



Original Article

The Evolution of Employability Prediction Models: A Machine Learning Perspective

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Abstract

Employability is integration of technical abilities relevant to a specific job and soft skills such as communication, problem-solving, teamwork, and adaptability which collectively shape an individual's job readiness. In the current era of digital transformation and evolving job market requirements, employability has played a crucial role within higher education systems globally. One of the primary objectives of the higher education system is to equip students with the necessary skills and competencies to enhance their employability and ensure they are job-ready upon graduation. Rates of unemployment around 60 % in most institutions. Investigating the determinants of work readiness in higher education students is a key area of research, driven by the growing demand for graduates. The transformation of employment trends necessitates accurate prediction of students' career readiness to enhance the effectiveness of higher education systems. From the last few years, Machine Learning (ML) has emerged as a powerful tool for predicting employability by analyzing varied student data ranging from academic performance, placement related data & data related extra-curricular activities. Through machine learning models, educational researchers can evaluate the success of institutional strategies designed to enhance student employability in a dynamic job market. Using machine learning, higher education systems can continuously monitor and improve employability development programs to align with evolving industry demands. A variety of machine learning techniques are utilized to train computational models that learn from data and support decision-making tasks. Professional standards and job opportunities are correlated to employability skills available. Current employability skill sets of graduates and industry expectations are not matched with each other. There exist many attributes related to employability skills of students that impact on getting job opportunities. Many higher education institutions are evaluating the possibility of developing predictive models using Machine Learning that use different sources of data available to identify students that might be at risk of failing a course or program. This paper discusses the applications of machine learning algorithms in employability prediction and provides recommendations for improvement. The findings of this research provide valuable insights to institutes to enhance their placement processes, by students to better prepare for employment opportunities, and by placement organizations to streamline recruitment strategies.

Keywords: Higher education, Machine learning, Predictive models

Introduction

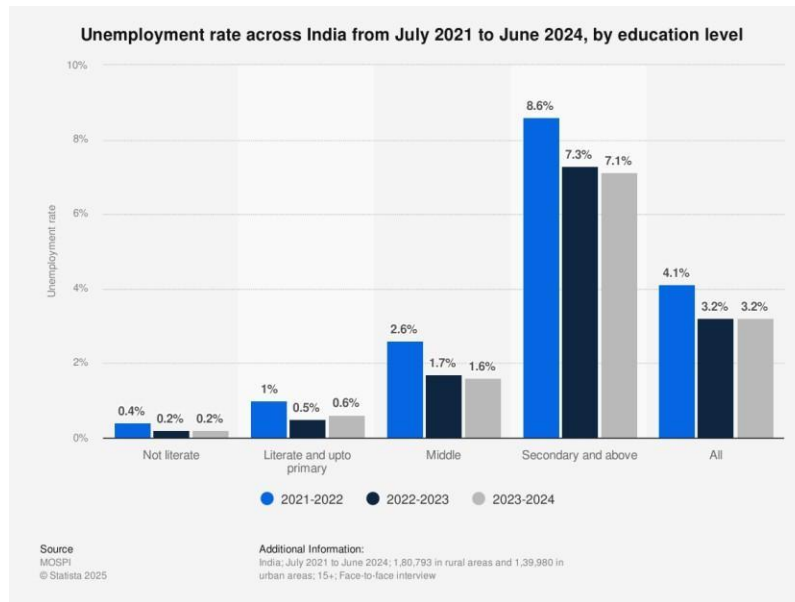
The goal of education is not just knowledge acquisition, but also its application in meaningful Employment said truly in employability literature. Education has become employment oriented. Employability is a set of an individual's skills and attributes that benefit the individual, the workplace, and the economy of the nation as well. Employability is influenced by many factors such as skills, knowledge, and personal attributes that are gained through the right education and appropriate training. University-level learners need to improvise technical skills, aptitude skills, skill of critical thinking, personal and interpersonal skills for enhancing their employability.[1] The report published by India Today in March 2017 relieved that out of eight lakhs engineering graduates in the country, 60 % remain unemployed.[2]

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Objective:

Employability prediction is a key aspect for an educational institute. The constantly changing global job market highlights the importance of understanding the skills that employers value the most. Educational institutions must adapt curricula with these evolving demands to equip students with relevant skills. Such **conformity** enhances employability and improves the connection between academic preparation and workforce readiness, ensuring students can contribute meaningfully to economic and social progress.

The main objective of this study is to:

1. Examining employability through existing literature provides insights into the definition and development of employability skills.
2. To review and evaluate the techniques adopted in prior studies for predicting employability using machine learning approaches.

Methodology:

This research examines literature available in academic and scholarly publications. The various types of research papers, review articles related to the topic are searched from Google by using special keywords like employability, employability skills, employability prediction, machine learning, and data mining. The review primarily considers research papers that examine employability and associated skill sets. The study further examines literature using various machine learning-based prediction models.

1. To explore term Employability and skills required for gaining employability in a broader way

Sr. No.	Research Paper/Article	Contribution	Reference No
1	Needs of employability skill characteristics based on employers' perception	This study assesses employers' perceptions of employability skills based on personal qualities, core skills, and subject knowledge. Through statistical analysis, the study identified that subject-specific knowledge was regarded by employers as the most important factor along with core skills, but personal qualities receiving comparatively lower evaluations. The literature highlights that graduate employability is dependent on broad skill set along with subject-specific knowledge.	1
2	IEEE student quality improvement program: To improve the employability rate of students	The preliminary study aimed at creating students who are more likely to be employable. Findings indicate that a considerable number of students lack essential communication skills, and only few participate in internship programs. Some of them show unwillingness to apply for the same. The study demonstrates that	3
		developing both soft and technical skills enhances Students' opportunities to engage in internships.	
	Statistical Analysis and Employability	The study collected data from final year students, and a statistical analysis was conducted to systematically	

3	skills Equation for Graduate Students in the Bahamas	elaborate and evaluate how to build employability skills and increase chances of getting a job after graduation. Research applied SPSS techniques to ensure data reliability and evaluate the statistical significance of employability factors, including academic, personal management, and teamwork skills and learning methods. A regression model equation was developed for predicting the probabilities of getting position at entry-level.	4
4	A Study on enhancing employability skills: key factors and strategies for a dynamic job	This research creates an empirical model that explores and focuses on the statistical analysis of how employers recognize fresher's from colleges and their employability skills. Study finds out the parameters that play a crucial role for employability and proposes strategies to enhance employability to meet the needs of the recent job market.	5
5	The Concept of Employability	This paper analyzes the concept of employability by tracing its historical development, reviewing working definitions, and examining its role in local, national, and international labor market policies. Beyond individual skills such as basic competencies, transferable abilities, job-seeking techniques, and ICT proficiency, the paper adopts a wider perspective. It highlights the impact of external conditions and personal circumstances on employability outcomes, emphasizing its multidimensional nature.	2
6	Practical framework of employability skills for engineering graduate in Malaysia	The Study contributes to providing insights into the linking of graduate attributes, using national accreditation criteria by referring to a practical framework. This proposed framework provided a roadmap to engineering students to become employable by considering technical and non-technical skills along with personal attributes, personal skills and engineering skills.	6

7	Impact of Digital Skills on Employability: Cross-Sectional Analysis	Digital Skills, mainly communication and collaboration & digital content creation play a significant role in enhancing employability. Using multiple regression analysis, the study found that not all digital skills equally affect employment, with advanced skills being more impactful.	7
8	Importance of Non-Technical Skills for Employment Opportunities: A Gap Analysis of Students and Employers Perception Importance of Non-Technical Skills	Students and employers hold differing perceptions regarding employability. This study tries to find a common platform for better understanding and deciding Policy. Students' evaluations of non-technical skills do not align with employers' expectations. While preparing for the interview process, if the student is aware about what the order of the skills considered important by the employer it would help to develop the skills and increase their chances of employability.	8

Employer expectations are continuously changing. It depends on the situation at the time of hiring. Broadly speaking, employability skills and attributes include the essential characteristics necessary for job readiness. It can be seen as broadly covering the essential attributes like interpersonal skills, individual capabilities as motivation, confidence, etc., essential skills, skills like problem-solving, communication, adaptability, team-working skills, high-level transferable skills including self-management, commercial awareness, possession of highly transferable skills, educational qualification. Demographic characteristics, psychosocial and health factors, job search skills with external factors significantly affect employability rate. Students should equip generic employability skills to gain employment to sustain and perform excellently in this dynamic world and global competitive market [9]. To bring substantial changes in teaching and learning process can also help to enhance employability rate. Various employability skills are considered for securing employment. An integration of multiple skills is necessary. For strengthening students with the skills needed for industry and placements, understanding employers' views is essential. Educational institutions must consider industry expectation to design effective strategies for skill up gradation and student guidance.[1]-[10]

Finding technical and non-technical skills is equally important. Communication skills play a crucial role in gaining employment. A variety of teaching and learning activities are essential for the development of effective communication and problem-solving skills. Such enrichment activities contribute to the development of communication and problem-solving skills, which are regarded as key attributes in the competitive global market [10]. Practical knowledge gives equal weight to theoretical concepts. Internship programs should be provided to students to help increase their chances of employability [6]. Features are fundamental in prediction model development. Employing feature selection algorithms to determine optimal features can significantly improve prediction accuracy and model reliability [12].

To review and evaluate the techniques adopted in prior studies for predicting employability using machine learning approaches.

Sr. No.	Research Paper/ Article	Contribution	Reference
1	Employability prediction using Machine learning	The paper consolidates machine learning algorithms used for employability prediction by performing an exploratory literature review from the Scopus database. The study highlights the characteristics, features, algorithms, and their accuracy.	13
2	Employability Prediction of Engineering Graduates using Machine Learning Algorithms	The proposed work used different machine learning algorithms like Logistic Regression, Decision tree, k-nearest neighbor, Support Vector Machine and Naïve Bayes for building models where ANN classifier resulted with the highest accuracy of 87.42%.	14
3	Enhancing Predictive Accuracy in Education: A Detailed Analysis of Student Performance Using Machine Learning Models	The study addresses critical issues of predicting student performance using machine learning algorithms. It includes logistic regression, random forest, multilayer perceptron and extra tree classifier were evaluated using a dataset of 2043 student attendance records. Research says that random forest, multilayer perceptron outperformed other models for predicting student performance.	15
4	Predicting Employability and Admission for MS Students using ML Regression Models	The model used Gradient Boosting regression, Support Vector Regression, Random Forest regression, Decision Tree Regression, and Ridge Regression. The author selects the best-performing model using Stream light (an open-source app framework) for developing a user-friendly web application interface for users using the best-performing model.	16
5	Evaluating and Enhancing Artificial Intelligence Models for Predicting Student Learning Outcomes	Research assesses ten different predictive models including 7 machine learning & 3 Deep learning architecture. All models are implemented using Python. Lasso regularization is used to measure efficiency and accuracy. Study applied dual evaluation strategies: k-fold cross validation and holdout methods.	17
6	Students' Employability Prediction Using Data Mining	Data is analyzed using decision tree algorithms where features like Academic record, Extracurricular activities.	18
7	Predicting Students' Employability using Machine learning approaches	This study was preparation for the machine learning approach of predicting students' employability. The preparation stage created a great effect on the results of learning algorithms. Therefore, researchers concluded that Support Vector Machine (SVM) produces a predictive model that obtained the highest accuracy of 91.22%	19
8	Predicting Student Employability Through the Internship Context Using Gradient Boosting Models	In this study, we author developed a new approach to predict student employability based on context and using Gradient Boosting Models.	20

Employability is a key measure of higher education system performance. It is possible to predict employability by using different features. Machine learning technique is used as an approach for prediction. Different machine learning techniques are employed for doing prediction. ANN Machine learning algorithms is found to be one of the best algorithms for prediction. [14]. The prediction model build considers different attributes for employability prediction. The selection of an optimal dataset comprising relevant attributes presents a substantial challenge in employability prediction. Studying the different factors and finding the most dominant factors is also a very important aspect. Selecting the appropriate technique for prediction and testing the accuracy of the model is equally important. Making use of a dominant factor for prediction will affect the accurate prediction of employability. Plenty of data is available in education institutes with respect to performance of students. Making use of this data in a correct manner and giving feedback analysis of the status of employability prediction to the students so that they can improve themselves is needed. This will increase their chances of employability and increase the overall percentage of placements at the

institute. Integrating the data required from different sources and stakeholders can make the prediction system stronger. The training and placement cell data can be utilized for prediction [21]. Employability status can be improved by providing skill enhancement programs to students in their area [15]. Studying the use of different Deep learning algorithms for employability prediction is an area which can be explored further. Applying different algorithms in educational data mining can unlock powerful innovations in education.[18]

Proposed Methodology:

A variety of literature is available with respect to employability skills and prediction of employability. Identifying an accurate employability prediction model remains challenging. There are various aspects which should be considered to make predictions accurate. The proposed model will be helpful to all stakeholders and policy makers in education. The model can achieve best accuracy by making use of machine learning algorithms. The proposed methodology is designed using a structured and systematic approach to enhance the validity and accuracy of the prediction outcomes.

1. To investigate the different factors that affect employability prediction.
2. To determine and find the most significant factors affecting prediction performance.
3. To systematically collect data using appropriate, reliable, and validated data collection methods.
4. To build a predictive system utilizing the best-performing algorithm, optimized for maximum dataset capacity and highest prediction accuracy.
5. To evaluate the accuracy of the developed predictive model.

Advantages of Proposed Methodology:

The proposed methodology provides significant advantages to all the stakeholders of the education institute and policy maker as well. The methodology is designed to improve student placement rates. It will help students to understand their level of skills. This feedback from the system can further result in providing the skills through skill enhancement programs to the students. The proposed model is beneficial for students by finding groups of individuals lacking specific skills, thereby enabling institutes to design and implement targeted skill-based training programs. Such organized programs help to bridge skill gaps henceforth enhance students' employability and improve overall placement outcomes. Employability predictive models provide key advantages, including early detection of skill deficiencies, personalized career guidance, optimization of student placement strategies, data-driven support for higher education policy decisions, and timely interventions to improve job readiness.

Conclusion:

Predictive analytics using Machine Learning (ML) plays a vital role in transforming data into actionable insights by predicting future outcomes based on available datasets. Education is an emerging domain where predictive analytics can drive meaningful improvements. Through predictive analytics, educational institutes can anticipate and reduce risks in advance to their occurrence. This enables organizations to make data-driven, accurate, and timely decisions. Building predictive models to examine students' employability at an early stage can significantly improve academic and career outcomes. By analyzing key performance indicators such as technical skills, communication abilities, and problem-solving aptitude, predictive models can identify existing gaps in a student's profile. Timely, insight-driven feedback enables institutions to implement targeted interventions that help students strengthen skill gaps before workforce entry, thereby improving employability and institutional placement success.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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