

Beyond Traditional Pathways: Leveraging Generative AI for Dynamic Career Planning in Vocational Education

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Abstract: This paper investigates the transformative impact of generative artificial intelligence (AI) on vocational education career planning, transitioning from traditional methodologies to personalized, dynamic strategies. By leveraging Natural Language Processing (NLP) and Machine Learning (ML), it delves into how generative AI can provide tailored career guidance, adaptive learning pathways, and labor market insights, underpinned by constructivist learning theory and career development models. The study's methodology blends theoretical analysis with practical implementation, focusing on strategic planning, stakeholder engagement, technology customization, and ethical considerations. It discusses the implications for educators, students, and institutions, emphasizing the necessity for continuous adaptation and innovation in the face of technological advancements. Additionally, the paper identifies future research avenues, including the long-term impact of AI on employment outcomes, its scalability across vocational disciplines, and ethical challenges, advocating for the strategic employment of generative AI to align vocational education more closely with the evolving job market and enhance students' readiness for future careers.

Keywords: Generative AI; Vocational Education; Career Planning; Personalized Guidance; Technological Integration

1. Introduction

In the domain of vocational education, the paradigm of career planning has historically manifested as a structured and albeit static procedure^[1,2]. This traditional model is predominantly characterized by generalized advisories and pathways, designed to serve the collective rather than to accommodate the nuances of individual aspirations^[3]. While these conventional frameworks provide a foundational basis, they increasingly demonstrate limitations in an era characterized by rapid evolution in the job market, propelled by technological innovation and shifting economic paradigms^[4]. The burgeoning demand for dynamic, personalized career guidance is more evident than ever, as students endeavor to decipher this complexity and synchronize their vocational training with the actualities of contemporary job opportunities and requirements^[5].

The conventional methodologies of career planning within the sphere of vocational education have frequently encountered constraints in addressing the multifaceted needs, ambitions, and backgrounds of students comprehensively^[6]. The prevailing "one-size-fits-all" strategy seldom considers the individual learning preferences, career aspirations, and the intricate details of both local and global employment markets^[7]. Consequently, students may emerge inadequately equipped for the workforce's realities, encountering career guidance that is deficient in flexibility to accommodate unique trajectories and the swiftly transforming landscape of employment^[8,9].

Against this backdrop, the advent of generative artificial intelligence (AI) technologies, such as ChatGPT, Claude, Bard, and others, heralds a significant paradigm shift in the potential for customized education and career planning^[10]. These AI models, endowed with the ability to analyze extensive datasets and generate context-sensitive content, unveil unparalleled opportunities for tailoring career guidance to meet the individual requirements of students^[11]. Leveraging these technologies, vocational education can transition from generalized career advisories to highly personalized guidance, dynamically realigning educational courses with the job market's evolving dynamics^[12].

This paper endeavors to elucidate the transformative influence of generative AI in augmenting career planning and guidance within the realm of vocational education. It aims to delineate how these sophisticated technologies can be utilized to furnish students with customized career advice, insights into nascent industry trends, and bespoke educational trajectories that equip them for the future's work landscape. The imperative of integrating generative AI into vocational education systems is profoundly significant, promising to redefine the manner in which students prepare for their careers—ensuring their educational experiences remain not only pertinent but also resilient amidst the fluxes shaping the global economy.

This paper provides an in-depth examination of the role of generative AI in the realm of vocational education career planning. After the introductory segment, it proceeds with a literature review in Section 2, analyzing both traditional and AI-enhanced career planning methods. Section 3 discusses the methodology of this study, detailing the research design and the integration of generative AI into career planning through theoretical and practical lenses. Section 4 focuses on translating theoretical frameworks into real-world applications of generative AI in vocational education. Finally, Section 5 summarizes the research findings, discusses the implications for vocational education, and concludes with recommendations for future research in this dynamic and evolving field.

2. Literature Review

The evolution of career guidance within the realm of vocational education signifies a pivotal transition from generalized, uniform methodologies to more nuanced, individual-focused strategies^[13]. Historically, career guidance was largely homogenized, dispensing broad-based advisories intended to cater to the median requirements of the student populace. While this approach facilitated efficient dissemination of information across large cohorts, it frequently neglected the distinct ambitions, capabilities, and contexts of individual learners^[14]. Progressively, with the advancements in educational psychology and pedagogical practices, there has been an increasing acknowledgment of the necessity for bespoke career guidance^[15]. Present-day methodologies underscore the significance of individual assessments, career coaching, and the formulation of personalized learning agendas^[16,17]. These strategies endeavor to synchronize educational and career trajectories with the personal interests, proficiencies, and prospective goals of each student, thereby engendering more impactful and efficacious career preparation.

Generative AI, especially through technologies like Natural Language Processing (NLP) and Machine Learning (ML) models, has become a fundamental driver of innovation within educational paradigms^[18]. NLP facilitates computational systems to comprehend, interpret, and produce human language in a manner that is both significant and contextually pertinent^[19]. Concurrently, ML models, through data learning, are capable of making predictions or generating content specifically tailored to the user's requisites^[20]. Within the educational sphere, these technologies are employed to devise personalized learning materials, adaptive learning platforms, and intelligent tutoring systems. Generative AI's capability to analyze extensive datasets for identifying learning patterns, foreseeing educational requirements, and crafting customized content and recommendations underpins a more individualized learning experience^[21].

The deployment of AI in educational frameworks spans across personalized learning environments, adaptive learning systems, to AI-driven career counseling tools^[22,23]. Personalized learning environments employ AI to customize content and pedagogical strategies to the learner's distinct needs, preferences, and pace of learning^[24,25]. Adaptive learning systems utilize AI algorithms to dynamically adjust the complexity of learning activities based on the learner's performance and engagement levels^[26]. AI-driven career counseling tools, alternatively, provide tailored career advice, recommend educational pathways, and assist students in navigating future job landscapes based on their interests and skills^[27]. These implementations exemplify AI's capacity to revolutionize educational practices by rendering learning more adaptive, engaging, and congruent with individual career aspirations.

Despite the extensive application of AI within educational settings, the review of existing literature uncovers a notable deficiency in exhaustive studies on the application of generative AI for dynamic career planning in vocational education. Although there is substantial research on AI's educational applications, investigations specifically targeting its impact on augmenting vocational career guidance remain scarce. This lacuna accentuates the imperative for further research to examine how generative AI can be efficaciously harnessed to innovate career planning and guidance services in vocational education, ensuring they are more personalized, adaptive, and anticipatory.

3. Implementation of Generative AI in Career Planning

3.1. Methodology

Within the expansive discourse on the integration of generative AI into the career planning processes of vocational education, delineating the methodological framework guiding this inquiry is paramount. This section elaborates on the theoretical foundations and analytical perspectives employed to assess the prospective applications and implications of generative AI technologies in this domain.

The investigation into the role of generative AI within career planning is rooted in several foundational theoretical constructs. Primarily, the principles of constructivist learning theory are invoked, advocating the notion that learners actively construct knowledge through engagements and interactions within their environment. This perspective highlights the criticality of tailored learning experiences—central to the offerings of generative AI—in enriching the educational and career planning endeavors. Moreover, career development theories such as Super's life-span, life-space theory, and Holland's theory of vocational choices, serve as frameworks to explore how AI-facilitated insights and advisories can aid individuals in steering their career trajectories in harmony with their personal interests, competencies, and values^[28].

The analytical assessment of generative AI's utility in career planning adopts a multifaceted approach, examining both the technological prowess of AI systems and their educational ramifications. This encompasses a meticulous review of generative AI's extant deployments within educational contexts, with a focus on its contributions to individualized career guidance, adaptive learning trajectories, and the augmentation of decision-making processes for vocational students.

This methodological stance facilitates an exhaustive exploration of both the opportunities and challenges presented by the adoption of generative AI in the career planning mechanisms of vocational education. By melding theoretical insights with empirical practices, this analysis strives to furnish a detailed comprehension of the efficacies and modalities through which generative AI can be seamlessly integrated to bolster dynamic and individualized career planning for vocational learners.

3.2. Integration of Generative AI Technologies in Vocational Career Planning

The introduction of generative AI technologies, notably Natural Language Processing (NLP) and Machine Learning (ML), marks a significant stride forward in the sphere of vocational education and career planning. These technologies lay the groundwork for the creation of systems that provide detailed, personalized guidance by harnessing extensive datasets to produce actionable insights. This subsection lays the foundation for understanding the pivotal role that NLP and ML play in enabling the transformative applications discussed later, emphasizing the technological capabilities and theoretical integration without delving into specific applications prematurely.

3.2.1. The Role of Natural Language Processing (NLP)

NLP stands at the forefront of developing interfaces that enable a level of human-like interaction within career advising systems that was previously unfeasible on a large scale. Its ability to interpret, understand, and generate language in response to user inputs facilitates personalized communication that significantly enhances the advising process. The utility of NLP extends beyond mere language translation, diving into the intricate tasks of interpreting complex queries and generating contextual advice. By analyzing the nuances of student inquiries, NLP technologies adeptly discern intent and contextual nuances, paving the way for a customized dialogue that closely simulates human interaction. Furthermore, through the interpretative prowess of NLP, AI systems are equipped to provide advice that is deeply resonant with the individual's unique circumstances, aspirations, and queries, thereby elevating the quality of career guidance offered.

3.2.2. The Impact of Machine Learning (ML)

ML emerges as a foundational element in the realm of predictive analytics and customization within career planning. By analyzing trends within extensive datasets encompassing labor market and educational information, ML's predictive functions play a crucial role. It facilitates the identification of emerging trends and personalizes educational pathways by continuously analyzing student performance and preferences. This ability to sift through labor market data allows for the anticipation of future industry demands, thus directing students towards sustainable and burgeoning career opportunities. Concurrently, ML algorithms enhance the personalization of educational recommendations, ensuring that learning

pathways are in congruence with both individual career ambitions and the evolving requirements of the job market.

The integration of NLP and ML into career planning transcends a mere technological upgrade; it is deeply intertwined with educational and career development theories. These technologies actualize the principles of constructivist learning and the frameworks of career development by facilitating dynamic, personalized learning and guidance experiences. This amalgamation of technology and theory fosters systems that assist students in navigating their educational and career journeys through interactive and adaptive engagement with AI-driven platforms.

Having delineated the foundational roles of NLP and ML in enriching vocational career planning, the ensuing discussion naturally transitions to the specific applications and models these advancements enable. The subsequent section ventures into the practical implementation of these generative AI technologies, showcasing their transformative effect on personalized career guidance systems, adaptive learning pathways, analysis tools for market trends, and enhanced platforms for career discovery. Through these applications, vocational students gain access to a level of personalized planning and exploration that was previously beyond reach, exemplifying the practical application of the theoretical frameworks previously discussed.

3.3. Potential Applications and Models of Generative AI in Career Planning

The deployment of generative AI within the career planning frameworks of vocational education heralds a broad spectrum of innovative applications and models. These advancements not only transform the manner in which students navigate their career development but also furnish educators with novel methodologies to facilitate this journey. This section delves into the specific applications and models through which NLP and ML technologies engender a dynamic and personalized career planning process.

3.3.1. Personalized Career Guidance Systems

Generative AI has catalyzed the development of advanced career guidance systems, which are accessible ubiquitously. Utilizing NLP, these systems facilitate natural and intuitive user interactions, while ML algorithms undertake a deep, analytical processing of user data alongside labor market trends. The implications and advantages of such systems include:

Dynamic Interaction and Support: NLP enables AI career advisors to engage in meaningful, context-sensitive dialogues with students, mirroring the nuanced consultations a human counselor would offer. This process permits an in-depth exploration of each student's career aspirations, strengths, and developmental needs, tailoring the guidance provided to each student's unique circumstances.

Bespoke Educational and Career Pathways: By analyzing a blend of individual student data—ranging from academic achievements and extracurricular interests to personal preferences—and external data on labor market trends and projections, ML algorithms generate highly personalized recommendations. These recommendations guide students towards vocational programs and potential career paths that align closely with their distinct profiles.

3.3.2. Adaptive Learning Pathways

Adaptive learning pathways, augmented by generative AI, mark a significant evolution towards customized educational experiences. These pathways adapt in real-time to students' changing interests, career ambitions, and academic progress, benefit from ML's capability for continuous data analysis:

Customization at Scale: Leveraging data from student interactions, performance metrics, and feedback, ML algorithms inform adaptive learning systems, recommending courses, certifications, and workshops that correlate with the student's evolving career focus and market demands.

Feedback and Forecasting: Generative AI systems offer ongoing feedback on students' progression towards their career objectives, integrating insights into current and future industry requirements. This approach assists students in making well-informed decisions regarding their education and career paths, priming them for success in their chosen fields.

3.3.3. Market Trend Analysis Tools

Generative AI also underpins the creation of sophisticated market trend analysis tools that provide real-time, data-driven insights into the job market. Powered by ML, these tools scrutinize patterns and forecast future industry needs, equipping students with actionable intelligence on burgeoning career opportunities:

Real-Time Labor Insights: By synthesizing data from diverse sources, including job postings and

economic forecasts, AI-driven tools pinpoint rapidly expanding sectors and roles. This information enables students to tailor their vocational training and career aspirations to meet market demands, thereby enhancing their marketability.

Skill Alignment and Gap Identification: Furthermore, these tools aid students and educators in pinpointing the skills and qualifications in highest demand within target industries. Identifying skills gaps allows students to concentrate their learning on areas that significantly enhance their career prospects.

3.3.4. Enhanced Career Discovery Platforms

AI-powered career discovery platforms provide an immersive exploration experience, allowing students to virtually delve into various vocational paths. These platforms use generative AI to simulate real-world career scenarios, offering a rich, interactive learning environment:

Immersive Exploration: Through detailed simulations and interactive content, students acquire a deeper understanding of diverse professions, grasping the day-to-day duties and challenges of various roles. This experiential learning process empowers students to make well-rounded decisions regarding their career trajectories.

Scenario-Based Learning and Decision Making: Presenting students with realistic career scenarios and decision-making exercises, these platforms facilitate an evaluation of students' responses and choices in professional contexts. This preparation not only aids in career decision-making but also readies students for the workplace's complexities and dynamics.

In summary, the integration of generative AI into the career planning mechanisms of vocational education constitutes a paradigmatic shift. By leveraging the capabilities of NLP and ML, educational institutions can provide a highly personalized, interactive, and informed career planning experience. This not only amplifies the student's capacity for making enlightened decisions about their future but also ensures that vocational education remains tightly coupled with the dynamic demands of the global job market.

4. From Theoretical Models to Real-World Integration

Transitioning from the theoretical foundations to the tangible integration of generative AI in vocational education's career planning necessitates a comprehensive understanding of both the capabilities of generative AI technologies and the distinctive requirements of vocational education students. Section 4 endeavors to bridge the conceptual with the practical by outlining actionable strategies for the real-world application of generative AI, aiming to bolster vocational career planning and guidance effectively.

The journey from theoretical models to their practical enactment involves a meticulous process that begins with strategic implementation planning. Developing a comprehensive strategy that is in harmony with the educational institution's objectives, caters to the specific needs of vocational students, and leverages the capabilities of generative AI technologies is paramount. This strategy should delineate clear goals, establish timelines, and define metrics for success to ensure a structured and coherent approach to the integration of AI. Such planning is critical for setting a clear direction and providing a roadmap for the effective employment of AI tools within the career planning framework.

Strategic Implementation Planning: The integration of generative AI into vocational education's career planning processes necessitates a multifaceted strategy that harmonizes with the educational institution's overarching objectives, addresses the distinct needs of vocational students, and leverages the full spectrum of generative AI capabilities. This strategy forms the cornerstone of a structured approach to AI integration, demanding the articulation of clear objectives, the establishment of precise timelines, and the identification of metrics for success to gauge the effectiveness of AI deployment.

Technology Selection and Customization: In the realm of technology selection and customization, insights derived from the exploration of NLP and ML technologies in Section 3 underscore the imperative for educational institutions to meticulously choose and tailor AI technologies. This customization process should focus on enhancing personalized interaction, developing adaptive learning pathways, and performing comprehensive labor market analysis to meet the specific career guidance needs of vocational students. The goal is to ensure that AI systems are not merely adopted but are intricately adapted to enrich the vocational career planning landscape.

Stakeholder Engagement and Training: The successful integration of generative AI technologies into vocational career planning hinges on the active engagement and training of key stakeholders, including educators, students, and industry partners. This entails equipping educators with the necessary training and resources to proficiently utilize AI tools in career planning endeavors, as well as

familiarizing students with the mechanisms of interacting with and deriving maximal benefit from AI-driven career guidance systems. Such efforts are instrumental in fostering widespread adoption and optimizing the utility of AI in vocational education.

Ethical and Privacy Considerations: Ethical and privacy considerations form an integral aspect of deploying generative AI solutions in career planning. Institutions are obligated to adhere rigorously to ethical standards and privacy regulations, necessitating the formulation of transparent data usage policies, ensuring the unbiased functionality of AI systems, and safeguarding sensitive student information. These measures are critical for cultivating and maintaining trust in AI-driven career planning tools, underscoring the institution's commitment to ethical integrity and the protection of student privacy.

In sum, the strategic integration of generative AI into vocational career planning encompasses a comprehensive planning phase, judicious technology selection and customization, concerted stakeholder engagement and training, alongside unwavering attention to ethical and privacy concerns. This holistic approach ensures that the deployment of AI technologies not only aligns with institutional goals and student needs but also adheres to the highest standards of ethical practice and data protection.

5. Conclusions

This paper has undertaken an in-depth exploration into the transformative impact of generative artificial intelligence (AI) on the career planning processes within vocational education. It illuminates the paradigm shift from traditional, generalized guidance methodologies to a more dynamic, personalized approach to career planning, enabled by the advancements in AI technologies. Through a meticulous literature review, an analytical examination of methodologies, and a discourse on practical implementations, this study has uncovered the complex role generative AI plays in refining career guidance and planning for vocational students.

Our analysis demonstrates that generative AI, particularly through applications of Natural Language Processing (NLP) and Machine Learning (ML), presents unparalleled opportunities for crafting personalized career guidance frameworks. These cutting-edge technologies facilitate the creation of systems capable of delivering bespoke advice, formulating adaptive learning pathways, and providing real-time insights into labor market trends. Such capabilities substantially bolster career readiness and decision-making processes among vocational students. The adoption of these AI technologies within vocational education is not only technologically innovative but also pedagogically sound, resonating with the principles of constructivist learning theories and career development models. This integration nurtures an educational landscape that is conducive to dynamic, individualized learning experiences, heralding a new era in vocational education career planning.

5.1. Implications

The incorporation of generative AI into the career planning processes within vocational education presents significant implications for all stakeholders involved. For educators, this technological integration necessitates a transition towards a more facilitative role, emphasizing guidance for students in the interpretation and application of insights generated by AI systems. This shift represents a move away from traditional didactic methods towards a collaborative, mentorship-based approach, enabling educators to support students in navigating the complexities of career planning with AI-enhanced precision.

For students, the advent of generative AI in career planning offers unprecedented access to customized career guidance, thereby empowering them to make well-informed decisions regarding their educational trajectories and career choices. This personalized guidance is instrumental in aligning students' training with their aspirations, strengths, and the evolving needs of the job market, enhancing their readiness and adaptability for future employment.

Educational institutions face the imperative of engaging in strategic planning and ethical deliberation, alongside a commitment to continual technological adaptation. The successful integration of AI technologies into career planning processes requires a forward-thinking approach, one that not only embraces technological innovation but also addresses the ethical considerations and privacy concerns associated with AI deployment. Institutions must navigate these challenges while fostering an environment conducive to learning and innovation.

Furthermore, the integration of generative AI into vocational education has the potential to significantly narrow the gap between educational training and labor market requirements. By ensuring that the curriculum and career guidance are closely attuned to the current and anticipated demands of the job market, educational institutions can enhance the employability of their graduates, thereby

contributing to a more dynamic and responsive workforce.

In essence, the practical application of generative AI in vocational education's career planning processes heralds a transformative shift in how career guidance is delivered and received. It demands a proactive stance from educators, institutions, and students alike, promising a future where vocational education is intimately linked with the labor market, ensuring that students are not only well-prepared for their future careers but also equipped to thrive in a rapidly changing economic landscape.

5.2. Directions for Future Research

This investigation lays the groundwork for understanding the influence of generative AI on vocational career planning, while simultaneously highlighting several paths for future research. An area ripe for further exploration is the longitudinal impact of AI-enhanced career guidance on student outcomes. Future studies could systematically assess how AI-driven career advice influences employment rates and job satisfaction over time, providing valuable insights into the efficacy and long-term benefits of these technologies.

Additionally, the scalability of AI solutions across various vocational disciplines and diverse educational settings represents another critical area of inquiry. Further research in this domain could elucidate the adaptability and applicability of AI technologies in different vocational fields, offering a broader perspective on the potential for AI to enhance career planning in a wide array of contexts.

Moreover, an in-depth examination of the ethical considerations and privacy concerns associated with deploying AI in educational contexts is paramount. Future research should aim to develop comprehensive frameworks that address these issues, ensuring the responsible and equitable use of AI technologies. Such studies would contribute significantly to the formulation of guidelines and policies that safeguard students' rights while maximizing the benefits of AI in vocational education.

In summary, the trajectory of future research should focus on evaluating the long-term outcomes of AI-driven career guidance, assessing the scalability and adaptability of AI solutions in diverse vocational and educational landscapes, and addressing the ethical and privacy implications of AI integration. Through these avenues of inquiry, scholars can build upon the foundational insights provided by this study, further advancing the field and ensuring that the integration of AI into vocational education is both effective and ethically sound.

In conclusion, the incorporation of generative artificial intelligence into the career planning processes of vocational education marks a pivotal shift towards a more personalized, adaptive, and efficacious approach to career guidance. This paper has meticulously delineated the theoretical foundations and practical implementations of such technologies, shedding light on both the advantages and the challenges that accompany their integration. As the landscape of vocational education undergoes transformation to meet the evolving demands of the workforce, generative AI emerges as a formidable instrument to equip students for the future. It promises to render their educational experience more relevant, engaging, and congruent with their career ambitions. The adoption of these technologies necessitates thoughtful consideration, comprehensive strategic planning, and continuous research to maximize their benefits. The potential dividends for students, educators, and the broader society are substantial. Looking ahead, it is evident that generative AI will significantly influence the future of vocational education and career planning, offering innovative avenues for students to realize their professional aspirations.

Acknowledgements

We extend our sincere gratitude to the faculty and students of the higher vocational colleges and universities who participated in this study. Their valuable insights and contributions were instrumental in shaping this research. Special thanks to the invaluable feedback and guidance provided by our peers and mentors, which significantly enhanced the quality of this work.

Funding: This research is supported by the Higher Education Reform Research Project of Higher Education Association of Jiangsu Province (No. 2023JSJG649) and the Philosophy and Social Sciences Research Program in Colleges and Universities of Jiangsu Education Department (No.2023SJYB0731).

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