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A Study on the Ethical Challenges of Digitalization in Vocational Education

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Abstract: Data security, fairness, and accountability of automated decision-making are some of the key ethical issues in digital technologies, still posing a serious risk. In this paper, scenario simulation and expert assessment are used to create three common digital education scenarios such as a learning management system gathering data, a system of automatic scoring based on AI, and a system of career planning based on recommendations. The alternatives applied in both situations are the use of various combinations of strategies such as data encryption and anonymization, access auditing, the creation of interpretability mechanisms in the algorithm, regular reviewing the algorithm, and offering ethical training to teachers. The experiment called upon education administrators, teachers and technical experts to consider each of the strategies in three dimensions, namely, data security, algorithmic fairness, and decision-making accountability. Effectiveness of the strategies was then compared using average scores. The findings indicate that the overall combination of the strategies is quite efficient in reducing ethical risks. Taking the example of learning management system, a combination of data encryption and data anonymization and access auditing and teacher training and algorithm review will result in an average score of 4.67; however, it will be approximately 0.4-0.5 points higher than a single strategy.

1. Introduction

Due to the high rate of application of artificial intelligence (AI) and big data, vocational education is being implemented using digital learning platforms, and digital education is becoming an influential tool. Digital education may enhance the effectiveness of teaching, allow students to learn individually, and develop the skills. Nevertheless, there are some serious ethical concerns that have been revealed with the fast emergence of the existing digital technologies. Such problems are the risks to the privacy and safety of student information, AI bias, and lack of responsibility because of automating the decision-making processes of education. Unless these concerns are properly managed, then the impartiality and credibility of technology use could be jeopardized.

In order to deal with this problem, this paper provides a systematic review of the key ethical concerns that occur when the vocational education goes digital and suggests governance solutions. The paper evaluates the performance of various combinations of strategies in common settings like

learning management systems, automatic scoring using AI and career advising suggestions using techniques like scenario simulation and expert appraisal. This offers guidelines to educational institutions on what they need to do in order to maintain data security, establish algorithmic fairness, and define the roles of decisions.

2. Related Work

Under the conditions of the widespread application of Artificial Intelligence (AI) and digital technology in the process of professional education, the teachers are subjected to the need to compromise ethics, humanistic care, and creativity in pursuit of skill development and effectiveness of learning processes. In order to have a comprehensive understanding of the opportunities and inadequacies of AI in professional education setting, this paper shall review literature regarding the topic and explain the developmental pattern of the association between the use of technology and humanism. Widayanthi discussed the use of artificial intelligence (AI) in vocational education and how it can be combined with humanistic care and argues that although it is essential to enhance digital skills and optimize training processes, the importance of humanistic values can be overlooked such as empathy, ethical judgment, and creativity. In literature review, it has been discovered that AI can be used to advance the development of learning by offering customized education, simulation software, and an automatic evaluation system [1]. Ghosh and Ravichandran discussed the primary role of the emerging technologies in the vocational education and their importance in influencing the style of teaching and the development of skills [2]. Amdan et al. had adopted adaptive learning algorithms, virtual simulation, and intelligent tutoring system to help technical and vocational education (TVET) institutions in Malaysia to advance the skills of students based on various methods of learning. The implementation of AI can bring the benefits to the fullest, thus, addressing the following issues and encouraging the adoption of AI-assisted education will assist in enhancing the educational performance, fostering innovations and developing the skills that the contemporary economy will require [3]. Gu detailed the evolution and influence of digital education in international learning and how implementation of technology and use of digital tools in pedagogy can transform the learning process and educational outcomes. Digital education dismantles the geographical and traditional restrictions, as it offers interactive and adaptive and accessible learning approaches [4]. Deckker and Sumanasekara examined the use and future opportunities of the artificial intelligence (AI) in technology and vocational education (TVET). AI is expected to improve student learning, retention, work preparation ability by providing adaptive instruction, intelligent tutoring platforms and virtual simulations, but has drawbacks like privacy of data, system complexity, its high cost and low digital literacy [5]. Lukmantorod et al. investigated the strategies of leadership and models of implementation of principals in character education during digital literacy. No. 1 Buduran Vocational School has developed an elaborate character education model through curriculum, classroom, extracurricular activities and school culture integration that has helped students to develop ethical awareness and positive values, in addition to learning digital skills [6]. Despite the fact that the application of artificial intelligence in vocational education and its positive impact on learning outcomes and skills development are widely studied nowadays, the specificity of the effective integration of humanistic care and ethics and fairness protection as well as the data privacy and system complexity remain the gaps in the research.

3. Method

3.1 Identification of Ethical Issues in Digitalized Vocational Education

3.1.1 Data Privacy and Security Risks

In the context of digitalized vocational education, educational platforms extensively collect and store data on student learning behaviors, personal information, and psychological assessments. While this data can support precise teaching and the design of personalized learning pathways, the potential risk of data leakage cannot be ignored. If this data is accessed or misused by unauthorized personnel, it could lead to violations of student privacy, leaks of identity information, and risks to social credit.

In addition, smart systems are usually not transparent enough in the way they handle personal information. During data collection and use, students and parents do not necessarily know the aim of data usage, procedures of processing and storage of the data. This is not only more likely to lead to the invasion of privacy but it can also make students lose confidence in the education system. Thus, the digitalization of vocational education should provide a strict data protection system, including access control, data encryption, and clear information disclosure guidelines, to secure and lawful usage of student data upon gathering, transmission, and storage.

3.1.2 Algorithmic Bias and Fairness Issues

The intelligent learning tools are usually based on algorithms to perform the learning tests, suggest courses and design careers. Nevertheless, such algorithms are subject to bias, according to the historic data, which results in the disparity of access to the learning opportunities. As an illustration, when there are differences in gender, region or economic background of datasets, AI recommendation systems can be biased by allocating more quality courses or resources to some groups, which contributes to the increase in educational inequality. The discrimination between the various groups received by intelligent teaching systems can take the form of unequal allocation of course materials, unequal learning progress recommendations, and even in the performance assessment of exams and grade recognition. Not only are these algorithmic biases a contravention of the principle of educational equity but the education system can be harmed by such biases as well. Thus, when carrying out the digitalization of vocational education, one of the most important steps is regular reviews, as well as various testing of algorithms to provide different groups with fair treatment in the intelligent teaching systems and to introduce some reparative measures to avoid the possible ethical risks.

3.1.3 Attribution of Responsibility for Automating Educational Decision-Making

Some of these decision-making processes can be automated using digital tools and can include course recommendation, grade assessment, and career guidance. This, however, poses some ethical issues, especially the uncertainty of accountability. The line of responsibility between teachers, school administrators and technology providers is usually lost when the intelligent systems bring false information or provide discriminatory outcomes. As an example, intelligent recommendation systems can be wrong about their learning capacities of the students, which affects course scheduling; or automated grade assessment systems can generate biases. Unless these issues are solved promptly, they might have detrimental effects on the academic results and future progress of students. Effective definition of responsibility and the mechanism of correcting the error is significant in ethical governance in online vocational instruction. Educational institutions may

explain to teachers their supervisory roles in the intelligent decision-making process and set standards of the quality assurance and legal liability of technology providers in a way that allows tracking any mistakes in decision-making and correct them, eliminating possible risks.

3.2 Ethical Governance Strategies for Digital Systems

3.2.1 Data Management Standards and Privacy Protection Measures

The most important resource in the digital vocational education is data. Student privacy protection and level of system trust are directly connected to data security management. To start with, there should be a standardized way of managing data, the whole lifecycle of data acquisition, storage, transfer and utilization. During the data collection phase, the nature, use and retention time of the data should be well stipulated and informed consent of the students and parents should be obtained. When storing and transferring data, there will be the use of encryption of the data, access control, and firewalls to make sure that data are not accessed or modified without permission.

In addition, it is possible to establish anonymization processes in case of sensitive data. As an illustration, the personal information, grades and data provided by students in the context of psychological tests can be anonymized or coded to be stored, which minimizes the chances of data leakage. Moreover, data access and processing records are traceable and auditable to provide a foundation on which the responsibility of possible issues can be tracked. This set of standardized and technological actions will allow a reliable source of data support to be provided later in the process of intelligent teaching, which will guarantee the safety of data.

3.2.2 Guaranteeing Algorithm Transparency and Fairness

In digital vocational education, algorithms are at the core of decision-making; however, black-box algorithms can lead to biases and unfairness. To address these issues, mechanisms for algorithmic transparency need to be established. These mechanisms specifically encompass the following: utilizing model interpretability tools to enable teachers, students, and administrators to understand the recommendation logic of the intelligent system and the basis for its evaluations. At the same time, every decision made must be traceable, i.e. any learning recommendations or evaluation findings generated by the system can be verified to the initial data and algorithm guidelines.

In addition, algorithms must be periodically assessed and tested in terms of diversity. As an example, the systematic biases in the recommendation or evaluation results can be checked by simulating the learning experiences of the groups of students with different genders, regions and economic backgrounds with the help of the system. In case of any biases that are identified, the model parameters must be modified or algorithm logic refined at the earliest so as to be fair to the various student groups in digital learning.

3.2.3 Ethics Training and System Development for Teachers and Administrators

Intelligent systems can be used to aid the teaching and decision-making process; however, the role of teachers and administrators cannot be substituted with an intelligent system in moral governance. Professional training in ethics, such as the data use policies, detection of algorithmic bias, and decision-making control, should also be given to teachers in a digital setting so that they can be able to monitor the utilization of intelligent tools and intervene in problematic cases.

Schools are also to institute internal checks and balances of ethics. As an illustration, the creation of the ethics committees to frequently evaluate the ethics, transparency, and fairness of digital

education systems and analyze the data processing, algorithms use, and decisions outcomes. Not only does institutionalized oversight assist in the recognition of potential risks in a timely manner, but it is also associated with the development of a continuous improvement mechanism, which allows digital education to reach a dynamic balance between the use of technology and ethical regulation.

3.3 Policy and Regulatory Support for Digital Vocational Education

3.3.1 National and Local Data Protection Regulations

Student data in digital vocational education consists of numerous personal data, such as identity information, learning history, behavioral pattern, and the results of psychological measures. The education sector is subject to legal limitations through national and local statutes of data protection. The Personal Information Protection Law can be used as an example: the law clearly spells out legal and compliant obligations of data collection, processing, storage, and transfer; the local education authorities have also provided certain operational guidelines to be followed by educational institutions such as the minimization of collection of student data, limitation of its usage and retention.

In addition, rules provide remedies of liability and penalty systems of infractions. As an example, administrative punishment, economic reparation, or criminal responsibility can be initiated because of unauthorized data breaches, misuse, or cross-border transfers. The systems do not only sensitize the educational institutions about compliance in data processing, but also offer legal protection to the rights of the students to strike a balance between the digitalization of education and the protection of privacy.

3.3.2 Ethical Guidelines and Industry Standards for Digital Education

In addition to the legal restrictions, self-regulation in the industry and ethical guidelines are also an important aspect of digital vocational education. Different educational technologies manufacturers and professional associations of vocational education have developed some similar ethical principles over time, which explains the behavior standards of companies in the data processing process, the use of algorithms, as well as the creation of smart educational devices. As an illustration, according to these guidelines, firms must make sure that their algorithms are fair, ensure that their data is secure, and offer explanatory power of decisions, as well as, mechanisms to obtain anomaly feedback and correction.

These guidelines should be mentioned in vocational education institutions, and implemented in terms of their internal management systems, which provide teachers, administrators, and partner companies with the requirements of compliance and supervision. Ethical risks can be also minimized by standardizing corporate behavior and educational practices, in such a way, that the use of technology does not go against the educational values.

3.3.3 International Experience and Local Adaptation Strategies

There are established practices the world over that govern ethical digitalization of vocational education. There have been efforts to establish elaborate data protection and algorithm governance systems in the countries of Europe and America by using a mix of policies and industry regulation. As an example, the General Data Protection Regulation (GDPR) of the EU sets high standards in processing educational data and the intelligent systems must be subject to interpretability and fairness reviews; certain states in the US have developed ethics review committees as intelligent

education systems to conduct a constant review of the use of algorithms and data.

These international experiences should be adjusted to domestic context education policies, legislative frames, and socio-cultural features. As an example, the international methods of reviewing the transparency of algorithms, ethics committees, and industry self-regulatory systems can be studied, but regarding the Chinese context, it is necessary to design practical plans of implementation based on the vocational education system, the data management of the country, and the judiciary. The scientificity and practicability of digitalization governance within the realm of professional education in my country can be enhanced by absorbing foreign experience and adapting it to the local circumstances.

4. Results and Discussion

4.1 Scenario Simulation

Design Principles: Choosing common scenario of digital application in Vocational Education.

(1) Learning Management System (LMS) gathers data of student behavior to offer personalized advice.

(2) AI scoring system is an automatically evaluated scoring system of homework or exam scores.

(3) Intelligent career planning recommendation system offers course or employment path recommendation.

Variable Settings:

Independent Variables: Various strategies of ethical governance.

Measures of Data Protection (encryption, anonymization, access control)

Transparency Mechanism (explainable model, decision traceability) Algorithms

System of Teacher/Administrator Training and Supervision.

Dependent variables: Level of alleviation of ethical risks;

Probability of data breach;

Frequency of algorithmic bias;

Mistakes in decision making or biased decisions.

4.2 Expert Evaluation

Participants: 15 invited education administrative, teaching, educational technology and legal/ethics experts.

Assessment Method:

Scenarios and combinations of strategies will be simulated. The effectiveness of every strategy in various situations will be rated by professionals according to their experience (e.g., 1-5 points).

The measures of assessment are: data safety, algorithmic equity and accountability of decision-making.

4.3 Data Collection and Analysis

Data obtained: Expert ratings + written comments.

Analysis methods:

Descriptive statistics: To determine the effectiveness of every strategy, means and standard deviations are calculated.

Comparative analysis: Relational variations in ethical dimensions among various strategy combinations.

Hierarchical ranking: The priorities of the strategy is determined depending on the rating results.

4.4 Experimental Procedure Example

Prepare 3 common digital education situations.

Each scenario has four governance strategy combinations to provide.

Engage a panel of experts to perform simulation testing, mark the strategies and give a feedback.

Tabulate the scores and give analysis of the mitigation impact of each strategy on ethical concerns.

Generate a table of strategy priority and improvement recommendations.

4.5 Output Format

Table 1. Effectiveness Scores of Different Ethical Governance Strategies in a Learning Management System Scenario

Scenario	Strategy Combination	Data Security Score (1–5)	Algorithm Fairness Score (1–5)	Decision Accountability Score (1–5)	Average Score
LMS Behavioral Data Collection	Data Encryption + Anonymization	4.6	4	4.2	4.27
LMS Behavioral Data Collection	Data Encryption + Anonymization + Access Audit	4.8	4.2	4.4	4.47
LMS Behavioral Data Collection	Data Encryption + Teacher Training	4.5	4.1	4.3	4.3
LMS Behavioral Data Collection	Data Encryption + Anonymization + Teacher Training + Algorithm Review	4.9	4.5	4.6	4.67

Note: Scoring is based on expert simulation assessment, with 1 being the lowest and 5 being the highest; the average score is the arithmetic mean of the three scores.

The strategy combinations that presented high scores pertaining to data security were those that included the data encryption + anonymization + access audit combination obtained the first position with a score of 4.8, indicating the great importance of data encryption and access audit to enhance the data security. The overall plan that recorded the most score in the decision-making responsibility was the comprehensive strategy, which is data encryption + anonymization + teacher training + algorithm review, with a score of 4.6. This conclusion suggests that the teacher training course combined with an algorithm review can be a good way to make the decision-making process more transparent and explain the responsibilities of all parties involved. However, the combination of data encryption and teacher training obtained a score of 4.3. (as represented in Table 1) in contrast.

The strategy of explainable model + teacher supervision + regular review of algorithms produced the highest score of the algorithmic fairness of 4.9 of all the strategy combinations. This finding demonstrates that periodic review of algorithms and model interpretability can be appropriate to reduce the impact of bias in algorithms and guarantee fairness in the assessment of the performance of students. The mean score of explainable model + teacher supervision + regular algorithm review in the AI automatic scoring situation was 4.57 which is slightly more than the 4.43 of explainable model + teacher supervision. The combination of algorithm review and training system + data access control had an average score of 4.57 in the career planning recommendation scenario with Figure 1 indicating it.

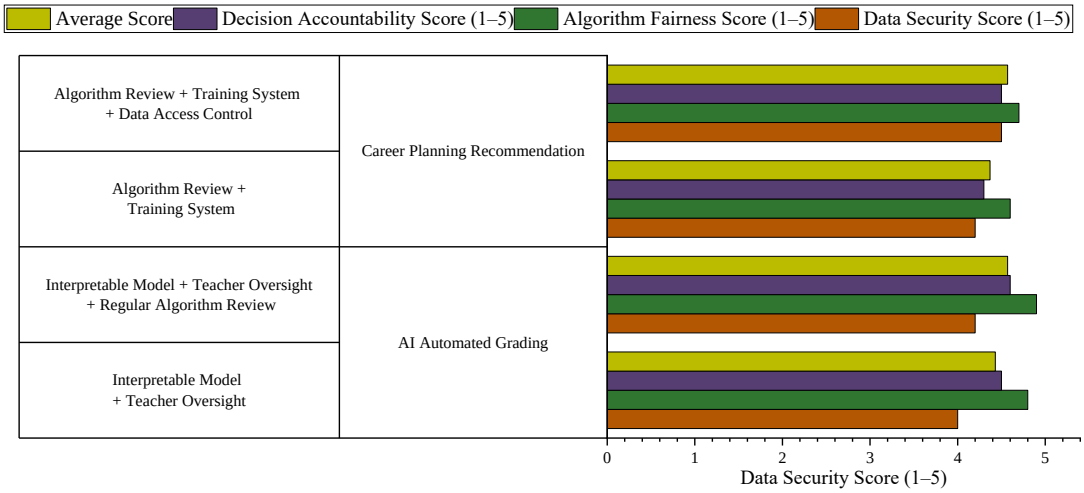

Figure 1. Effectiveness Scores of Different Ethical Governance Strategies in AI-powered Automatic Scoring and Career Planning Recommendation Scenarios.

Note: The career planning recommendation scenario mainly examines the fairness of the recommendation system algorithm and the responsibility for decision-making; the score is based on expert simulation judgment.

5. Conclusion

This paper methodically examines the ethical issues of digitalization of vocational education with the themes of data privacy and security, bias and fairness of algorithms, and the responsibility assigned to automating educational decision-making. Suggested targeted governance strategies would encompass data management standards, algorithmic transparency strategies, and training of teachers and administrators on ethical issues. This paper has limitations however: the experimental data are on expert simulation and not on large scale real world applications which may not be similar to real life situation; as well as, the technological potential and policy setting of different institutions could also influence the applicability of the strategies. The combination of the data on practical application and long-term tracking and analysis in future research can further streamline the approaches to ethical governance and investigate the local adaptation possibilities in various educational systems and cultural contexts, which will form a scientific foundation of the sustainable and compliant approach to digitalization of vocational education.

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