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Exploration of Teaching Practice for the HarmonyOS Application Development Course Based on Project-Based Learning

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Abstract: Project-based teaching is a practical instructional model well-suited for software development courses. The HarmonyOS Application Development course combines both theoretical and practical components, yet traditional teaching approaches struggle to meet its talent cultivation requirements. This paper employs project-based teaching as the core methodology, examines its alignment with the HarmonyOS Application Development curriculum, identifies existing challenges in project design, implementation, and evaluation, and explores practical solutions through three dimensions: project framework development, teaching implementation optimization, and evaluation mechanism enhancement. The findings provide theoretical insights and actionable strategies to improve course quality and cultivate students' hands-on application development skills and engineering literacy in HarmonyOS.

Keywords: Project-based teaching; HarmonyOS; Application development; Teaching practice

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1. Introduction

HarmonyOS Application Development is an emerging core course designed for computer science majors to align with the development of the HarmonyOS ecosystem. Characterized by rapid technological iteration, strong practicality, and interdisciplinary knowledge integration, it challenges the traditional teaching model that prioritizes theoretical instruction over hands-on training. Project-based teaching, utilizing real-world projects as its foundation and employing the "learning by doing, doing while learning" approach, achieves deep integration of knowledge and practice, serving as an effective solution to the course's instructional challenges. Grounded in practical teaching realities, this paper explores the implementation of project-based teaching in the HarmonyOS Application Development course, optimizes the instructional process and methods, and enhances students' core HarmonyOS development capabilities and engineering practice competencies.

2. The integration logic between project-based teaching and the HarmonyOS application development course

2.1. The value alignment logic between project-based teaching and the practical characteristics of the curriculum

The core objective of the HarmonyOS Application Development Course is to cultivate students practical development skills, requiring them to master hands-on competencies such as the Ark development framework, UI design, and component development, rather than relying solely on theoretical memorization. This aligns perfectly with the project-based teaching approach's value orientation of "practice-centered learning". By using concrete development projects as vehicles, project-based instruction exposes students to real-world development scenarios, transforming abstract theoretical knowledge into practical operational skills, thereby fulfilling the course's core requirement for hands-on ability. Theoretical instruction divorced from practice fails to enable students to truly master HarmonyOS development techniques; in contrast, project-based teaching breaks down the barrier between theory and practice by integrating course content into various project development phases, allowing students to understand the application scenarios of theoretical knowledge through hands-on development. This teaching model consistently focuses on practical implementation, closely matching the hands-on nature of the HarmonyOS Application Development Course and effectively addressing the traditional issue of "disconnection between theory and practice".

2.2. The integration and construction logic of the course knowledge system through project-based teaching

The knowledge framework of the HarmonyOS Application Development course is interdisciplinary and interconnected, encompassing multiple modules such as programming languages, development frameworks, interface design, and data storage. Each knowledge point is seamlessly integrated and progressively built upon the previous one, a contrast to traditional fragmented teaching methods that often lead to disorganized understanding among students. Project-based instruction uses real-world projects as a cohesive thread to consolidate scattered knowledge into a unified system, enabling students to grasp the intrinsic relationships between different concepts through practical development experiences. Following standard project workflows, the course structure is divided into modules including requirement analysis, framework implementation, feature development, and testing/optimization. By completing tasks at each stage, students gradually establish a comprehensive knowledge framework for HarmonyOS development. This integrated approach helps students clarify logical connections between concepts, avoid knowledge gaps caused by fragmented learning, and achieve a holistic understanding coupled with flexible application of the course content.

2.3. The empowering logic of project-based teaching in cultivating students' developmental competencies

The HarmonyOS application development role demands professionals with comprehensive skills in project design, teamwork, and problem-solving, whereas traditional teaching methods focus solely on individual skill training, failing to cultivate students' holistic capabilities. Project-based learning immerses students in the entire development lifecycle, from requirement analysis and solution design to functional implementation and testing optimization, allowing them to hone core competencies through hands-on practice and achieve well-rounded development capabilities. During this approach, students independently analyze project requirements and devise development strategies, enhancing their project design and logical thinking skills; they address challenges such as framework compatibility and component debugging during development, improving problem-solving abilities; and complete collaborative projects that foster communication, coordination, and teamwork skills. These competencies align closely with the requirements of HarmonyOS development roles, laying a solid foundation for students' future careers.

3. Existing teaching issues in the application of project-based learning in curriculum

3.1. The course project design lacks hierarchy and relevance to industry practices

Current HarmonyOS application development courses suffer from a lack of scientific project hierarchy, featuring predominantly projects of uniform difficulty levels. They offer neither introductory projects suitable for students with weak foundations nor advanced projects tailored for more capable learners, making it challenging for beginners to keep up while preventing advanced students from achieving meaningful growth, a fundamental failure to implement differentiated instruction. Moreover, most projects resemble classroom simulations rather than reflecting real-world industry development scenarios. Many projects focus solely on implementing individual features, omitting critical phases such as requirement analysis, process standardization, and testing optimization, rendering graduates' projects incompatible with actual industry needs. Additionally, some project designs fail to keep pace with HarmonyOS's technological advancements, still employing outdated development frameworks and technical solutions. This creates a gap between students' acquired skills and real-world industry applications, hindering their rapid adaptation to job requirements post-graduation and diminishing the practical value of project-based learning [1].

3.2. Absence of a collaborative teacher-student guidance mechanism during project-based teaching implementation

In the implementation of project-based teaching, some instructors still adhere to the traditional lecture-based model, providing only brief explanations of development requirements before project initiation. This approach lacks comprehensive collaborative guidance throughout the students' development process, leaving them without timely effective support when encountering challenges, thus easily falling into development bottlenecks that compromise project efficiency and learning motivation. Additionally, the communication and feedback mechanisms between teachers and students are inadequate. Instructors fail to promptly monitor students' project progress, technical difficulties, or knowledge acquisition levels, making it impossible to adjust teaching pacing and guidance strategies accordingly. Furthermore, many courses lack collaborative exchange mechanisms among students; projects are predominantly completed independently, with insufficient peer experience sharing and problem discussions. This not only hinders the cultivation of teamwork skills but also prevents the resolution of development challenges through intellectual exchange, significantly diminishing the effectiveness of project-based teaching.

3.3. The course teaching evaluation system emphasizes outcomes over processes and features a single-dimensional approach

The current project-based assessment in HarmonyOS application development courses primarily focuses on final project outcomes, neglecting students' performance during the development process, including requirements analysis skills, design rationale, problem-solving methodologies, and teamwork effectiveness. This approach leads some students to adopt perfunctory approaches or directly replicate others' work, preventing genuine skill enhancement through project-based learning. Moreover, the evaluation framework remains overly simplistic, lacking diversified metrics. Assessments predominantly concentrate on functional implementation while failing to adequately evaluate code compliance, project innovation, or documentation completeness, nor do they incorporate students' self-directed learning capabilities or problem-solving skills. Additionally, evaluation is predominantly teacher-centered, lacking student self-assessment and peer feedback, resulting in incomplete and subjective outcomes that fail to accurately reflect students' actual learning progress and competency levels.

4. The core instructional principle for integrating project-based teaching into the curriculum

4.1. Practical principles for project design that align with cutting-edge technology and industry needs

The core of project-based teaching lies in project design. The project design for the HarmonyOS application development course must adhere to practical principles that align with technological advancements and industry needs, keeping pace with HarmonyOS's technical iterations by integrating the latest development frameworks, technical features, and development standards into the projects. This ensures that students' acquired skills remain synchronized with industry technological developments. Additionally, project designs must address real-world industry development requirements. By referencing actual development projects from HarmonyOS ecosystem enterprises and incorporating authentic project needs, development workflows, and testing standards, students gain exposure to real-world development scenarios in the classroom and master core competencies required for their future roles. Adhering to this principle enhances the practical value of project-based instruction, prevents a disconnect between student learning and industry demands, and ensures graduates can swiftly adapt to the requirements of HarmonyOS development positions [2].

4.2. The principle of balancing autonomous inquiry and tiered guidance in teaching implementation

The essence of project-based teaching lies in emphasizing students' central role in learning. The HarmonyOS application development course combines theoretical knowledge with practical skills, and its implementation must strictly adhere to the principle of integrating self-directed inquiry with tiered guidance. Teachers should fully empower students' initiative by assigning core tasks, including project requirement analysis, technical solution design, functional module development, and testing optimization, to students themselves. This approach enables students to refine their development strategies and overcome technical challenges through independent thinking and hands-on practice, gradually cultivating self-directed learning and problem-solving abilities while preventing over-instructional intervention that may lead to cognitive dependency and weakened practical skills. Additionally, educators must account for students' varying foundational knowledge, programming proficiency, and learning capacities. Tailored tiered guidance strategies should be implemented: for students with weaker foundations, focused instruction should cover HarmonyOS syntax, tool operation, and basic component usage to solidify their fundamentals; for more advanced learners, emphasis should be placed on functional innovation, technical optimization, and exploration of cutting-edge development frameworks, encouraging them to push technical boundaries independently. This organic integration of self-directed inquiry and tiered guidance ensures all students master core development skills while precisely meeting diverse learning needs, achieving true personalized instruction that enables learners at all levels to enhance their capabilities through project-based practice [3].

4.3. The synergistic principle of competency development integrating knowledge acquisition and engineering practice

The core objective of the HarmonyOS Application Development Course is to cultivate application-oriented developers with solid theoretical foundations and strong engineering practical skills. Therefore, project-based teaching must adhere to the principle of deeply integrating knowledge acquisition with engineering practice, breaking down the traditional disconnect between theory and hands-on application to achieve "learning-through-application and unity of knowledge and action". The teaching process should closely link theoretical instruction with project development exercises, avoiding purely theoretical explanations divorced from real-world contexts. The curriculum should focus on addressing practical technical challenges encountered during project development, enabling students to clearly understand the application scenarios and practical value of HarmonyOS development frameworks, component principles, and data communication mechanisms, making theoretical learning a robust support for solving practical problems. Additionally, students are required to strictly follow industry engineering standards throughout the project lifecycle, from drafting requirement documents and writing standardized code to conducting unit testing, deploying projects, and organizing development documentation, thereby

comprehensively simulating real enterprise development workflows and fostering engineering mindset and standardized operational capabilities. Through this integrated approach, students not only master core HarmonyOS theories but also develop robust practical development skills, becoming application-oriented technical professionals who meet the industry demands of the HarmonyOS ecosystem and can swiftly adapt to professional roles [4].

5. Optimization strategies for curriculum teaching practice based on project-based learning

5.1. Establishing a hierarchical and progressive HarmonyOS project design framework

Establishing a scientifically structured, tiered HarmonyOS project design framework serves as the cornerstone for ensuring the effectiveness of project-based learning. This framework must strictly align with students' learning progress, knowledge base, and development capabilities, dividing teaching projects into three clearly defined tiers, beginner, advanced, and comprehensive, that progressively increase in difficulty to match students' skill levels precisely. Beginner-level projects focus on practical applications of fundamental HarmonyOS concepts, covering basic UI design, component invocation, and page navigation. These projects lower the development barrier, enabling students to quickly master DevEco Studio operations and acquire essential HarmonyOS application development skills. Advanced projects emphasize integrated application of multi-chapter knowledge, addressing topics like data storage, network requests, and component communication, requiring students to apply their knowledge to solve complex development challenges while enhancing coding proficiency and logical design capabilities. Comprehensive projects closely align with real-world HarmonyOS ecosystem demands, incorporating practical scenarios such as smart home control mini-programs, mobile office applications, and campus service tools. Students independently complete the full development lifecycle, from requirements analysis and solution design to functionality implementation and testing/deployment, holistically cultivating engineering practice competencies. Meanwhile, projects at all levels stay closely aligned with the latest advancements in HarmonyOS technology, incorporating cutting-edge development frameworks, technical features, and industry standards to ensure both practicality and technological sophistication. Through a layered, progressive project design, students' development skills are progressively enhanced as projects advance, enabling a steady progression from foundational development to comprehensive applications.

5.2. Optimizing the classroom implementation path for the entire project-based teaching process

To optimize the classroom implementation pathway for the entire project-based teaching process, it is essential to establish a closed-loop, systematic instructional framework tailored to the characteristics of HarmonyOS application development courses. The teaching process should be clearly divided into five core stages: project introduction, knowledge explanation, project implementation, outcome presentation, and reflective summary. Each stage is interconnected and progressively built upon the previous one, ensuring instructional coherence and effectiveness. During the project introduction phase, real-world industry cases from the HarmonyOS ecosystem are used to vividly illustrate the development context, practical applications, and core requirements, effectively sparking students' interest and curiosity in project development. The knowledge explanation phase moves away from traditional theoretical lectures, focusing instead on addressing key challenges and core technologies specific to this project to eliminate knowledge barriers. The project implementation phase provides ample time for independent development or teamwork, allowing students to choose their preferred approach while teachers provide continuous guidance, promptly resolving technical issues and helping students organize problem-solving strategies. The outcome presentation phase encourages students to showcase their projects, sharing development concepts, technical solutions, and practical insights through teacher-student and peer evaluations, thereby broadening their technical perspectives. In the reflective summary phase, instructors conduct a comprehensive review of the project, highlighting key concepts and development techniques, offering precise feedback on strengths and areas for improvement, and guiding students to independently summarize their learning experiences and lessons learned. Furthermore, an integrated online-

offline communication platform has been established. Online, tools such as Xuexutong and WeChat groups enable real-time Q&A sessions between teachers and students, as well as student discussions; offline, face-to-face guidance is provided in classrooms and laboratories, facilitating instant communication and feedback among faculty and students alike, thereby ensuring the effective implementation of project-based teaching.

5.3. Improve a comprehensive, multi-dimensional course teaching evaluation and feedback mechanism

Enhancing a comprehensive and multi-dimensional course evaluation and feedback mechanism is crucial for improving project-based teaching quality and motivating student engagement. It requires moving beyond the traditional single-evaluation model that prioritizes outcomes over processes, and establishing an all-encompassing, diversified assessment system that integrates "process + outcome", "quantitative + qualitative" and "teacher + student" perspectives. The entire project development lifecycle should form the core of evaluations, with quantitative assessments covering indicators such as the completeness of requirements analysis, project progress management, timeliness of problem resolution, and team collaboration participation, alongside qualitative evaluations of students' development approaches, innovative thinking, and learning attitudes. Concurrently, final project deliverables should be comprehensively assessed across multiple dimensions, including functional completeness, code coding standards, interface aesthetics, project innovation, and documentation quality. A tripartite evaluation framework should be implemented involving teacher assessments, student self-evaluations, and peer reviews: teachers provide objective professional evaluations; students identify learning achievements and areas for improvement through self-assessment; and peers exchange insights and identify mutual challenges through peer feedback, ensuring comprehensive and impartial outcomes. Additionally, a timely and efficient two-way feedback mechanism should be established, where teachers offer personalized recommendations addressing specific learning gaps and improvement directions. Student feedback on project design, teaching implementation, and instructional methods should be systematically collected to optimize project frameworks, refine teaching approaches, and enhance instructional guidance, forming a closed-loop management system of "evaluation–feedback–optimization". Through a multi-dimensional and comprehensive evaluation and feedback mechanism, the guiding, motivating, and improvement functions of assessment are fully leveraged to continuously enhance the overall effectiveness and teaching quality of project-based learning.

6. Epilogue

The deep integration of project-based teaching with the HarmonyOS application development course represents a pivotal initiative to align with the evolution of the HarmonyOS ecosystem and enhance instructional quality. This paper establishes a research framework encompassing four dimensions, adaptation logic, existing challenges, implementation principles, and practical strategies, clarifying the core direction for implementing project-based teaching within the course. By developing a tiered, progressive project design system, optimizing the entire instructional implementation process, and refining a comprehensive, multi-dimensional evaluation and feedback mechanism, this approach effectively addresses the limitations of traditional teaching methods while fostering deep integration between theoretical knowledge and engineering practice. Simultaneously, it enables students to systematically acquire HarmonyOS application development skills, improve their engineering competencies and job readiness, thereby providing robust practical support for cultivating high-caliber, application-oriented developers for the HarmonyOS ecosystem.

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