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Uncovering Hidden Skills of Students In Higher Education Using Artificial Intelligence: A Review

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Abstract

In today's fast-changing job market, it has become increasingly important to understand and make use of the hidden skills of students in higher education. Traditional evaluation systems mainly focus on academic performance and technical knowledge, often missing important abilities such as motivation, behavior, communication, and personal interests developed outside the classroom. However, these less visible skills play a key role in shaping a student's overall potential and career readiness. With the advancement of Artificial Intelligence (AI) and Deep Learning (DL), it is now possible to analyze large amounts of academic, behavioral, and contextual data to better understand these hidden abilities. These technologies help in identifying patterns, mapping skills, and providing more personalized career guidance, allowing students to align their strengths with the changing demands of the job market.

At the same time, existing research still has some limitations. Most studies focus more on technical skills and give less attention to a complete view of student abilities. Issues such as lack of transparency in AI models, limited use of real-time data, and minimal involvement of human guidance also remain challenges.

This review paper looks at existing studies on hidden skill identification and AI-based career guidance systems using sources such as Scopus, IEEE Xplore, Web of Science, and Google Scholar. It also highlights key gaps and suggests the need for more balanced, transparent, and practical approaches to support better career decision-making and improve student employability.

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1. INTRODUCTION

In today's rapidly changing global job market, it is clear that academic qualifications alone are no longer sufficient to ensure success. Students are increasingly expected to possess a broader set of skills, including practical abilities and digital literacy. However, higher education systems have traditionally placed strong emphasis on academic performance, often measured through Grade Point Average (GPA), which does not fully reflect a student's real-world capabilities. As noted in previous research, a large part of what students learn contributes to who they become, highlighting the concept of the hidden curriculum **(Abroampa, 2020).** The hidden curriculum refers to the values, attitudes, and social intelligence that students develop during their educational experience but are not formally assessed. These hidden skills are essential, yet they remain difficult to measure using conventional evaluation methods. Consequently, many of these competencies go unrecognized, resulting in a gap between graduates' abilities and the expectations of the job market **(Zhang et al., 2023).** To address this issue, higher education institutions are increasingly adopting Educational Data Mining (EDM) and Artificial Intelligence (AI) to enable a more comprehensive assessment of student capabilities. These technologies allow for the analysis of large-scale educational data and help in identifying patterns related to both academic and non-academic skills **(Roy et al., 2018; Tomy & Pardede, 2019).**

Recent advancements in Machine Learning (ML) and Deep Learning (DL) have made it possible to analyze and interpret students' skill sets more effectively. For instance, Game-Based Assessment (GBA) techniques are being used to evaluate soft skills in interactive environments **(Marengo et al., 2025),** while Explainable Artificial Intelligence (XAI) improves transparency and trust in AI-based career guidance systems **(Bearman et al., 2023).** Furthermore, intelligent recommendation systems and AI-driven models enable better alignment between students' abilities and the dynamic needs of the job market **(Amin, 2024; José-García et al., 2023).**

The purpose of this paper is to provide a structured approach to identifying and leveraging the hidden potential of students, ensuring that they are not only academically qualified but also well-prepared for the demands of the future workforce.

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2. CONCEPT OF HIDDEN SKILLS IN HIGHER EDUCATION

In higher education, students are usually evaluated based on their academic performance. However, many important abilities, known as hidden skills, are often overlooked. These include qualities like motivation, communication, adaptability, and critical thinking. While traditional systems focus on visible skills such as knowledge and technical abilities, hidden skills play a key role in long-term success

2.1 The Iceberg Model of Competence

The iceberg model explains that only a small part of a student's abilities is visible, such as academic skills, while a larger part remains hidden, including attitudes and behavior **(Kwok et al., 2016).** These hidden skills are important for career growth and long-term success **(Zhang et al., 2023).**

2.2 The Hidden Curriculum and Latent Skills

Hidden skills are often developed through the hidden curriculum, which includes learning from experiences, environment, and interactions. These skills, such as teamwork and social understanding, are not usually measured but are essential in real life **(Abroampa, 2020).**

2.3 Soft Skills and Digital Skills

Today, having only a degree is not enough. Employers expect students to have soft skills like communication and problem-solving, along with digital skills. These are important for meeting modern job requirements **(O'Connor et al., 2016; Ornellas, 2018).**

2.4 Identifying Hidden Potential using AI

It is difficult to measure hidden skills using traditional methods. However, AI and machine learning can help identify these skills by analyzing student data. Models and systems like SkillRec support better career guidance based on student abilities **(Roy et al., 2018; Ong & Lim, 2023).**

3. DATA SOURCES FOR HIDDEN SKILL PREDICTION

To identify hidden skills effectively, it is important to use different types of data. These data sources help in understanding not only students' academic performance but also their behavior, personality, and real-world experiences. By combining these, a more complete picture of a

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student's abilities can be developed **(Roy et al., 2018; Zawacki-Richter et al., 2019; Xu & Ouyang, 2022)**.

3.1 Academic and Foundation Data

Academic data is the most basic and easily available information in any educational institution. It includes grades, attendance, and course-related details. By analyzing this data over time, it is possible to identify patterns in student performance and consistency, which reflect their learning ability and cognitive skills **(Alamgir et al., 2024).** In addition, course rubrics and evaluation methods can reveal what types of skills students develop during their studies. AI techniques can analyze course structures to identify hidden digital and technical skills gained through academic activities **(Fan & Chiong, 2023; Munir et al., 2022).**

3.2 Behavioral and Interaction Data

Student behavior is an important factor in identifying hidden skills. Behavioral data shows how students interact with their learning environment. For example, Learning Management System (LMS) logs track how often students log in, participate in discussions, and submit assignments. These activities indicate skills such as self-discipline, engagement, and time management **(Omae et al., 2023; José-García et al., 2023).**

Game-based data is also useful, as it captures how students think and respond in different situations. Their strategies and decision-making during gameplay can help measure problem-solving and critical thinking skills **(Marengo et al., 2025; Ramalingam et al., 2021).**

3.3 Psychometric and self-Assessment Data

Psychometric data focuses on how students view themselves. Surveys, questionnaires, and feedback forms are used to collect information about confidence, motivation, leadership, and personality traits. These insights are important because they highlight skills that are not visible through academic performance alone **(Ramalingam et al., 2021; Rana et al., 2023)**.

3.4 Textual and Professional Data

Textual data involves analyzing written content using Natural Language Processing (NLP). Documents such as resumes and Statements of Purpose (SOPs) can provide valuable information about a student's achievements, interests, and career goals. Similarly, job descriptions help in understanding current industry requirements. Systems like SkillRec use this information to

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compare student skills with job market needs and provide better career recommendations **(Ong & Lim, 2023; Akinleye et al., 2024).**

3.5 Experiential and Extracurricular Data

Experiential data comes from internships, projects, hackathons, and extracurricular activities. These experiences provide strong evidence of students' practical skills and readiness for real-world challenges. They also reflect important soft skills such as teamwork, leadership, adaptability, and communication, which are essential for professional success **(Rana et al., 2023; Hughey & Hughey, 1999).**

4 AI AND OTHER APPLIED TECHNIQUES

4.1 AI for Skill Prediction

Artificial Intelligence (AI) and Deep Learning (DL) play an important role in identifying hidden skills from large volumes of student data, such as academic records, behavioral data, and resumes. These technologies can analyze complex patterns and relationships that are not easily visible through traditional evaluation methods, making skill prediction more accurate and effective **(Roy et al., 2018; Zawacki-Richter et al., 2019).**

4.2 Machine Learning Classifiers

Machine learning classifiers are used to categorize student data and identify their strengths and potential career paths. By analyzing past performance and behavioral patterns, these models can predict areas where students are likely to perform well. For example, consistent participation in group activities may indicate strong teamwork skills. AutoML further improves this process by automatically detecting skill patterns across multiple courses and datasets **(Munir et al., 2022; Fan & Chiong, 2023)**.

4.3 Deep Learning and NLP

Deep learning models are useful for analyzing complex and unstructured data. They can identify relationships between student skills and job requirements. Systems like **SkillRec** use these techniques to match student profiles with suitable job roles **(Ong & Lim, 2023).**

Natural Language Processing (NLP) is also widely used to analyze resumes, essays, and other textual data. It helps in identifying hidden skills by understanding the meaning and context of

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written content, even when specific skills are not directly mentioned **(Roy et al., 2018; Akinleye et al., 2024).**

4.4 Game-Based Assessment (Assessment through games)

Game-Based Assessment (GBA) is an innovative method used to evaluate student skills through interactive games. It measures abilities such as problem-solving, decision-making, and critical thinking based on how students respond during gameplay. Since students behave naturally while playing, this method provides more realistic and reliable results **(Yi et al., 2018; Marengo et al., 2025).**

4.5 Explainable AI (XAI)

One of the main challenges in AI systems is the lack of transparency in decision-making. Explainable AI (XAI) addresses this issue by providing clear explanations for AI-generated results. For example, it can explain why a specific career path is recommended based on a student's skills and performance. This improves trust and acceptance among students and educators **(Guleria & Sood, 2023; Bearman et al., 2023).**

4.6 Generative AI

Generative AI tools provide personalized career guidance by interacting with students and analyzing their interests, skills, and goals. These systems can also suggest new skills that students should develop based on current job market trends. This helps in aligning student capabilities with industry requirements **(Akinleye et al., 2024; Kamalov & Gurrib, 2023; Shabur, 2024).**

5. LITERATURE REVIEW

Jonathan M. L. Kwok, Macy M. C. Wong, and Peggy M. L. Ng, in their paper titled ***"Don't Hide Our Students' Competencies: The Importance to Establish the Hidden Competence"***, emphasized the significance of recognizing both visible and hidden student competencies **(Kwok et al., 2016)**.The study highlights that while higher education institutions actively develop observable skills such as teamwork, communication, and technical knowledge, there are several underlying competencies—such as motivation, enthusiasm, professionalism, and self-confidence—that are not easily visible or quickly developed. The authors argue that these hidden competencies play a crucial role in long-term career success. Unlike technical skills, they require continuous personal development and supportive learning environments. The paper further

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suggests that educational institutions can foster these qualities by redesigning their curricula to promote holistic student development, ultimately supporting both academic and professional growth **(Kwok et al., 2016).**

The paper titled ***"Identifying, Developing and Grading 'Soft Skills' in Higher Education: A Technological Approach"***, presented by Adrian O'Connor, Jeffrey Buckley, and Niall Seery at the Higher Education in Transformation (HEIT) Conference in November 2016, focuses on the identification and assessment of students' soft skills in higher education **(O'Connor et al., 2016)**. The study emphasizes that essential competencies such as communication, teamwork, creativity, responsibility, and positive thinking are difficult to evaluate through traditional examinations or standard assessment methods.

To address this limitation, the authors propose a technological approach for identifying and assessing these hidden skills. The system combines multiple evaluation methods, including self-assessment, peer observation, and teacher evaluation, to provide a more balanced and comprehensive understanding of student capabilities. This integrated approach supports more effective skill development and helps enhance students' career readiness and overall professional growth **(O'Connor et al., 2016).**

The paper titled ***"Defining a Taxonomy of Employability Skills for 21st-Century Higher Education Graduates",*** presented by **Adriana Ornellas** at the 4th International Conference on Higher Education Advances (HEAd'18) in 2018, focuses on identifying key skills required for students to succeed in the modern workforce **(Ornellas, 2018)**. The study aims to support students in preparing for future career demands by systematically categorizing essential employability skills.

To develop this taxonomy, the author adopted two primary approaches: a comprehensive literature review and focus group discussions involving diverse stakeholders, including students, graduates, employers, lecturers, and consultants. Based on this analysis, the study identifies several categories of skills. These include cognitive skills such as analytical thinking, creativity, and problem-solving; methodological skills such as digital literacy, time management, and stress management; and social skills such as communication, teamwork, and conflict resolution. In addition, subject-specific technical skills are also considered important **(Ornellas, 2018).**

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This structured taxonomy provides a clear framework for understanding the range of competencies required in the 21st-century job market and helps students enhance their employability by developing a balanced set of skills **(Ornellas, 2018).**

The paper titled ***"Artificial Intelligence in Education: A Review",*** authored by Chen, Chen, and Lin (2020), provides a comprehensive overview of the role of Artificial Intelligence (AI) in the education sector **(Chen et al., 2020)**. The study highlights that AI is increasingly being applied in teaching, learning processes, and administrative functions within higher education institutions.

The authors emphasize that AI-based systems can analyze large volumes of student data to enhance learning experiences and provide personalized educational support. Techniques such as machine learning and learning analytics are used to understand students' academic performance, interests, and progress more effectively. These technologies also assist educators in identifying both high-performing and struggling students, enabling targeted interventions **(Chen et al., 2020).**

Furthermore, the study indicates that AI can identify patterns related to students' abilities and learning behaviors. However, it also points out a significant research gap, as limited attention has been given to identifying deeper hidden skills such as creativity, critical thinking, and problem-solving abilities. The authors suggest that further research is required to explore the potential of AI in uncovering these latent competencies in higher education **(Chen et al., 2020).**

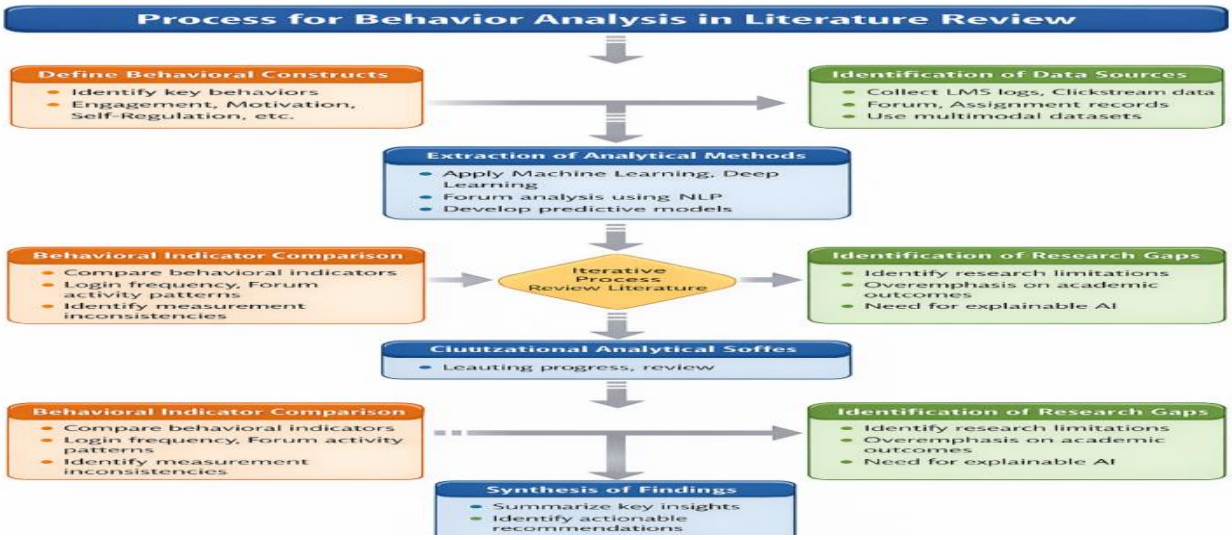

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Fig-1. Process for Behaviour Analysis in Literature Revie

The paper titled ***"Systematic Review of Research on Artificial Intelligence Applications in Higher Education: Where Are the Educators?",*** authored by **Zawacki-Richter et al. (2019)**, presents a comprehensive analysis of the growing use of Artificial Intelligence (AI) in higher education **(Zawacki-Richter et al., 2019)**. The study highlights that the adoption of AI technologies has increased significantly in recent years, contributing to improvements in the teaching–learning process through more efficient, effective, and personalized educational experiences.

The review identifies that AI applications in higher education are primarily focused on areas such as student profiling and prediction, assessment and evaluation, adaptive learning systems, and intelligent tutoring systems. Various machine learning and deep learning techniques, including Support Vector Machines, Decision Trees, Random Forests, and Neural Networks, are widely used to analyze student data. These techniques are effective in predicting academic performance and identifying underlying competencies, such as problem-solving and analytical skills **(Zawacki-Richter et al., 2019).**

However, the study also emphasizes important limitations in the existing literature. In particular, there is a lack of focus on pedagogical integration, as well as insufficient attention to ethical concerns such as data privacy, transparency, and algorithmic bias. The authors argue that future research should adopt a more human-centered approach to AI in education, ensuring that technological advancements align with educational values and ethical standards **(Zawacki-Richter et al., 2019).**

The paper titled ***"The Hidden Curriculum and the Development of Latent Skills: The Praxis",*** authored by **Winston Kwame Abroampa (2020)** and published in the *Journal of Curriculum and Teaching*, explores the role of the hidden curriculum in student development **(Abroampa, 2020)**. The study emphasizes that learning in educational institutions extends beyond formal academic content, encompassing influences such as teacher behavior, institutional culture, and the overall learning environment.The author highlights that these informal and often unstructured learning experiences contribute significantly to the development of latent skills.

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Such skills include creativity, social awareness, and other non-cognitive or affective competencies that are not explicitly assessed through traditional academic methods. The paper further suggests that the hidden curriculum plays a crucial role in fostering the holistic development of students, which can have long-term benefits for their personal and professional growth **(Abroampa, 2020).**

The study by Ramalingam et al. (2021), titled ***"A Hybrid Model to Profile and Evaluate Soft Skills of Computing Graduates for Employment,"*** published in the *International Journal of Advanced Computer Science and Applications (IJACSA)*, addresses the growing importance of soft skills in addition to technical competencies **(Ramalingam et al., 2021)**. The authors emphasize that skills such as teamwork, decision-making, integrity, and accountability play a critical role in employability, yet remain difficult to measure using conventional approaches.
Traditional evaluation methods, including interviews and self-assessments, are often limited in accurately capturing these competencies. Similarly, game-based assessment approaches, such as OWIWI, have shown potential but lack consistent validation in measuring true skill levels. To overcome these limitations, the study proposes a hybrid model that integrates multiple techniques, including traditional assessments, game-based methods, artificial intelligence, machine learning, neuro-fuzzy systems, and ranking models **(Ramalingam et al., 2021).**
This hybrid approach enables a comprehensive analysis of students' skill profiles and aligns them with job requirements. Furthermore, the model evaluates students' skills before and after internships, allowing for a better understanding of skill development and employability readiness. As a result, the proposed system supports more accurate identification of hidden skills and improves the alignment between student competencies and labor market demands **(Ramalingam et al., 2021).**

The study by **Xu and Ouyang (2022)**, titled ***"The Application of AI Technologies in STEM Education: A Systematic Review from 2011 to 2021,"*** published in the *International Journal of STEM Education*, examines the growing role of Artificial Intelligence (AI) in enhancing educational practices, particularly in STEM disciplines **(Xu & Ouyang, 2022)**. The authors highlight that AI technologies are increasingly being adopted to improve teaching and

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learning processes through access to real-time student data, enabling more informed instructional decisions and improved student outcomes.

The paper emphasizes that traditional educational approaches primarily focus on measurable outcomes such as test scores and grades, often overlooking the development of deeper student abilities. As a result, important competencies—such as communication skills, higher-order thinking, creativity, and positive learning behaviors—often remain unrecognized. The authors argue that these limitations prevent educators from gaining a comprehensive understanding of student potential **(Xu & Ouyang, 2022).**

To address this issue, the study suggests that AI-based systems, including machine learning models, assessment analytics, and intelligent tutoring systems, can help identify hidden talents and provide personalized learning experiences. These technologies enable adaptive content delivery based on individual student performance and learning needs. Furthermore, AI-driven assessment tools can automate evaluation processes, allowing for faster feedback and more timely support for students, particularly those at risk. Overall, the study demonstrates that AI has significant potential to move beyond traditional assessment methods and support a more holistic evaluation of student capabilities **(Xu & Ouyang, 2022).**

The study by **Rana et al. (2023)**, titled ***"A Novel Employability Embedding Framework for Three-Year Bachelor's Programs,"*** focuses on enhancing the employability and career readiness of undergraduate students in higher education **(Rana et al., 2023)**. The authors emphasize that, in addition to academic knowledge, transferable skills such as communication, teamwork, problem-solving, and self-reflection are essential for success in the contemporary job market.

The paper proposes a structured employability embedding framework that integrates skill development into the curriculum, assessment strategies, and the use of e-portfolios. This approach enables students to systematically develop and reflect on their competencies throughout their academic journey. The study also highlights the importance of reflective learning and e-portfolios in helping students understand their skills and build a strong professional identity, thereby supporting career development **(Rana et al., 2023).**

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However, despite its contributions, the study presents certain limitations. The framework primarily relies on manual evaluation and self-reflection, which can be subjective in nature. It does not incorporate advanced data-driven techniques for skill identification. In particular, there is a lack of integration of Artificial Intelligence (AI) and Deep Learning (DL) methods for predicting hidden skills based on academic and behavioral data. Therefore, a clear research gap exists in the development of intelligent, data-driven systems that can accurately identify latent skills and provide personalized career guidance for higher education students **(Rana et al., 2023).**

The study by **Guleria and Sood (2023)**, titled ***"Explainable AI and Machine Learning: Performance Evaluation and Explainability of Classifiers on Educational Data Mining Inspired Career Counselling,"*** published in *Education and Information Technologies*, focuses on developing an intelligent career counselling framework using Machine Learning (ML) and Explainable Artificial Intelligence (XAI) **(Guleria & Sood, 2023)**. The primary objective of the study is to assist students in making informed career decisions based on their abilities, academic performance, and interests. The authors utilize educational data, including academic scores, subject preferences, skills, and interests, to train and evaluate various machine learning models. The study compares different classification techniques, distinguishing between white-box models, such as Decision Trees, which are easily interpretable, and black-box models, such as Neural Networks, which are more complex and less transparent. To address the challenge of interpretability, XAI techniques are incorporated to provide clear explanations for model predictions, thereby improving trust and usability in career guidance systems **(Guleria & Sood, 2023).**

The findings indicate that the Naïve Bayes classifier demonstrates superior performance compared to other models in terms of accuracy. The study is based on the Kaggle dataset titled *Factors Affecting Campus Placement*, which consists of 215 records and 15 attributes. Furthermore, the research highlights the potential of Educational Data Mining (EDM) to uncover hidden patterns and latent skills, enabling more effective and data-driven career counselling for students **(Guleria & Sood, 2023).**

The study by **Ong and Lim (2023)**, titled ***"SkillRec: A Data-Driven Approach to Job Skill Recommendation for Career Insights,"*** presents an AI-based recommendation system

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designed to identify and suggest relevant job skills **(Ong & Lim, 2023)**. The proposed system, SkillRec, utilizes a large dataset comprising over 6,000 job titles and job descriptions to generate meaningful insights into market-required skills. The authors employ Natural Language Processing (NLP) techniques to create word and sentence embeddings from job-related textual data. These embeddings are then used to train a feed-forward neural network, enabling the system to recommend appropriate skill sets for specific job roles. The results demonstrate that the model achieves promising performance in terms of accuracy and F1-score, indicating its effectiveness in skill recommendation **(Ong & Lim, 2023)**.

The study highlights that skill mismatch is a significant challenge in the evolving job market, and AI-based recommender systems can play a crucial role in bridging this gap by providing data-driven career insights. Although the primary focus of this research is on recommending required job skills rather than identifying hidden skills, it contributes significantly to the field by supporting career enhancement and improving employability through intelligent skill alignment **(Ong & Lim, 2023)**.

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Recent literature highlights the growing importance of Artificial Intelligence (AI) in transforming the education sector **(Kamalov & Gurrib, 2023)**. The integration of AI technologies is significantly reshaping teaching, learning, and assessment practices. **(Kamalov & Gurrib, 2023)** note that the emergence of advanced AI models, such as ChatGPT, has

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accelerated the adoption of AI in education, demonstrating substantial potential in areas such as language processing, intelligent tutoring, and automated content generation.

The study further identifies several key applications of AI in education, including personalized learning systems, intelligent tutoring systems, automated assessment, and enhanced collaboration between educators and students. AI-powered personalized learning enables the customization of content and learning pace according to individual student needs, thereby improving engagement and academic outcomes. Intelligent tutoring systems provide real-time feedback and tailored guidance, while automated assessment tools reduce the workload of educators and enhance evaluation efficiency. Additionally, AI facilitates broader access to quality education by offering scalable and cost-effective learning solutions **(Kamalov & Gurrib, 2023)**

However, the literature also highlights several challenges associated with AI integration in education. Key concerns include data privacy, algorithmic bias, issues related to academic integrity, and the evolving dynamics of the teacher–student relationship. Overall, while AI presents significant opportunities to improve educational practices, its effective implementation requires careful consideration of ethical implications and the promotion of AI literacy among stakeholders **(Kamalov & Gurrib, 2023)**

The paper titled ***"SUNFIT: A Machine Learning-Based Sustainable University Field Training Framework for Higher Education"***, authored by **Gollapalli et al. (2023)** and published in *Sustainability (MDPI)*, emphasizes that identifying students' hidden skills has become increasingly important in higher education **(Gollapalli et al., 2023)**. While academic performance can be measured through examinations and grades, hidden skills such as communication, teamwork, leadership, creativity, and problem-solving are more difficult to identify using traditional assessment methods.

The study explains that many existing machine learning models, including Naïve Bayes, J48, and Support Vector Machines (SVM), primarily focus on predicting academic performance rather than identifying hidden competencies. Although the SUNFIT framework evaluates field training and rubric-based assessments, its primary objective is to improve curriculum quality rather than detect latent student skills. The authors suggest that Artificial Intelligence (AI) and Deep

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Learning (DL) techniques have the potential to identify hidden talents by analyzing data from student projects, presentations, attendance, and behavioral activities **(Gollapalli et al., 2023)**

The study by **Fan and Chiong (2023)**, titled ***"Identifying Digital Capabilities in University Courses: An Automated Machine Learning Approach,"*** addresses the growing importance of digital competencies in higher education **(Fan & Chiong, 2023)**. In the contemporary academic and professional landscape, digital capabilities—such as data literacy, analytical skills, and technological proficiency—are essential for student success. However, given the large number of courses offered by universities, manually evaluating each course for the presence of such skills is both time-consuming and impractical.

To address this challenge, the study proposes an automated machine learning approach to analyze course rubrics, which outline course content and assessment criteria. The researchers employ the Term Frequency–Inverse Document Frequency (TF-IDF) technique to convert textual data into numerical representations suitable for computational analysis. By identifying relevant keywords such as *analysis*, *research*, and *statistics*, the system detects the presence of digital skill components within course structures **(Fan & Chiong, 2023).**

The study evaluates multiple machine learning models and finds that the Support Vector Machine (SVM) algorithm achieves the highest performance, with an accuracy exceeding 85%. The proposed system enables academic institutions to efficiently assess and improve curriculum design by identifying gaps in digital skill development. Additionally, it assists students in selecting courses that enhance their technical competencies, thereby supporting their future career readiness **(Fan & Chiong, 2023).**

The study by **Bearman et al. (2023)**, titled ***"Discourses of Artificial Intelligence in Higher Education: A Critical Literature Review,"*** provides a comprehensive critique of the growing integration of Artificial Intelligence (AI) in higher education **(Bearman et al., 2023)**. The paper highlights that AI is becoming increasingly prominent across academic institutions, particularly in areas such as learning analytics, automated grading, intelligent tutoring systems, and decision support systems. These applications are primarily aimed at enhancing efficiency, personalizing learning experiences, and improving overall educational outcomes.

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However, the study adopts a critical perspective, arguing that AI is not a neutral or purely objective tool. Instead, it is embedded within broader social, political, and economic contexts that often prioritize efficiency, performance, and market-driven values. As a result, there is a risk that AI may be implemented without sufficient consideration of pedagogical principles, potentially marginalizing human-centered approaches to education. The paper also identifies several key concerns, including data privacy, surveillance, algorithmic bias, lack of transparency, and the increasing commodification of education. Furthermore, the growing reliance on AI raises questions about its impact on teachers' professional autonomy and decision-making **(Bearman et al., 2023)** At the same time, the study acknowledges that AI has the potential to expand access to education and support more flexible and inclusive learning environments, provided it is implemented responsibly. The authors emphasize the importance of ethical AI practices, the development of AI literacy among stakeholders, and active engagement in the design and deployment of AI systems in education **(Bearman et al., 2023)**

The study by **Shabur (2024)**, titled ***"The Potential and Implications of Artificial Intelligence in Bangladesh's Early Career Planning Education,"*** explores the transformative role of Artificial Intelligence (AI) in supporting students' career development **(Shabur, 2024)**. The paper highlights that AI techniques, including Machine Learning (ML), Natural Language Processing (NLP), and Deep Learning (DL), can analyze diverse data sources such as academic records, personal interests, and behavioral patterns to provide personalized career guidance.

The study emphasizes that AI-driven systems are capable of identifying not only technical competencies but also social and emotional skills, often referred to as soft skills. Through predictive modeling and career forecasting, these systems can uncover hidden talents and identify skill gaps, thereby assisting students in making informed career decisions aligned with their abilities and market demands **(Shabur, 2024).**

However, the paper also acknowledges several challenges associated with the implementation of AI in career planning. These include factors related to cognitive development, parental influence, cultural context, and ethical concerns such as data privacy and fairness. Despite these challenges, the study concludes that AI-based platforms have significant potential to support students in areas such as career exploration, interview preparation, and job-market alignment. Overall, the research

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demonstrates that AI can play a vital role in identifying hidden skills and enhancing career readiness in higher education **(Shabur, 2024)**

The study by **Akinleye et al. (2024)**, titled ***"Using Generative AI to Provide Personalized Career Advice and Skills Mapping,"*** examines the role of generative Artificial Intelligence (AI) in enhancing career counselling and skill development **(Akinleye et al., 2024)**. The paper highlights the limitations of traditional career guidance approaches, which often provide generalized recommendations without adequately considering individual differences in students' abilities, interests, and goals.

The authors explain that earlier advancements in Artificial Intelligence (AI) and Machine Learning (ML) enabled the analysis of student data to generate more tailored career suggestions. With the emergence of generative AI technologies, such as ChatGPT, career counselling systems have become more interactive and personalized. These systems not only recommend suitable career paths but also identify skill gaps and suggest relevant training programs or courses to address them. As a result, students are better supported in making informed decisions and are encouraged to develop new competencies aligned with market demands, leading to improved career satisfaction **(Akinleye et al., 2024).**

The study is based on the integration of multiple data sources rather than a specific dataset. These include user input data (such as education, experience, interests, and career goals), labor market information (including job trends, job postings from platforms such as LinkedIn and Indeed, and databases like O*NET and NSDC reports), and feedback mechanisms that allow continuous updates based on user interaction **(Akinleye et al., 2024)** Despite its advantages, the paper also highlights several challenges associated with the use of generative AI, including concerns related to data privacy, potential algorithmic bias, and the need to ensure equitable access to such technologies. Overall, the study demonstrates that generative AI has significant potential to transform career guidance by providing more personalized, data-driven, and adaptive solutions **(Akinleye et al., 2024)**

The study by **Alamgir et al. (2024)**, titled ***"Enhancing Student Performance Prediction via Educational Data Mining on Academic Data,"*** investigates the application of educational data mining techniques to predict student performance in higher education **(Alamgir et al.,**

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2024). The research is based on an extensive dataset comprising 15 years of academic records of computer science students.

The findings indicate that grades obtained during the first four semesters serve as strong predictors of a student's final cumulative grade point average (CGPA). The authors employ the Random Forest algorithm, a robust machine learning technique, to analyze patterns in student performance data. The model demonstrates high accuracy in identifying trends and predicting future academic outcomes, thereby enabling early identification of students who may require additional academic support **(Alamgir et al., 2024)**

This study is particularly relevant to research on hidden skills and career development, as it highlights the predictive value of early academic performance. Specifically, strong performance in foundational subjects such as programming and data structures is shown to be indicative of success in more advanced courses, including software engineering. These findings suggest that AI-driven approaches can be effectively used to identify students' technical strengths at an early stage, thereby supporting informed career decision-making and long-term skill development **(Alamgir et al., 2024).**

6. STATISTICAL OVERVIEW OF REVIEWED STUDIES

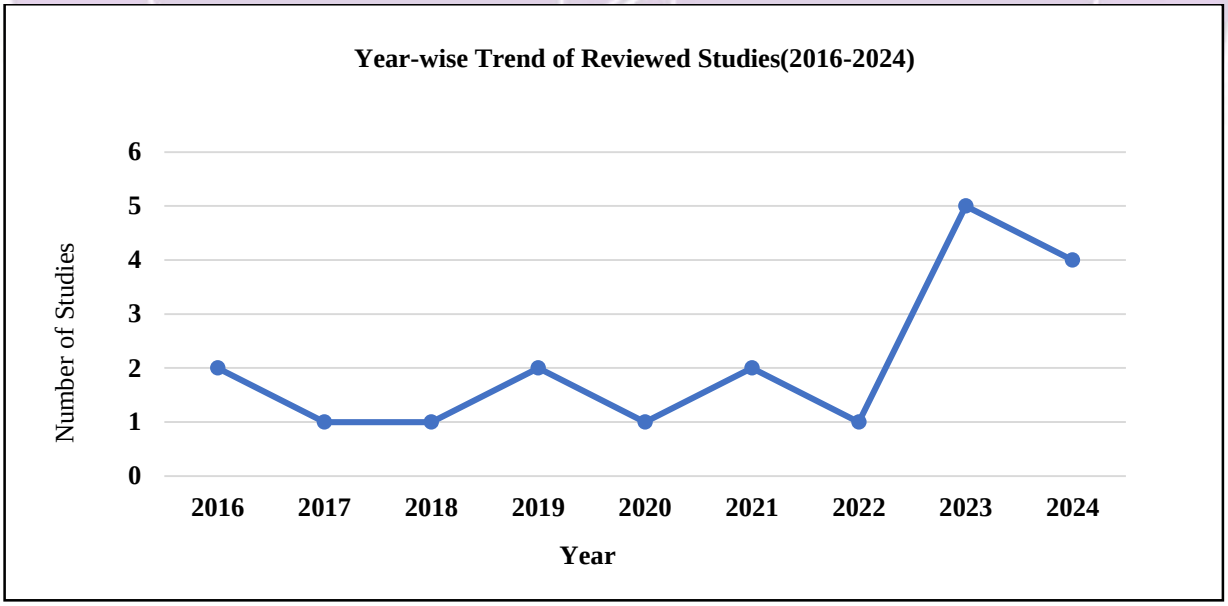

Fig. 2. Year-wise distribution of selected studies (2016–2024) highlighting the recent growth in AI-based hidden skill research.

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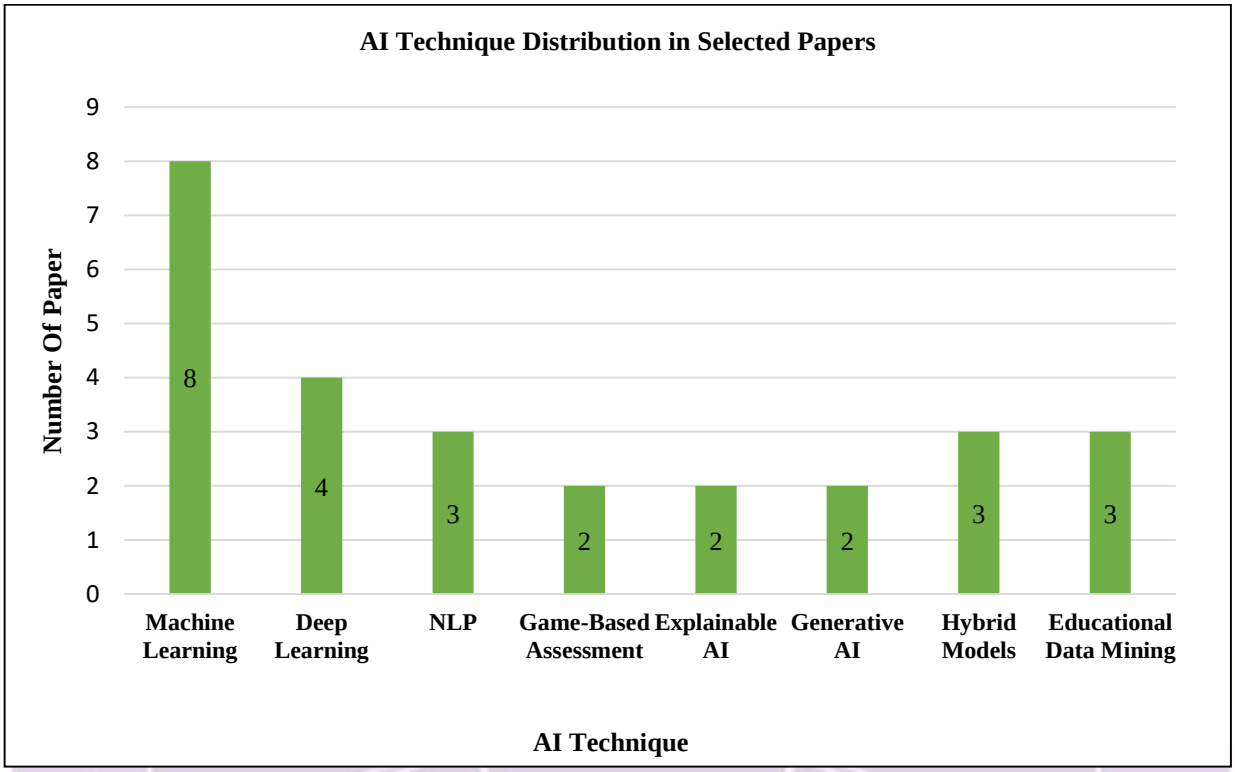

Fig. 3. Distribution of Artificial Intelligence techniques applied in the reviewed literature for hidden skill prediction and career guidance.

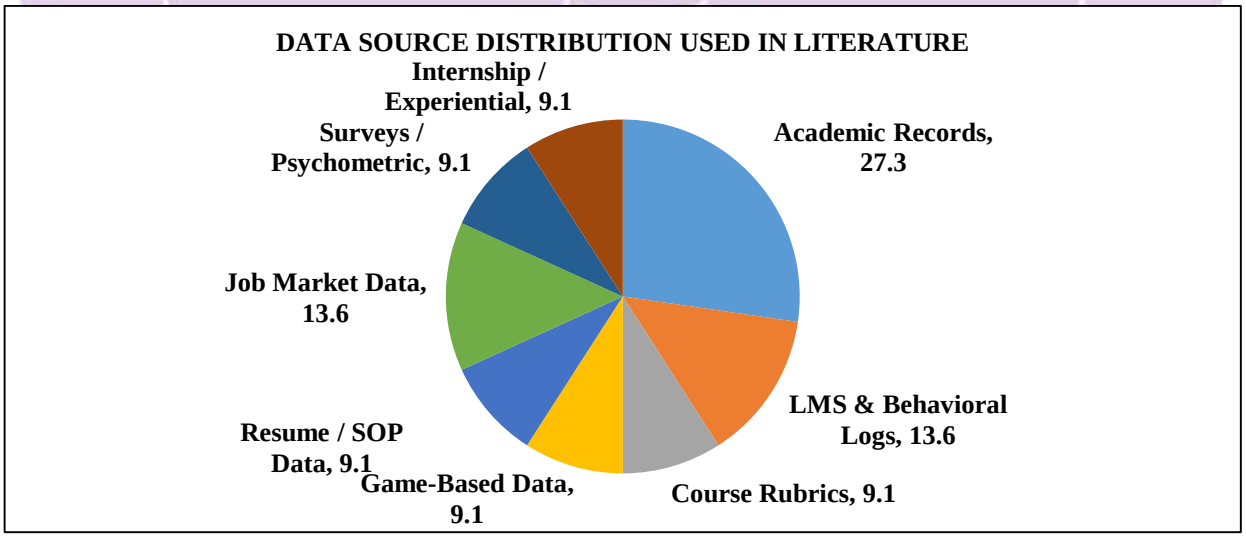

Fig. 4. Distribution of data sources utilized in the selected studies for AI-driven hidden skill identification.

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7. METHODOLOGY

The purpose of this review paper is to investigate current methods for identifying students' hidden skills using Artificial Intelligence (AI) and Deep Learning (DL) in higher education. A systematic review methodology was adopted to ensure a structured and comprehensive analysis of existing literature.

7.1 Identification

A comprehensive literature search was conducted across major academic databases, including IEEE Xplore, Scopus, Web of Science, and Google Scholar. Additional records were identified through ResearchGate and citation tracking. Keywords such as *"hidden skills," "AI in education," "career guidance systems,"* and *"educational data mining"* were used. Approximately 250 records were initially retrieved from these sources.

7.2 Screening

Duplicate records were removed, and the remaining studies were screened based on titles and abstracts. Studies that were not relevant to Artificial Intelligence applications in hidden skill identification, career guidance, or higher education were excluded at this stage.

7.3 Eligibility

The full text of the shortlisted articles was reviewed to assess their eligibility. Studies were included if they focused on AI, Machine Learning (ML), or Deep Learning (DL) techniques for skill prediction, employability enhancement, or hidden competency identification. Studies were excluded if they lacked a clear AI-based methodology, focused solely on general academic performance prediction, or were not aligned with recent technological developments.

7.4 Included Studies

After the eligibility assessment, a total of 18 relevant studies were selected for qualitative analysis. These studies formed the basis for identifying key trends, methodologies, research gaps, and future directions in AI-based hidden skill prediction.

8. CAREER ENHANCEMENT AND SKILL RECOMMENDATION SYSTEMS

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AI-based career enhancement systems are increasingly being used to bridge the gap between students' skills and industry expectations. These systems combine skill prediction techniques with labor market intelligence to provide more meaningful and personalized career guidance. In simple terms, such systems analyze a student's academic performance, interests, and behavioral data, and then compare this information with current job market requirements. Based on this analysis, they can offer **tailored career suggestions**, helping students choose paths that align with their abilities and goals. At the same time, they identify **skill gaps**, allowing students to understand what competencies they need to develop further.

Another important feature of these systems is their ability to recommend **relevant courses, certifications, and training programs** that can help students improve their profiles. Additionally, they can suggest suitable **internships or job roles**, ensuring a better match between a student's capabilities and industry needs. Recent advancements have made these systems more dynamic and accurate. Modern approaches often use **hybrid models**, which combine Machine Learning (ML), Deep Learning (DL), and recommender systems. This integration enables continuous updating of recommendations based on both student progress and evolving labor market trends.

Overall, AI-driven career enhancement and skill recommendation systems play a significant role in supporting students' professional development by providing data-driven, personalized, and adaptive career guidance.

9. RESEARCH GAP

Despite significant advancements in Artificial Intelligence (AI) in higher education, several important gaps remain. Most existing educational systems and AI-based tools primarily focus on measurable factors such as academic performance, grades, and technical skills **(Chen et al., 2020; Zawacki-Richter et al., 2019)**. While these indicators are useful, they do not fully capture a student's overall potential. Critical non-cognitive attributes—such as motivation, creativity, confidence, professionalism, and attitude—commonly referred to as *hidden skills*—are not effectively identified or measured **(Abroampa, 2020; Kwok et al., 2016; Ramalingam et al., 2021).** Although methods such as self-assessment and peer evaluation have been used to assess these skills, they are often subjective and lack consistency

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(O'Connor et al., 2016; Ramalingam et al., 2021). Furthermore, the concept of the **hidden curriculum**, which includes the influence of institutional culture, learning environment, and informal learning experiences, plays a significant role in shaping these competencies but is not adequately integrated into AI-based systems or formal educational frameworks **(Abroampa, 2020).** In addition, most AI-driven career guidance systems focus on matching existing skills with job requirements rather than identifying latent abilities or predicting future potential. These systems rely heavily on structured academic data while overlooking behavioral, social, and experiential factors **(Ong & Lim, 2023; José-García et al., 2023; Akinleye et al., 2024).**

Therefore, there is a need to develop more comprehensive, data-driven, and human-centered AI frameworks that integrate multiple sources of information—including academic, behavioral, psychometric, and experiential data—to accurately identify hidden skills and provide more effective, transparent, and personalized career guidance in higher education **(Bearman et al., 2023; Guleria & Sood, 2023; Shabur, 2024).**

10. FUTURE DIRECTIONS

1. Integration of **federated learning** techniques to ensure data privacy and secure handling of sensitive student information
2. Development of **multimodal deep learning frameworks** to combine academic, behavioral, and contextual data for comprehensive skill analysis
3. Design of **bias-aware and fairness-driven AI models** to ensure equitable and unbiased outcomes across diverse student populations
4. Conducting **cross-cultural and longitudinal validation studies** to assess the reliability and generalizability of AI-based systems over time
5. Implementation of **real-time skill monitoring systems** to support continuous learning and lifelong career guidance
6. Establishment of **ethical governance frameworks and explainable AI (XAI) standards** to enhance transparency, accountability, and trust
7. Integration of **hidden curriculum elements**, such as institutional culture and informal learning, into AI-based models for better identification of hidden skills

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8. Development of **holistic and human-centered frameworks** that incorporate both cognitive and affective domains of student learning
9. Utilization of **multi-source data**, including academic, behavioral, and experiential information, for accurate and comprehensive skill prediction
10. Strengthening **industry-academia collaboration** to align AI-driven systems with real-world job market requirements and enhance employability

11. CONCLUSION

This review paper shows how Artificial Intelligence (AI) and Deep Learning (DL) are becoming important tools for identifying students' hidden skills, especially for career development in higher education. By using different types of data and advanced technologies, these systems can go beyond traditional methods and help uncover abilities that are not visible through exams or grades.

At the same time, there are still some challenges that need attention. Issues such as data privacy, fairness, and the lack of transparency in complex AI models must be handled carefully. If these concerns are not addressed properly, they can affect the reliability and trust in such systems.

Therefore, it is important to design AI systems in a responsible and human-centered way. Collaboration between educators, researchers, and industry experts can further improve these systems and make them more useful in real-world situations. Overall, AI has strong potential to improve employability and support students in their career growth, especially when it is used in a fair, ethical, and thoughtful manner.

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