also among the most used packages in R. Generally, a neural network is made up of input (X) nodes, hidden (h) nodes, output (Y) nodes, and weights between the nodes. The main aim of setting up a neural network is to find the optimal weight between these nodes to make accurate predictions on the data. There are various algorithms that can be used to find the optimal weights, such as backpropagation, Levenberg–Marquardt algorithm etc. These algorithms are usually implemented using R. The package has got many functions that help user to set up the neural network models and make accurate predictions on the data. The main challenge is to find out the optimal weights for the neural network model. There are various algorithms that help us to find this weight. Feedforward Neural Network (FFNN) is one of the most widely used algorithms to find the optimal weights. To use FFNN, we must set up a neural network using library ("neuralnet"). Then we train this neural network using some datasets to develop best fitted model. After that we use the trained neural network model to make predictions on a testing dataset and compare results. Figure 4 shows the structure of proposed feed-forward neural network.

9 Result and Discussions

It is observed that improved performance in project work, presentations, MCQ tests, and online learning improves the possibility of selection for recruitment of students during campus selection. The teacher must motivate the students to put more effort into such activities to increase their knowledge and confidence. According to Table 2, the confusion matrix shows the predicted output among true positives and false positives.

Confusion matrices summarize prediction results for classification problems. With the help of count values, the number of correct and incorrect predictions is summarized and broken down by class. The confusion matrix relies on this data.

Here, we have depicted result using 2x2 confusion matrix. In this case, the number of correct and incorrect predictions corresponds to the number of targets (positive subjects)

Table 2. Confusion Matrix

	YES	**NO**
YES	289	7
NO	8	104

and non-targets (negative subjects). The result of a prediction is denoted as shown in Table 2, in this case, we have either a true positive (TP) or false positive (FP). Here 408 records considered for testing, according to the experimentation it is observed that 393 recodes gives true positive result whereas 15 records shows false positive result. The overall accuracy of the proposed neural network model for placement prediction is 96.29%, which results in improved performance.

10 Recommendations

Student recruitment is a significant problem in the world of higher education. This is especially true for students who are first-time college-goers, and they may not be aware of what to expect at their new institution. This leads to students dropping out of college before they complete their degree because they have no idea what they are getting themselves into. Predictive analytics are being used as tools by some universities and colleges to predict when a student will opt-out or declare themselves as inactive so that the educational institution can intervene early on, becoming more personable in the process, which will ultimately make all parties involved more satisfied and get a better result than if this intervention did not occur. Much of this is done by using students' profiles and past performances. However, these predictions can also be made based on a student's formative assessment. This is valuable because it allows Institutes of higher education to gather more data that can show what students' strengths and weaknesses may be, which can then be addressed in a way that helps the student do better in their classes and stick with their course of study. This will also lead to a culture of continuous internal assessment. Predictive analytics is heavily used in higher education to make better decisions regarding financial aid and student recruitment. In higher education, predictive analytics can predict which students are likely to drop out of the program. Dropping out of college means that students will not complete their degrees, so it becomes extra important for colleges and universities to find ways to stop this from happening. Predictive analytics through the feedforward neural network approach can be used in various ways to show which students are likely to drop out of the program because it gives the institution a better understanding of what is happening inside their college and why. This can help the college see where and how to make changes so that students are more likely to complete their degree or stay enrolled. Through predictive analytics, student experience can also be improved. Colleges and universities can use predictive analytics in student recruitment by using data on students' demographic characteristics and their career potentials to find people who are likely to be a good fit for their college. For the future research in the area the authors are working on implementing the Genetic algorithm to select the best formative assessment parameters and employ a fuzzy-neural

approach for determining the best formative assessment technique to improve students' performance and maximize their chances of being admitted to the best fit institute of higher learning.

11 Conclusion

It is a difficult task for all professional institutes to provide students with campus placements in today's highly competitive environment. During a campus placement itself, the ability to gain meaningful employment is one of the most important criteria used to assess the performance and quality of educational institutions. As this study has demonstrated, teaching and learning pedagogies known to improve student performance, including formative assessment, can be used to improve performance in the classroom. The purpose of the formative assessment is to provide the teacher with a practical and systematic way to assess the knowledge, skills, and abilities of the students. The results of the formative assessment that was used to identify the strengths and weaknesses of each student can further be used to mentor the students so that they are prepared for recruitment procedures. The data from formative assessments that students complete during a semester can be an invaluable asset for predicting students' probability at the time of recruitment, as evidenced by this paper. Proposed feed-forward neural network model gives 96% accuracy in student's placement prediction. As such, the implementation of a neural network for placement prediction is one of the best soft computing approaches.

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