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The Curriculum Reform and Practical Exploration of HarmonyOS Application Development Under the Background of Emerging Engineering Education

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Abstract: With the steady advancement of the construction strategy for emerging engineering disciplines and the explosive proliferation of domestic operating system industrial ecosystems, cultivating compound technical talents proficient in distributed application development based on HarmonyOS has evolved into an indispensable strategic pathway to foster high-quality growth within the digital economy sector and safeguard national critical information security infrastructure. At present, undergraduate and vocational colleges are plagued with multiple structural drawbacks in the delivery of HarmonyOS application development curricula, including stagnant teaching content that lags behind iterative technological breakthroughs, rigid instructional methodologies disconnected from real-world industrial engineering scenarios, as well as monotonous, ossified student performance evaluation frameworks. Such systemic defects fundamentally fail to satisfy the core training objectives of emerging engineering education, which prioritize interdisciplinary competence, innovative thinking and hands-on engineering practice. Grounded in the core ideological connotation of emerging engineering construction, this paper integrates the proprietary technical architectures of HarmonyOS and the actual talent recruitment demands of downstream industrial enterprises. It systematically dissects the intrinsic value and feasible implementation avenues of curriculum renovation, and puts forward targeted, operable reform countermeasures. The research outcomes are intended to optimize the overall curriculum architecture, elevate comprehensive instructional quality, and furnish solid theoretical references and actionable practical inspirations for institutions of higher learning undertaking homologous curriculum transformation initiatives.

Keywords: Emerging engineering education; HarmonyOS; Application development; Curriculum renovation & reform

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1. Introduction

Institutions of higher education function as the core incubation hubs for industrial technical talents. They are obligated to proactively align instructional planning with the evolving demands of industrial chains, accelerate comprehensive reform initiatives targeting HarmonyOS application development courses, break the rigid shackles of conventional lecture-dominated teaching paradigms, and establish integrated curriculum systems and diversified instructional modes consistent with the competency training benchmarks of emerging engineering disciplines. Rooted in frontline teaching practices carried out at vocational universities, this paper centers on curriculum transformation of HarmonyOS application development within the emerging engineering context. It elaborates on the profound practical value, prevalent institutional bottlenecks and tangible implementation schemes of curriculum reform, with the intention of providing multi-faceted support for upgrading curriculum teaching quality and cultivating high-caliber interdisciplinary engineering practitioners.

2. Intrinsic value of HarmonyOS application development curriculum reform under emerging engineering background

Curriculum restructuring constitutes a pivotal strategic instrument to materialize the talent cultivation missions of emerging engineering education and fill the domestic talent vacuum within the operating system industry. The construction of emerging engineering disciplines is formulated to underpin state-level grand strategies such as manufacturing power construction, and its layout logic closely correlates with the spatial distribution of economic belts, urban agglomerations and complete industrial value chains. Domestic independently-developed operating systems serve as the foundational core infrastructure of the information technology industry, whereas the acute scarcity of specialized technical personnel has emerged as the primary bottleneck stifling sustainable industrial advancement [1]. As the flagship indigenous distributed operating system, HarmonyOS's industrial developmental prospects are directly contingent on the scale and proficiency of its application development talent pool, which is a decisive factor determining the autonomy, controllability and high-quality progression of China's digital industrial system. Talents graduated from existing university training systems generally suffer a stark disconnection between theoretical knowledge accumulation and on-site engineering practice, alongside severe mismatches between mastered technical skill sets and corporate recruitment criteria, rendering them incapable of fulfilling enterprises' demand for versatile full-stack developers. Through systematic curriculum overhaul, educators can revamp outdated teaching syllabi, renovate rigid instructional vehicles and amplify hands-on practical modules, thereby boosting undergraduates' comprehensive proficiency in HarmonyOS application programming. Such reform endeavors facilitate the cultivation of application-oriented technical elites equipped with solid theoretical foundations, specialized technical expertise and standardized vocational awareness, offset the prevailing talent deficit within the domestic operating system sector, and lay a robust foundational bedrock for fully realizing the talent cultivation objectives of emerging engineering education [2].

Furthermore, curriculum reform acts as an efficient driving mechanism to synchronize instructional delivery with the rapid iterative evolution of HarmonyOS technology and advance deep-seated industry-education integration. HarmonyOS has undergone successive generational upgrades ranging from the primitive Version 2.0 to the cutting-edge NEXT iteration, accompanied by continuous structural overhauls to its core system architecture, official development toolchains and open API interfaces, alongside the constant emergence of innovative technical paradigms such as distributed inter-device collaboration, atomic service modules and the ArkTS statically typed programming language. Conventional curricula feature sluggish content renewal cycles that fail to keep pace with fast-track technological evolution, forcing newly recruited graduates to endure lengthy re-training cycles before meeting post-competency standards [3]. Post curriculum restructuring, a dynamic iterative updating mechanism for teaching syllabi will be institutionalized, integrating state-of-the-art HarmonyOS technical architectures and up-to-date industrial recruitment demands into daily instructional sessions. Simultaneously, colleges ought to deepen strategic collaborative partnerships with leading tech conglomerates represented by Huawei, assimilate authentic industrial development projects, standardized official development utilities and unified technical specifications into teaching resources, and achieve dual synchronization: alignment between instructional contents and industrial market demands, and integration between classroom teaching workflows and on-site engineering operations. This dual synergy profoundly deepens industry-education integration mechanisms and substantially enhances the adaptability and practical efficacy of course delivery. Standardized systematic teaching resources released by Huawei, including the official First Lesson of HarmonyOS, furnish abundant resource reserves for curriculum content renewal and instructional model innovation, laying a solid groundwork for integrated teaching frameworks that unify knowledge acquisition, practical drills, and competency assessments [4].

3. Reform and practical countermeasures for HarmonyOS application development curricula under emerging engineering framework

3.1. Reconstruct hierarchical curriculum content architecture

First, the foundational module is designed to consolidate rudimentary theoretical knowledge and establish seamless articulation with prerequisite courses. It encompasses core introductory theories and fundamental conceptual frameworks of HarmonyOS, laying a robust knowledge foundation for subsequent advanced learning sessions. The module's core coverage spans the evolutionary chronicle, distinctive functional characteristics, layered system architecture of HarmonyOS, deployment procedures of dedicated development environments, and elementary syntactic specifications of the ArkTS programming language [5]. Aligned with the interdisciplinary integration tenets of emerging engineering disciplines, the module augments instructional coverage of auxiliary foundational disciplines including computer network communication, relational database systems and Internet of Things infrastructure, enabling seamless knowledge linkage with preceding compulsory courses and nurturing students' cross-domain systemic thinking capacities. The ArkTS language, designated as the core foundational programming framework, is introduced with reference to standardized syllabi extracted from Huawei's official *First Lesson of HarmonyOS*, ensuring students master normative programming grammars and industrial-standard development workflows.

Second, the core specialized module revolves around pivotal technical frameworks and industrial engineering deployment scenarios, with content configuration calibrated to core knowledge nodes of HarmonyOS application development and actual post-competency benchmarks within the industry, aiming to cultivate students' core end-to-end development capabilities. Its core instructional contents cover the complete developmental workflow of HarmonyOS applications, multi-dimensional page layout architectures, reusable component programming logic, persistent data storage mechanisms, cross-device distributed capability exploitation, atomic service deployment protocols and diversified API invocation architectures. In addition, standardized debugging methodologies and systematic testing workflows for HarmonyOS applications are formulated in accordance with real industrial operational requirements, with the objective of elevating undergraduates' hands-on engineering problem-solving competencies [6]. The content layout adheres to the principle of integrating theoretical elucidation with practical operational drills, attaching authentic industrial case studies following every independent knowledge node to facilitate students' immediate application of newly acquired theories. Special thematic lectures centering on domestically-originated core root technologies such as the Ark Compiler and native HarmonyOS kernel architecture are embedded within teaching schedules, strengthening students' recognition and identity toward indigenous independent core technological systems.

3.2. Innovate diversified instructional modalities

First, the project-based teaching method takes real projects as the carrier and runs through the entire course teaching process. At the start of the course, several typical HarmonyOS application projects are introduced to explain project requirements, functions and development objectives, and break down the course knowledge points into each development phase of the projects [7]. During instructional delivery, full-cycle project development acts as the primary narrative thread. Instructors guide students to execute systematic procedures including demand feasibility analysis, high-level architectural design, modular coding implementation, systematic debugging and comprehensive functional testing. Students proactively absorb and internalize targeted knowledge modules amid iterative project construction, which significantly augments their engineering practice proficiency and independent troubleshooting capabilities. Taking distributed multi-device collaborative development as a concrete illustration, the cross-device intelligent control industrial project is adopted for instructional demonstration, empowering students to independently design interconnection control logic between smart mobile terminals and peripheral hardware such as smart desk lamps and wearable smart watches, while systematically mastering distributed data scheduling and cross-device task allocation mechanisms. Learners are partitioned into multi-person project teams with clear role divisions and delineated job responsibilities, simulating standardized enterprise R&D team operational modes and cultivating students' teamwork awareness and cross-individual communication coordination capacities [8].

Second, the case-based teaching method improves the pertinence and practicality of teaching by combining real industrial cases. Typical cases are selected from the HarmonyOS ecosystem for research to analyze their development ideas, technical challenges and problem-solving approaches, as well as present real industrial development standards and requirements, so that students can grasp the development requirements of the industry. Corresponding cases are designed according to the knowledge points of the course. When explaining "page layout", various types of web page layout cases are analyzed to explore applicable scenarios and operating procedures of each layout mode. When teaching "atomic service development", atomic service cases related to daily life are adopted to guide students to reflect on the design concepts and deployment methods of atomic services. Through case analysis and simulated development, students can transform theoretical knowledge into practical capabilities, broaden their horizons, and keep abreast of the latest industrial development concepts and technical trends [9].

Third, the online-offline blended teaching method organically integrates "online autonomous learning" and "offline centralized teaching" via online teaching platforms [10]. For the online segment, teaching resources including courseware, instructional videos, training cases, and extended materials are uploaded to online teaching platforms such as MOOCs and Xuexitong. This enables students to independently learn basic knowledge points and finish preview tasks before class. During offline classes, teachers focus on explaining and answering questions encountered by students in preview, and organize group discussions, practical operations and other activities. Online assignments and training tasks are assigned after class to help students consolidate knowledge and expand their learning scope [11]. The interactive functions of online platforms are leveraged to build communication channels between teachers and students as well as among students, so as to timely resolve learning problems arising during the learning process.

3.3. Overhaul comprehensive curriculum evaluation mechanisms

First, attach importance to process evaluation and conduct inspections and assessments covering students' entire learning process. Process evaluation accounts for 40% to 50% of the overall course score, serving as a comprehensive assessment of students' pre-class preview, in-class performance, homework completion status, progress of practical training projects, group collaboration performance and other dimensions. Pre-class preview is assessed based on students' completion of preview tasks and scores of preview tests on online platforms. In-class performance is evaluated from perspectives including students' speech delivery, participation in group discussions, and enthusiasm for practical operations. Homework completion mainly assesses homework quality, submission timeliness, and students' ability to apply learned knowledge into practice. The progress of practical training projects is measured through students' project reports and presentations of phased achievements. Group collaboration performance focuses on evaluating students' capabilities in task division, communication and teamwork within group projects [12]. Process evaluation integrates teacher assessment, peer group evaluation and self-assessment to ensure objectivity and comprehensiveness of evaluation. Meanwhile, evaluation results can be fed back in a timely manner to guide students to identify their deficiencies and make improvements. During practical training projects, teachers conduct regular inspections of students' project progress, group members grade one another, and students are required to conduct self-reflection, forming a closed loop of evaluation, feedback, and improvement [13].

Second, reform summative evaluation methods and prioritize the assessment of students' comprehensive literacy. Summative evaluation takes up 30% to 40% of the total course score. It abandons the traditional mode that solely relies on theoretical written examinations for summative assessment, and replaces it with practical assessments and project defenses. Practical assessments mainly examine students' hands-on capabilities in HarmonyOS application development. Students are required to develop, debug and test a small-scale HarmonyOS application within a designated time frame, with focus on evaluating their technical application skills, problem-solving abilities and engineering practice competence [14]. Project defense requires students to present the development process of their comprehensive practical training projects or innovation and entrepreneurship projects, and elaborate on project content from the perspectives of demand analysis, design concepts, technical implementation and innovative highlights. A defense panel composed of teachers and enterprise engineers conducts a comprehensive evaluation of students based on project quality, presentation skills and innovation capacity. Summative evaluation emphasizes testing students' comprehensive application abilities, avoids mechanical rote memorization, and ensures that evaluation results can truly reflect students' competency matching corresponding job requirements [15].

4. Conclusion

To sum up, curriculum reform constitutes an iterative developmental process featuring constant trial, error correction and systematic optimization. Institutions of higher learning ought to continuously refine and upgrade HarmonyOS-related curricula in response to iterative technological updates and shifting industrial talent recruitment demands, intensify the construction of hands-on practical instructional modules, and adopt multi-dimensional composite evaluation frameworks to comprehensively elevate overall curriculum delivery quality. Colleges need to deepen long-term strategic school-enterprise collaborative partnerships, vigorously advance multi-layered industry-education integration initiatives, and construct full-functional integrated practical teaching platforms. Through sustained reform efforts, a large cohort of proficient HarmonyOS application developers equipped with solid technical foundations, abundant industrial practical experience, and forward-looking innovative awareness can be cultivated, furnishing robust intellectual support for the comprehensive construction of emerging engineering disciplines, high-quality sustainable advancement of the digital industry, and vigorous expansion of the indigenous HarmonyOS industrial ecosystem.

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Disclosure statement

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