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Curriculum Optimization for the Big Data Major through Industry-Education Integration Oriented toward Enhancing College Students' Professional Competencies

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Abstract: Recognizing the importance of big data and big data technology, an increasing number of colleges and universities in China have established majors related to this field. With experience in educating these majors and encountering new challenges, it is necessary to optimize the curriculum for majors related to big data. To better prepare college students for the job market, colleges and universities in China have reached a common agreement to adopt the Industry-Education Integration strategy. Therefore, it is of great importance to study strategies for optimizing the curriculum for majors related to big data through the Industry-Education Integration approach. In this paper, we focus on exploring and analyzing strategies aimed at optimizing the curriculum of the Data Science and Big Data Technology through the implementation of the Industry-Education Integration approach. Our objective is to enhance college students' professional competencies. Through our research, we propose a series of strategies to enhance and refine the curriculum of the Data Science and Big Data Technology. These strategies are designed to align educational outcomes with industry requirements, thereby fostering the development of critical competencies in data science and big data analytics among college students. An empirical study is conducted based on the quantitative analysis of teaching data for Data Science and Big Data Technology, the results obtained indicate that our suggested strategies are valid.

1. Introduction

The last ten years have witnessed the increasing importance of big data and big data technology, and this significance has become increasingly clear[1-5]. As with educational institutions worldwide, an increasing number of colleges and universities in China have established majors related to big data. For instance, Suqian University, where we work, has established the Data Science and Big Data Technology major[4]. As colleges and universities gain experience in educating students in these disciplines and face emerging challenges, it is necessary to optimize the

curricula of majors related to big data[1,2,5]. In response to the evolving demands of the job market, a consensus has emerged among colleges and universities in China to adopt the Industry-Education Integration strategy. Industry-Education Integration is a strategy that involves cooperating with potential job providers, to collaboratively educate college students, aimed at equipping students with the relevant skills and knowledge required for success in their future careers.

In the literature, there are several approaches for optimizing the curriculum, with some establishing multiple targets for curriculum optimization[2]. By reviewing the references, we conclude that among the approaches to optimizing the curriculum, Industry-Education Integration is the most effective strategy. Additionally, among the targets for curriculum optimization, improving college students' professional competence is the most prominent. This paper aims to investigate effective strategies for optimizing the curriculum of majors related to big data through the lens of the Industry-Education Integration approach. Specifically, we focus on the Data Science and Big Data Technology major, analyzing and exploring various strategies to refine the educational framework. Our primary objective is to enhance college students' professional competencies, ensuring that they are well-prepared to meet industry expectations.

The rest of the paper is organized as follows. In Section 2, we explain in detail the curriculum's role in fostering the professional competencies of college students. In Section 3, we propose several strategies for optimizing the curriculum of the Data Science and Big Data Technology major through Industry-Education Integration. In Section 4, we perform an empirical study based on our teaching team's experience. In Section 5, we present several concluding remarks.

2. The curriculum's role in fostering the professional competencies of college students

In this section, our main aim is to explore the curriculum's pivotal role in developing essential professional competencies for college students majoring in Data Science and Big Data Technology. A well-designed curriculum not only imparts knowledge but also equips students with the skills and attributes necessary to excel in their chosen fields. By aligning academic content with industry demands, the curriculum helps bridge the gap between theory and practice, fostering competencies such as critical thinking, communication, teamwork, and adaptability. This section will examine how curriculum choices influence students' readiness for the professional world and the ways in which these competencies support lifelong learning and career advancement.

2.1. The curriculum prepares resources for college students to be systematically trained

The curriculum for the Data Science and Big Data Technology major is designed to provide a structured system of courses that helps college students systematically grasp the major, thereby fostering their professional competencies. There are many goals of higher education, but helping college students improve their professional competencies is one of the most prominent. The curriculum encompasses all the resources a college or university offers its students. Therefore, the curriculum for the Data Science and Big Data Technology major itself contributes significantly to fostering the professional competencies of college students.

2.2. The curriculum can help college students study theoretical knowledge systematically

For the Data Science and Big Data Technology major, the curriculum offers a series of theoretical courses related to data science for college students. In general, these theoretical courses can be categorized into several modules: The Mathematics module, the module focused on applications of computer technology, the module addressing applications of foreign languages, and the module of universal courses in philosophy, literature, ethics, and related subjects. The future

world is increasingly defined by globalization; therefore, courses in foreign languages for college students are essential. It is widely acknowledged that, for college students majoring in science and technology, universal courses in literature, philosophy, ethics, and related subjects are essential complements to their education, helping them enhance their innovation competencies, critical thinking skills, teamwork abilities, and more. Additionally, the Mathematics module and the module focused on applications of computer technology are essential for the Data Science and Big Data Technology major. In summary, the curriculum helps college students systematically study theoretical knowledge related to data science and big data technology.

2.3. The curriculum can help college students gain practical experience and skills

For college students, acquiring practical experiences and skills is crucial for their academic and professional development. For majors like Data Science and Big Data Technology, courses such as Data Mining, Machine Learning, Data Analysis and Visualization, and Database Management play a crucial role in equipping students with the practical skills and experiences necessary for success in the field. By bridging theoretical concepts with hands-on applications, these courses prepare students to meet the demands of an increasingly data-driven world. The integration of theoretical knowledge with hands-on applications allows students to navigate complex data challenges effectively. Data Mining equips students with techniques to discover patterns and insights from large datasets. Machine Learning is another pivotal course that introduces students to algorithms and models that enable computers to learn from and make predictions based on data. Data Analysis and Visualization teaches students how to interpret data effectively and communicate insights through visual means. Database Management provides students with foundational knowledge in managing and querying databases. Understanding how to design databases and manipulate data using SQL is vital for any data professional. The curriculum includes such courses to help college students majoring in Data Science and Big Data Technology acquire practical experience and skills.

3. Strategies for optimizing the curriculum of the Data Science and Big Data Technology major through Industry-Education Integration

In this section, we discuss strategies for enhancing the curriculum of the Data Science and Big Data Technology major by leveraging Industry-Education Integration. As the fields of data science and big data evolve rapidly, keeping the curriculum relevant and aligned with industry demands is essential to preparing students for real-world challenges. Industry-Education Integration involves collaboration between academic institutions and industry partners, enabling students to gain practical insights, hands-on experience, and skills that are directly applicable to the workforce. This section will explore various strategies for curriculum optimization, including reducing lecture time for theoretical courses, increasing focus on practical ones, reorganizing course sequences, establishing collaborative courses with industry partners, and enhancing evaluation methods by integrating industry perspectives, all aimed at equipping students with the knowledge and competencies necessary to thrive in the data-driven job market.

3.1. Reduce lecture time for theoretical courses

For college students majoring in Data Science and Big Data Technology, it is crucial for the enhancement of their professional competences to optimize the curriculum via reducing the duration of lectures focused on theoretical content. Theoretical courses provide foundational knowledge that underpins practical applications, yet excessive lecture time can lead to diminished engagement and retention of essential concepts. It is widely acknowledged that students learn more effectively when

they are actively engaged in the learning process. By reducing the duration of traditional lectures, the college students have more time for active learning opportunities. This shift not only enhances student comprehension but also fosters critical thinking and problem-solving skills, which are vital in the data science field. Additionally, the reduction of lecture time for theoretical courses should be accompanied by a structured approach to content delivery. Instructors can design curricula that prioritize core theoretical principles while systematically integrating them with technical applications. For example, after introducing a theoretical concept, educators can immediately follow up with case studies, simulations, or real-world scenarios that demonstrate the practical application of this knowledge. This approach builds problem-solving skills by requiring students to think critically about how theoretical insights are implemented in real-world data science challenges.

In conclusion, optimizing lecture durations in theoretical courses for college students majoring in Data Science and Big Data Technology is essential for improving their professional competencies.

3.2. Increase lecture time for practical courses

To enhance the professional competences of colleges students majoring in Data Science and Big Data Technology, it is crucial to extend the instructional time allocated to practical courses. As the duration of practical courses is increased, the college students could benefit from more comprehensive lab sessions, project-based assignments, and collaborative problem-solving exercises, thereby obtaining the opportunity to experiment with different methodologies and technologies. This hands-on approach fosters critical thinking and innovation, as college students can explore various solutions to real-world problems. Additionally, extended time allows for the integration of interdisciplinary knowledge, connecting technical skills with principles from related fields such as engineering, mathematics, and computer science.

As supported by our teaching team's empirical experience, optimizing the curriculum by increasing lecture time for practical courses contributes to enhancing the professional competencies of college students majoring in Data Science and Big Data Technology.

3.3. Reorganize the sequence of courses

For college students majoring in Data Science and Big Data Technology, the influence of the order the sequence of courses cannot be neglected for the cultivation of their professional. Restructuring the order of course presentation is a critical strategy for enhancing the learning experience, particularly in technical and scientific disciplines. This approach should be grounded in cognitive learning theories that emphasize the importance of scaffolding, where foundational knowledge serves as a building block for understanding more complex concepts. By carefully sequencing courses, instructors can ensure that students first acquire essential skills and theoretical principles before progressing to advanced subjects. For example, introductory courses that cover basic concepts in a discipline should precede intermediate and advanced courses that require a deeper understanding of those foundational elements. This alignment not only facilitates comprehension but also promotes the transfer of knowledge, allowing students to apply what they have learned in practical contexts. Moreover, incorporating feedback loops within the curriculum can further enhance learning. When foundational courses are aligned with subsequent subjects, students can revisit and reinforce earlier concepts while exploring more complex material. This iterative process not only solidifies their understanding but also fosters critical thinking and problem-solving skills, as students learn to connect disparate ideas and apply them in novel situations. Additionally, structuring courses to include interdisciplinary connections can enrich the learning experience. By showing how foundational concepts relate to each other, instructors can promote a comprehensive understanding that prepares college students for real-world applications.

In summary, a thoughtfully restructured course sequence, grounded in educational theory, can significantly enhance college student learning by ensuring that foundational knowledge supports the acquisition of more advanced concepts. This approach fosters deeper engagement of knowledge, ultimately preparing college students for success in their academic and professional endeavors.

3.4. Establish collaborative courses with industry partners

As evidenced by our teaching team's empirical experience, developing and implementing courses in collaboration with industries is essential for ensuring that academic curricula remain aligned with current industry standards and practices.

To begin with, collaborative courses with industry partners can provide valuable insights into the skills and competencies that are in high demand. Through teaching courses, curriculum developers can gain access to the latest trends, tools, and methodologies utilized in the field. This information can then be integrated into course content, ensuring that students are equipped with relevant knowledge and practical skills upon graduation. What's more, collaborative course development can include the creation of internships and project-based learning opportunities that involve real-world applications. This exposure not only enhances their technical skills but also develops soft skills such as teamwork, communication, and problem-solving. In addition, partnerships with industry can enable a range of experiential learning opportunities, such as guest lectures, hands-on workshops, and structured mentorship programs led by professionals, experts and engineers currently working in data science and big data technology.

To summarize, optimizing the curriculum by developing and implementing courses in partnership with industry creates a framework that is beneficial for enhancing the professional competencies of college students majoring in Data Science and Big Data Technology.

3.5. Enhance evaluation methods by incorporating industry perspectives

College students majoring in Data Science and Big Data Technology will enter the industry upon graduating from colleges or universities, making it essential to design the curriculum with an emphasis on evaluation that incorporates industry perspectives.

Refining evaluation strategies by integrating feedback and insights from industry professionals is a vital process for ensuring that evaluations accurately reflect the skills and competencies required in specific fields. This approach aligns educational outcomes with real-world expectations, thereby enhancing the relevance and efficacy of college student evaluations.

Incorporating industry feedback can also lead to the adoption of performance-based assessments, which evaluate college students through practical applications of their knowledge and skills. For example, instead of relying solely on traditional exams, programs can implement project-based evaluations, case studies, or simulations that mirror real-world scenarios. These methods not only assess college students' understanding but also their ability to apply concepts in practice, providing a more comprehensive evaluation of their capabilities.

Gathering insights from industry professionals or integrating standardized industry certifications into evaluation strategies can highlight areas for improvement in both the curriculum and evaluation methods concerning college student performance. By aligning course evaluations with widely recognized certification standards, educational programs can equip college students with credentials that are respected by employers and accurately reflect their competencies.

To encapsulate, as evidenced by the empirical insights gathered from our teaching team's direct experience, optimizing the curriculum by refining evaluation strategies with integrated industry feedback significantly enhances the development of professional competencies for college students majoring in Data Science and Big Data Technology.

4. An empirical study based on Analytic Hierarchy Process (AHP)

Drawing from our teaching team's experience, we endeavored to identify effective strategies for optimizing the curriculum at our affiliated university. To this end, we constructed the following AHP model (see Figure 1 for the details) to identify how industry-education integration influences the professional competencies of college students majoring in Science and Big Data Technology.

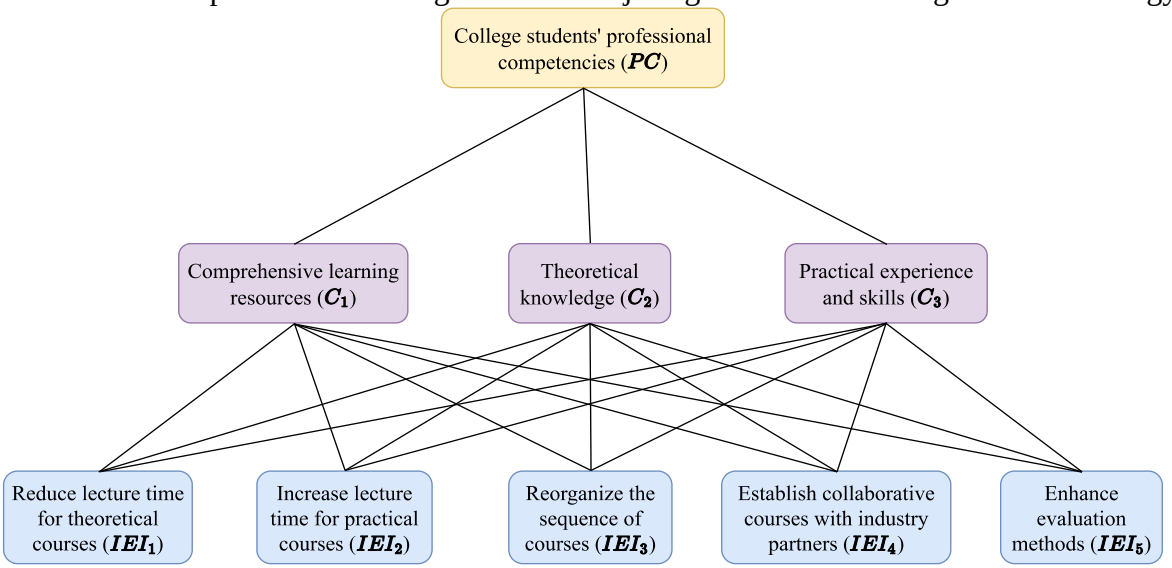

Figure 1: AHP model for college students' professional competencies.

By consulting experts' suggestions, issuing questionnaires to gather suggestions from job providers such as industries, government and so forth, and surveying future expectations from college students, we obtained the judgement about the influence of the curriculum on the professional competencies of college students majoring in Science and Big Data Technology (see Table 1). By utilizing the AHP model, we calculated the relative priority weights and the associated random consistency ratio of the curriculum's contribution to the professional competencies of college students (see also Table 1); the random consistency ratio is approximately 0.0572 and is less than 0.1, this implies that the proposed AHP model is valid.

Table 1: Judgement and evaluation of the influence of curriculum on professional competencies.

	C_1	C_2	C_3	
C_1	1	$\frac{7}{3}$	3	0.1587
C_2	$\frac{3}{7}$	1	1	0.4031
C_3	$\frac{1}{3}$	1	1	0.4382
	0.1587	0.4031	0.4382	

Analogously, by consulting experts' suggestions, issuing questionnaires to gather suggestions from job providers such as industries, government and so forth, and surveying future expectations from college students, we obtained the judgement about the influence of Industry-Education Integration on curriculum optimization of Science and Big Data Technology; by utilizing the AHP model, we calculated the relative priority weights and the associated random consistency ratios of the Industry-Education Integration 's contribution to the curriculum optimization; by combining the

relative priority weights of the curriculum's contribution to the professional competencies of college students, gathered in Table 1, we obtained the overall relative priority weights and the overall random consistency ratio of Industry-Education Integration's contribution to the professional competencies of college students (see Table 2 and Figure 2).

Table 2: Evaluation of the influence of Industry-Education Integration on curriculum optimization and professional competencies.

	IEI_1	IEI_2	IEI_3	IEI_4	IEI_5	
C_1	0.1252	0.1143	0.1327	0.3455	0.2823	0.0947
C_2	0.1171	0.1179	0.1361	0.3451	0.2838	0.0919
C_3	0.1091	0.1236	0.1273	0.3636	0.2764	0.0932
PC	0.1149	0.1198	0.1317	0.3533	0.2803	

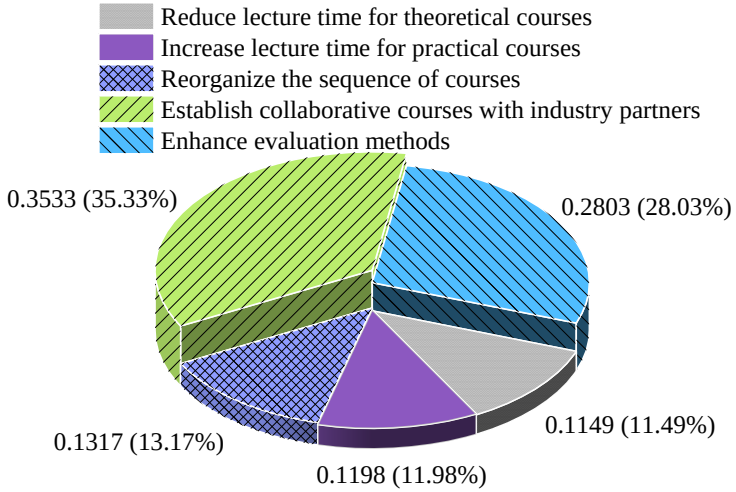

Figure 2: Evaluation of the curriculum through Industry-Education Integration on professional competencies.

The overall random consistency ratio is

$$CR = 0.1587 \times 0.0947 + 0.4031 \times 0.0919 + 0.4382 \times 0.0932 < 0.1$$

which implies that our AHP evaluation method applies very well to our problem. The quantitative analysis above reveals that optimizing the curriculum by establishing collaborative courses with industry partners has the most significant impact on the professional competencies of college students majoring in Data Science and Big Data Technology. This is followed by optimizing the curriculum through enhancing evaluation methods that incorporate industry perspectives. The effects of reorganizing the sequence of courses, increasing lecture time for practical courses, and reducing lecture time for theoretical courses are nearly equivalent in their influence on the professional competencies of these students. Building on the findings presented above, we have initiated specific curriculum optimization efforts for the Data Science and Big Data Technology major at Suqian University, our affiliated institution.

5. Conclusions

In this paper, we investigated and analyzed strategies for enhancing the curriculum of Data Science and Big Data Technology through the Industry-Education Integration approach, aimed at improving college students' professional competencies. We elucidated the pivotal role of the

curriculum in fostering the professional competencies of college students majoring in Data Science and Big Data Technology. We have proposed several strategies for optimizing the curriculum of the Data Science and Big Data Technology through the Industry-Education Integration approach. We conducted an empirical study, grounded in our teaching team's experiences, to validate these strategies. Our results in this paper provide valuable insights for colleges and universities regarding the implementation of the Industry-Education Integration strategy across various majors.

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