Optimization Pathways for the Teaching of Deep Learning for Computer Vision in Higher Education Oriented Towards Innovation Capability Cultivation

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Abstract: The continuous evolution of AI technology has driven the continuous updating and development of the field of Computer Vision. Concurrently, it has put forward higher requirements for the teaching innovation and educational quality of the Deep Learning course in higher education. Currently, in the teaching of Deep Learning for Computer Vision in higher education, there are common problems such as outdated content, theory-practice disconnection, and unclear educational orientation, which makes it difficult to adapt to the demands for cultivating the innovation capabilities of engineering talents in the new era. This paper attempts to explore the teaching optimization pathways that align with innovation capability cultivation, aiming to establish a new theory-leading edge combined, practice-innovation integrated teaching model and provide theoretical basis and practical reference for improving the quality and efficiency of the Deep Learning for Computer Vision course in higher education, and for cultivating high-quality innovation-oriented engineering talents.

Keywords: Innovation Capability; University Teaching; Computer Vision; Deep Learning; Teaching Optimization

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1.Introduction

Computer Vision is an important application field of artificial intelligence. It leverages Computer Vision algorithms to achieve the updating of technological paradigms. And it has been widely applied in various cutting-edge fields such as intelligent manufacturing, smart healthcare, and autonomous driving. The demand is continuously growing for visual technology talents with innovative thinking and engineering practice capabilities in society and industries. Higher education institutions are the main platforms for cultivating AI talents. The Deep Learning for Computer Vision course serves ss an important bridge connecting theoretical research and industrial application. Its teaching quality directly affects students' algorithm updating ability, scenario adaptation level, and technological iteration efficiency. Based on this, this paper takes innovation capability cultivation as the anchor point to systematically analyze the problems in the teaching of this course and construct a systematic strategy framework to promote the teaching of Deep Learning for Computer Vision in higher education to adapt to the demands of industrial upgrading and talent cultivation reform.

2.Core Problems in the Teaching of Deep Learning for Computer Vision in Higher Education

2.1 *Rigid and Lagging Teaching Content Systems*

Currently, the teaching content of the Deep Learning for Computer Vision course in higher education suffers from rigidity and lag, updating slowness and other problems. The overall knowledge framework is difficult to adapt to the rapid evolution of technology and meet the cultivation requirements of innovators. The teaching content of most courses mainly focuses on traditional machine vision algorithms and basic Computer Vision theories, and emphatically introduce the base structure of convolutional neural networks, classic image classification and detection algorithms, etc., while paying less attention to advanced technologies such as Transformer visual architectures, diffusion models, and multimodal visual fusion. This results in a significant discontinuity in the knowledge system [1]. Concurrently, the course content is charactered by fragmentation and isolation. There is a lack of logical connection and iterative organization among various knowledge points. It merely focuses on the explanation of an isolated algorithm principle, without delving into the algorithm design logic, optimization methods, and updating paradigms. As a result, students only master the basic theoretical formulas and model architectures, and have difficulty in understanding algorithms' internal logic of continuous improvement and breakthrough directions. Furthermore, the teaching content is disconnected from industrial application realities. It overemphasizes theoretical derivation and standard model training, and lacks engineering and innovative content such as algorithm adaptation to complex scenarios, model lightweighting, and performance optimization. It fails to guide students to develop a mindset converting from theoretical research to technological innovation, seriously hindering the cultivation of students' innovative consciousness.

2.2 *Superficial and Monolithic Practice Teaching Models*

Practice teaching is a crucial part for cultivating students' innovation capabilities. However, in current practice teaching of Deep Learning for Computer Vision in higher education, there are common problems such as monolithic models, simple tiers, and insufficient innovation. The practical components of most courses are mainly centered on verification experiments, where students are required to complete standardized operations such as model reproduction, Data Set training, and result testing according to fixed procedures, the experimental process is highly predefined, and the task objectives are relatively monolithic. In the experimental process, students only need to mechanically carry out the prescribed operations to meet the experimental requirements. There is a lack of cultivation of independent thinking, scheme design, and problem-solving capabilities. It is difficult for them to effectively enhance innovation capabilities and independent inquiry capabilities. Concurrently, practice teaching has not yet formed a tiered and progressive teaching design, or established a gradient practice platform that ranges from foundational practical operations to algorithm optimization and then to independent innovation. Most practical tasks remain confined to foundational application, and lack complex engineering application scenarios, open-ended research topics, and innovative research and development activities.

2.3 *Lack of Evaluation Mechanisms for Innovation Education*

A scientific and sound evaluation mechanism serves as an important safeguard for cultivating students' innovation capabilities. However, the current evaluation system of the Deep Learning for Computer Vision course in higher education still adopts the traditional exam-oriented evaluation approach and suffers from problems of emphasizing results over processes and scores over capabilities. The course assessment is mainly conducted through final written exams, regular assignments, and standardized lab reports. The assessment focuses on testing the memorization of theoretical knowledge and basic operational skills and fails to incorporate students' innovative thinking, scheme improvement, issue inquiry, project development and other innovation capabilities and practice achievements into the assessment scope. The evaluation methods are relatively monotonous and rigid, and lack process-oriented and diversified evaluation dimensions, struggling to dynamically reflect students' capability changes and thinking development during course learning, practical exploration, and project research. Evaluation criteria suffer from the prominent problem of homogeneity. Uniform assessment criteria are imposed on all students, which fails to fully consider the personalized development and innovative potential of each student, and struggles to stimulate students to engage in extended learning activities such as independent inquiry, algorithm improvement, and scenario innovation.

3.Restructuring a Curriculum Teaching Content System Guided by Innovation

3.1 *Building a Tiered and Progressive Knowledge Framework*

Higher education institutions should re-establish a "foundation-based, core-advanced, frontier-expanded" tiered and progressive knowledge system based on the terraced cultivation law of innovation capabilities to break the traditional fragmented and rigid knowledge framework. The foundation tier takes the core underlying principles of Deep Learning and Computer Vision as main structure to systematically tease out the Foundation of Mathematics, core logic of Machine Learning, and Classic Visual Algorithm Architectures so as to help students solidify their theoretical foundation, and form the underlying support for innovative thinking, enabling them to understand the underlying logic and theoretical boundaries behind algorithm designs. The core tier is centered on the mainstream

Computer Vision visual algorithms, emphatically introduces the evolution process and improvement idea of key technologies such as convolutional neural networks, object detection, image segmentation, and feature extraction, and compares the advantages, characteristics, and applicable scenarios of various algorithms in order to guide students to master the basic methods for algorithm improvement and parameter optimization [2]. The frontier tier dynamically integrates with new technologies, new paradigms and new application in the sector, covering multi-modal visual fusion, lightweight visual models, generative visual algorithms, intelligent visual perception, and other frontier content.

3.2 *Integrating Innovative Thinking Cultivation into Course Content*

Higher education institutions should integrate innovation thinking into the whole course teaching process, abandon the teaching method of pure knowledge impartation and incorporate innovation logic and research thinking into the process of explaining knowledge points. For every kind of major algorithms, course teaching should not remain confined to principal explanations and process descriptions, but rather focus on tease out algorithms' development history, technical challenges, and updating & iteration process so as to help students understand the underlying logic of technological innovation and cultivate critical thinking and the awareness of improvement. In the theory teaching, they should set open-ended questions, technical disputes and industrial difficulties, integrate the application shortcomings of visual algorithms in complex scenarios to guide students to independently think about the directions for algorithm improvement, model optimization strategies and scene adaptation methods. Concurrently, they should introduce scientific research innovation methods, engineering innovative thinking and other content, and elaborate on the basic pathways for the project research, technological R&D, and scheme iteration in the visual domain in order to enable students to develop a complete "problem-finding → problem analysis → innovative problem-solving" thinking paradigm, advance them shift from knowledge recipients to innovative explorers, and fundamentally enhance their innovation capabilities.

4.Relying on Diversified Teaching Methods to Strengthen Innovation Practice Cultivation

4.1 *Implementing the Project-driven Teaching Model*

Higher education institutions should take innovative projects as the main carrier to carry out project-driven teaching activities, and break through the limitations of traditional confirmatory operational teaching to form a new teaching method of "project steering, independent inquiry, and iterative optimization". To be specific, they should design tiered and open-ended teaching projects according to the industry demands, research hotspots and teaching difficulties in the field of Computer Vision, covering research topics of different difficulty gradient on the improvement of basic algorithms, the adaptation to specific scenarios, the development of emerging visual technologies, etc. in order to meet the needs of students at different levels to carry out innovative practical activities. Course teaching uses projects act as a go-between to integrate throughout theory and practice. Under the guidance of teachers, students independently complete the whole-process operations across project selection, scheme design, model construction, algorithm debugging, result optimization, and summary report to break away from standardized or template-based practical operation procedures [3]. Concurrently, they should guide students to independently expand the project content, improve and optimize the existing algorithm models and update the application scenarios based on their own interests and industry demands so as to enhance their problem analysis capabilities, technological iteration capabilities, and scheme innovation capabilities, and achieve the synergistic advancement of knowledge internalization and creativity development during the project research process.

4.2 *Constructing an Online-Offline Integrated Teaching Model*

Higher education institutions should rely on digital educational resources to build an online-offline integrated blended teaching model and provide diversified support for students' independent innovation and deep learning. Online, they should establish systematic course resource platforms to integrate high-quality resources such as cutting-edge teaching courseware, algorithm open-source resources, research literature, instructions, and frontier lectures so as to break through temporal-spatial limitations of classroom teaching and enable students to leverage their spare time to independently expand their frontier knowledge, conduct experimental operations, and delve into innovative research projects. In addition, they should establish online open-ended discussion modules to conduct continuous communication and discussions on industrial technological difficulties, algorithm updating challenges, and cutting-edge technological controversies in order to encourage students to freely express innovation standpoints and share exploration idea, and create learning environment that encourages independent innovation. Offline, they should carry out precision teaching around Q&A on key points and difficulties, project guidance, and innovation discussions, provide special guidance for personalized issues arising during students' independent exploration, and organize activities such as project result presentation, innovative idea defenses, and group mutual evaluation and communication to achieve the organic integration of online independent exploration innovation and offline precise empowerment cultivation, thereby enhancing the innovativeness and effectiveness of teaching.

4.3 *Establishing Industry-University-Research Collaborative Practice Platforms*

Higher education institutions should anchor in the industrial innovation demands to establish industry-university-research collaborative education platforms, and open up channels between on-campus teaching and industrial innovation, thereby enhancing students' engineering innovation capabilities and practical application skills. Concretely speaking, they should strengthen the construction of school-enterprise collaborative education mechanisms, and collaborate with AI, intelligent manufacturing, and intelligent healthcare enterprises to introduce authentic visual technology projects, industrial application scenarios, and technical challenges from the enterprises into the teaching process, convert industrial innovation demands into course practice topics, and enable students to foster their innovation capabilities in the process of solving practical engineering problems. Concurrently, they should rely on university research laboratories and disciplinary innovation platforms to build professional Computer Vision innovation practice bases, and equip them with high-performance computing equipment, open-source algorithm frameworks and Data Set resources to provide hardware support for students to conduct algorithm development, model optimization and experiment iteration.

5.Establishing an Innovation-oriented and Diversified Teaching Evaluation System

5.1 *Optimizing the Process-based Evaluation Dimensions*

Higher education institutions should abandon the traditional summative monolithic evaluation methods and establish a process-based evaluation system centered on innovation capabilities to conduct multi-dimensional and dynamic evaluation throughout the whole learning process of students. Concretely speaking, they should integrate the whole process of course learning into the evaluation scope, including pre-class independent exploration, in-class innovation discussions, online topic exchanges, project iterative revision, and experimental innovation improvement to place emphasis on students' thinking development, inquiry process and innovation breakthroughs and reduce the weight of outcome-based assessment [4]. In addition, they should set differentiated evaluation criteria according to different learning stages, with a focus on assessing students' problem identification ability, innovativeness in scheme design, algorithm improvement idea, and depth of independent research, to avoid using uniform standards to measure learning outcomes. Concurrently, they should leverage normalized process-based evaluation to timely record students' innovation behavior and capability development, guide students to attach importance to Computer Vision and innovation exploration, abandon the exam-oriented learning method, and continuously stimulate students' innovation initiative and exploratory enthusiasm.

5.2 *Diversifying Evaluation Entities*

Higher education institutions should establish a multi-entity evaluation system consisting of teacher evaluation, student peer-evaluation, self-evaluation, and enterprise evaluation to enhance the comprehensiveness, objectivity and innovativeness of teaching evaluation. Teacher evaluation focuses on students' holistic academic performance, innovation achievement quality, and breakthroughs in key and difficult points to conduct professional and targeted comprehensive evaluation. Student peer-evaluation is carried out through group projects, topic discussions, and achievement presentation, with a focus on assessing individual innovation contributions, inspiration, and scheme improvement value in team collaboration. It aims to cultivate students' innovation identification ability and critical thinking. Self-evaluation guides students to autonomously tease out their learning deficiencies, innovation progress, and capability improvement according to innovation cultivation objectives, thereby achieving self-reflection, self-updating, and self-improvement.

5.3 *Establishing an Incentive Evaluation Mechanism for Innovation*

Higher education institutions should establish a differentiated and incentive-based evaluation mechanism to comprehensively stimulate students' innovation potential and create inclusive and supportive innovation education environment. Concretely speaking, they should avoid adopting uniform standards to conduct evaluations, set differentiated evaluation indicators for students with different foundations and specialties, focus on students' development increments, innovation attempts, and idea updating, and give positive recognition and support to unconventional and innovative exploration, including tolerance of students' faults during the innovation exploration process and dispelling of concerns about innovation exploration. In addition, they should add an additional innovation evaluation module, and take extended innovation achievements that students independently completed, such as algorithm improvement, project research, competition awards, patents, and scene optimization as important evaluation criteria to fully recognize the value of their extracurricular innovation practice. Concurrently, they should leverage positive evaluations to prompt students to break through the traditional learning boundaries, and actively engage in independent innovation and inter-disciplinary integration practice so as to continuously enhance their innovative awareness, innovative thinking and innovation capabilities [5].

6.Conclusion

The innovation education quality of the Deep Learning for Computer Vision course directly affects the cultivation effectiveness of innovation-oriented engineering talents in the field of artificial intelligence. To optimize the teaching models aligned to technological iteration and industry demands is an inevitable trend in the reform of engineering education in higher education. To address the main problems such as rigid course content, superficial practical components, and weak evaluation systems in current course teaching, this paper constructs a systematic teaching improvement pathway from four aspects: content reconstruction, model updating, practice reinforcement, and evaluation improvement, focusing on developing students' innovative thinking, enhancing their inquiry ability, and cultivating their engineering innovation literacy. In the future, higher education institutions should continue to anchor in technological frontiers and industry demands to dynamically optimize teaching systems, update educational models, dismantle the barriers among theory teaching, research & exploration and industrial innovation, continuously enhance the innovation educational efficiency of courses, and provide high-caliber professionals with core innovation capabilities for the high-quality development of the AI industry.

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