

Project-Based Teaching Reform and Analysis of Outcomes for the ‘AI + HarmonyOS’ Course

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Abstract: Against the industrial backdrop of the deep integration between the development of a domestic, independent operating system ecosystem and artificial intelligence technology, the HarmonyOS mobile application development course faces practical challenges such as outdated teaching content, monotonous teaching methods, low teaching efficiency, and a disconnect between theory and practice. Guided by the talent development objectives of applied undergraduate institutions, this paper constructs a project-driven ‘AI + HarmonyOS’ curriculum reform system. The reform is implemented across four dimensions: optimisation of the curriculum framework, innovation in teaching methods, strengthening of practical teaching, and restructuring of the assessment system. Through dynamic updates to course content, the full-process empowerment of AI tools, university–industry collaborative practice, and diversified assessment methods, the reform enhances students’ multidisciplinary development capabilities, engineering practice skills and employability. Practice has demonstrated that this reform model has effectively optimised the quality and efficiency of course delivery, promoted the development of a ‘dual-qualified’ teaching staff, and deepened the integration of industry and education as well as the university–industry collaborative talent development mechanism. It can serve as a practical reference for digital teaching reform in engineering programmes at applied undergraduate institutions.

Keywords: Project-Driven; AI + Harmonyos; Mobile Application Development; Teaching Reform; Effectiveness Analysis

1. Introduction

In response to the calls set out in the ‘14th Five-Year National Informationisation Plan’ to promote the construction of an integrated ecosystem based on the HarmonyOS operating system and to deepen the development of artificial intelligence applications, the installed base of HarmonyOS is projected to reach over 1 billion units by 2025, with widespread application in fields such as smart terminals, the Industrial Internet and smart education. Consequently, mastering AI technology based on the HarmonyOS system has become an inevitable trend and an urgent requirement [1]. Applied technology-oriented universities serve as key bridges between higher education and industrial needs. The HarmonyOS mobile application development course, which is the focus of this study’s teaching reform, is a core module for cultivating relevant technical professionals and bears the important mission of supplying the HarmonyOS ecosystem with application-oriented, skilled talent [2]. However, traditional courses often suffer from issues such as slow knowledge updates, outdated project case studies [3], a disconnect between AI and HarmonyOS development, insufficient practical components, and one-dimensional assessment methods, making it difficult to meet the industry’s demand for multidisciplinary talent who ‘understand both HarmonyOS development and AI applications’. Specifically, the HarmonyOS operating system undergoes rapid version updates, whilst development tools, component capabilities and ecosystem standards are constantly evolving; if teaching materials and case studies are not updated in a timely manner, the content students learn is likely to become disconnected from industry realities; Artificial intelligence technology is rapidly permeating the entire mobile application development process [4]; from intelligent interaction, image recognition and natural language processing to recommendation

algorithms, intelligent customer service and device collaboration, AI has become a crucial pillar of HarmonyOS application innovation. However, traditional courses often treat AI and HarmonyOS development as separate disciplines, resulting in students lacking an awareness of technological convergence and the ability to implement solutions in an engineering context. Furthermore, if project-driven teaching lacks the support of AI tools, lecturers must devote a significant amount of time to repetitive code guidance and debugging, making it difficult to improve teaching efficiency [5]; similarly, without real-world enterprise projects and dual-mentor guidance in practical teaching, students' engineering standards, teamwork and job adaptability are unlikely to be adequately developed [6]. In light of this, the course team has adopted a project-driven approach as the central focus, utilising AI technology as an enabling tool, and has undertaken systematic reforms centred on the curriculum framework, teaching methods, practical instruction and the assessment system. The aim is to achieve a precise alignment between teaching content and industry needs, as well as a deep integration between teaching models and the cultivation of students' competencies, thereby providing a reference framework for the reform of 'New Engineering' courses at application-oriented undergraduate institutions. Drawing on the practical experience of developing the 'HarmonyOS Mobile Application Development' course at the School of Computer Science, Guangdong University of Science and Technology, this paper summarises the reform objectives, core measures, practical outcomes and innovative features, with a view to providing a reference for similar courses.

2. Objectives and Design Principles of the 'AI + HarmonyOS' Course Reform

This teaching reform takes addressing the core issues in traditional HarmonyOS mobile application development courses as its starting point, aiming to achieve four major objectives through systematic reform: firstly, to construct a curriculum system that deeply integrates AI with HarmonyOS development, establishing a mechanism for the dynamic updating of teaching content to resolve issues of outdated material and the disconnect between theory and practice; secondly, to innovate an AI-empowered, project-driven teaching model, enriching teaching

methods and enhancing both teaching efficiency and student engagement; thirdly, to strengthen an AI-empowered practical teaching system, refine practical training resources and assessment standards, and enhance students' engineering practice and teamwork skills; fourthly, to restructure a diversified teaching evaluation system, produce replicable and scalable outcomes from the teaching reform, and improve students' employability and the course's industry relevance. These objectives are not isolated from one another but mutually supportive: the curriculum framework serves as the foundation, determining the comprehensiveness of students' knowledge structure; teaching methods act as a bridge, determining the efficiency of knowledge transfer and skills development; practical teaching is the key, determining whether students can transform knowledge into engineering competence [7]; and the assessment system serves as a guiding principle, determining what students learn, how they learn it, and what teachers teach and how they teach it. In terms of reform design, the curriculum adheres to the integration of industry and education [8], with course content and practical projects closely aligned with the practical needs of the HarmonyOS ecosystem's development and the industrial applications of AI technology, ensuring that teaching content remains synchronised with cutting-edge industry technologies and actual enterprise development standards; It adheres to AI-enabled learning, applying AI tools to project development, teaching assessment and other aspects, whilst deeply integrating fundamental AI theory with HarmonyOS development scenarios to achieve integrated teaching of 'AI technology + HarmonyOS development'; it adheres to a project-driven approach [9], using real-world HarmonyOS AI development projects as the core vehicle, breaking down course knowledge points and incorporating them into each stage of project development, enabling students to master theoretical knowledge and practical skills whilst completing the projects; Adhere to a student-centred approach, utilising AI technology to analyse students' learning behaviours and ability levels, formulating personalised learning plans, and providing differentiated teaching resources and guidance to meet the learning needs of students with diverse academic backgrounds and varying levels of prior knowledge. Through these principles, the course emphasises both

industry relevance and technological innovation whilst accommodating student diversity and fostering the development of competencies, thereby forming a closed-loop logic of ‘industry needs – course objectives – project-based learning – learning assessment’. In terms of breaking down specific objectives, the course also emphasises the three-dimensional integration of ‘knowledge—competence—competencies’: the knowledge dimension focuses on AI fundamentals, HarmonyOS components, system architecture and development standards; the competence dimension emphasises requirements analysis, architectural design, code implementation, model integration, testing and optimisation, and team collaboration; whilst the competencies dimension emphasises engineering ethics, an innovative mindset, independent learning, a sense of national pride and a sense of responsibility towards technology. Through the coordinated advancement of these three-dimensional objectives, the curriculum reform focuses not only on whether students ‘can do it’, but also on whether they ‘can do it well’ and ‘are willing to continue doing it’, thereby providing a clear direction for the cultivation of multidisciplinary technical talent.

3. Core Measures for Project-Driven ‘AI + HarmonyOS’ Curriculum Reform

With project-driven learning at its core and AI technology as an enabling tool, systematic teaching reforms are being implemented across four dimensions—curriculum framework, teaching methods, practical instruction and assessment systems—to establish an integrated teaching reform framework characterised by ‘knowledge integration, model innovation, practical reinforcement and assessment restructuring’.

3.1 Optimising the Curriculum Framework and Innovating Teaching Methods

In terms of optimising the curriculum framework, we have broken down the knowledge barriers of traditional HarmonyOS development courses to construct a systematic, dynamic and adaptable ‘AI + HarmonyOS’ curriculum framework. Firstly, we have achieved the integrated fusion of AI and HarmonyOS development knowledge. The curriculum systematically incorporates fundamental AI theories such as machine learning and deep learning; explains how AI

algorithms—including image recognition and natural language processing—are integrated and invoked in HarmonyOS applications; and introduces practical case studies from the HarmonyOS ecosystem, such as AI-driven intelligent interaction interfaces and AI-based device collaboration functions. This enables students to understand the logic behind the integration of AI technology and HarmonyOS development, and to master the complete knowledge chain of “theory—algorithms—application”. Unlike simply adding separate AI or HarmonyOS courses, this framework emphasises embedding AI capabilities into HarmonyOS application development and adapting AI algorithms to comply with HarmonyOS device and ecosystem specifications, enabling students to understand both algorithmic principles and practical engineering implementation methods. For example, in the AI image recognition project for the HarmonyOS photo album, students must complete camera permission requests, image capture, model inference, result display and performance optimisation; in the AI recommendation algorithm project for HarmonyOS e-commerce, students must carry out user behaviour data collection, recommendation model invocation, product list sorting and adaptation to HarmonyOS’s distributed capabilities; and in the AI customer service HarmonyOS application, students must handle voice input, intent recognition, dialogue management and service card display. Through these specific projects, AI ceases to be merely a concept and becomes an integral part of functional innovation in HarmonyOS applications. Secondly, a mechanism for the dynamic updating of course content has been established. A system for updating teaching content has been established that is linked to the iterative releases of the HarmonyOS operating system and advancements in AI technology. Each term, the latest case studies from the Huawei Developer Community and real-world project requirements from enterprises are collected to update the course case study repository; teaching content is promptly adjusted in response to newly developed tools such as the HarmonyOS AI Editor and intelligent debugging tools, ensuring that the curriculum remains at the cutting edge of the industry. At the same time, the course team has established an update process comprising ‘version tracking – case

selection – pedagogical adaptation – student feedback’, enabling new knowledge to be rapidly integrated into the classroom, incorporated into projects and reflected in assessments. Thirdly, the system for building foundational knowledge has been optimised. The prerequisite knowledge required for HarmonyOS development—including programming languages, data structures and operating system fundamentals—has been systematised to form a visualised knowledge graph; tailored supplementary learning programmes have been designed for students from different academic backgrounds, such as software engineering and Internet of Things engineering; an online learning platform has been developed to provide self-study resources such as video tutorials and exercise sets, helping students address knowledge gaps and lower the barrier to entry. Through these measures, the course no longer treats AI and HarmonyOS as two separate modules; instead, it uses projects as a unifying thread to organically link AI theory, HarmonyOS components, development tools and industry case studies, forming a clearly structured and dynamically updated knowledge system.

In terms of innovation in teaching methods, with project-driven learning at the core, AI tools and technologies are integrated throughout the entire teaching process to create an AI-empowered, project-driven teaching model. Firstly, AI-assisted project-based teaching is implemented [10]. Tiered HarmonyOS AI development project cases are designed, ranging from basic HarmonyOS application development to the development of complex ‘AI + HarmonyOS’ integrated applications, thereby forming a step-by-step project training system; AI programming assistants, AI code editors and intelligent optimisation tools are introduced into project development to guide students in rapidly generating reusable code and enabling intelligent debugging and optimisation, significantly enhancing project development efficiency and allowing students to focus on cultivating core competencies such as project design and technological integration. Secondly, promote the integration of diverse teaching models. Based on the flipped classroom approach, AI-assisted instructional videos are assigned in advance for self-study of key concepts, whilst classroom time is primarily devoted to practical project training, problem-solving and technical

extension; blended learning is implemented via online platforms, utilising intelligent learning analytics systems to monitor students’ learning progress and outcomes, thereby enabling targeted individual tutoring; learning is facilitated through competition by organising student participation in HarmonyOS development contests and AI application innovation competitions, thereby stimulating innovative thinking and teamwork skills. Thirdly, we implement AI-driven personalised teaching. We utilise AI technology to analyse students’ learning behaviours, ability levels and learning needs, thereby devising personalised learning plans and pathways for each student; we have developed an AI-powered Q&A system that provides 24-hour online support and automatically recommends targeted learning resources based on individual progress, thereby realising the goal of personalised teaching that ‘teaches according to individual aptitude’. Through AI-assisted project-based learning, flipped classrooms, blended learning and competition-driven approaches, course delivery has shifted from a ‘teacher-centred’ model to one ‘centred on practical projects with teacher guidance as a supplement’. Students have transitioned from passive recipients to active explorers, resulting in a marked improvement in classroom efficiency and learning engagement. In practice, the course team has also established a teaching sequence comprising ‘pre-class AI-guided learning – in-class project discussions – post-class intelligent Q&A – presentation of stage outcomes’: Before class, students master basic concepts through AI-assisted videos and preparatory tasks; during class, lecturers organise discussions, demonstrations and one-to-one guidance centred on project challenges; after class, the AI Q&A system addresses common queries, whilst lecturers focus on higher-order problems and fostering innovation; and stage-based outcome presentations—through project pitches, code reviews and peer assessments—encourage students to reflect and iterate.

3.2 Strengthening Practical Teaching and Restructuring the Assessment System

In terms of strengthening practical teaching, we emphasise the distinctive features of applied undergraduate institutions, utilise AI technology to empower practical project development, enhance practical teaching resources, introduce real-world corporate projects, and establish an

integrated practical teaching system combining ‘on-campus training and university-industry collaboration’. On the one hand, we have increased both the number and complexity of AI-based HarmonyOS development practical projects. These include practical projects such as an AI image recognition HarmonyOS photo album, an AI recommendation algorithm for HarmonyOS e-commerce, an AI customer service HarmonyOS application, an AI voice assistant for HarmonyOS control, and an AI health monitoring HarmonyOS wearable. Students are required to fully integrate AI technology with HarmonyOS development, utilising the capabilities of HarmonyOS devices and AI algorithms to realise intelligent, scenario-based applications; At the same time, real-world development projects from HarmonyOS ecosystem companies, such as Huawei, are introduced to guide students in understanding corporate development processes and standards. On the other hand, an AI + HarmonyOS development training platform is established, integrating AI tools, the HarmonyOS development environment and project case studies to provide students with a one-stop practical training platform; virtual simulation experiments are developed to simulate HarmonyOS devices in various AI scenarios, enabling students to conduct experiments and development in a virtual environment, thereby reducing the difficulty of hands-on operations; In collaboration with companies such as Huawei, off-campus practical training bases have been established to provide students with internship and employment opportunities, thereby realising a practical training model characterised by ‘practising at university, applying in the workplace’. At the same time, a dual-mentor system comprising ‘university lecturers and industry engineers’ has been implemented: university lecturers are responsible for guiding students in theoretical knowledge and basic development skills, whilst industry engineers provide guidance on project development processes, industry technical standards and practical problem-solving, ensuring that the development of students’ practical abilities is more closely aligned with the requirements of industry roles. Through a progressive sequence of in-class projects, comprehensive practical training, academic competitions and corporate placements, students gradually achieve a leap in capabilities—from basic development to AI

integration, from individual programming to team collaboration, and from on-campus assignments to corporate projects. In terms of organising practical teaching, the course team also adopts a ‘project group + role allocation’ approach, whereby students take on roles such as requirements analysis, UI design, HarmonyOS client-side development, AI model integration, testing and documentation writing, rotating these roles periodically to enable them to understand the complete development process through team collaboration. For outstanding projects, the course team encourages students to continue developing them further, entering them into academic competitions, the Undergraduate Innovation and Entrepreneurship Training Programme, or corporate internship schemes, thereby establishing a progressive pathway from ‘course projects’ to ‘competition projects’ and on to ‘corporate projects’.

In terms of restructuring the assessment system, the traditional approach—which relied primarily on end-of-term written examinations or the evaluation of a single final project—has been replaced with a diversified system combining formative and summative assessment, alongside coordination between internal university evaluation and corporate evaluation. Formative assessment focuses on students’ project engagement, code quality, technical documentation, teamwork, stage reports and problem-solving abilities; summative assessment is primarily based on project outcome presentations, system demonstrations, innovation, and the degree of integration between AI and HarmonyOS. Specifically, the weighting for formative assessment could be set at around 50 per cent, comprising project participation (10 per cent), code quality (15 per cent), technical documentation (10 per cent), teamwork (5 per cent) and stage reports (10 per cent); summative assessment could account for approximately 50 per cent, comprising project defence (20 per cent), system demonstration (15 per cent) and innovation and technological integration (15 per cent). At the same time, industry mentors should be invited to participate in the teaching evaluation, incorporating corporate development guidelines, engineering standards and job competency requirements into the assessment criteria; an AI learning analytics system should be utilised to track students’ learning trajectories and changes in competence, generating value-added assessments that help students identify

areas for improvement and enable lecturers to adjust their teaching strategies in a timely manner. Assessment results are not only used for grading but also to inform teaching: for common issues, lecturers can provide collective explanations in class; for individual issues, the AI system can recommend relevant learning resources; outstanding projects may be converted into case studies, competition entries or innovation and entrepreneurship projects. Consequently, assessment has shifted from ‘outcome-based judgement’ to ‘process-driven promotion’, from ‘teacher-only evaluation’ to ‘multi-stakeholder collaborative evaluation’, and from ‘knowledge assessment’ to ‘equal emphasis on competencies and literacy’, providing data-driven support for continuous course improvement. Furthermore, the course team places great emphasis on the transparency of assessment criteria. At the outset of the course, project briefs, marking schemes and competency attainment indicators are made available to students, ensuring they have clear objectives throughout the project development process; mid-project checkpoint reviews are conducted to identify issues promptly and adjust plans; and at the conclusion of the project, defence sessions and project presentations are organised, with industry mentors invited to provide feedback, thereby enhancing the industry perspective and job relevance of the assessment.

4. Practical Outcomes of the ‘AI + HarmonyOS’ Course Reform

Through multiple rounds of teaching practice, students’ multidisciplinary development capabilities and employability have been significantly enhanced. Students have gained a solid grasp of the core technologies for HarmonyOS mobile application development, acquired practical skills in applying AI technologies within the HarmonyOS ecosystem, and are able to proficiently utilise AI tools for project development, debugging and optimisation. In practical projects, they have successfully developed several applications that combine AI functionality with the distinctive features of HarmonyOS; some of these works have won awards in provincial and university-level HarmonyOS development competitions. Each year, over a hundred students enhance their employability through this course, becoming a reserve pool of technical talent for the development of the HarmonyOS ecosystem.

Based on observations by the course team and student feedback, the combination of project-driven learning and AI-enabled training has enabled students to understand the complete development process—including requirements analysis, architectural design, API calls, model integration, and testing and optimisation—through real-world tasks. There has been a marked improvement in their awareness of coding standards, documentation skills and teamwork abilities; Some students are able to independently integrate modules such as AI image recognition, intelligent recommendation and voice interaction with HarmonyOS pages, and clearly articulate their technology selection and integration logic during project defences, indicating a high degree of achievement of the course objectives. The quality and efficiency of course delivery have also been significantly optimised. Following the introduction of AI technology, stages such as programming implementation, testing and evaluation can be assisted by AI tools, reducing repetitive guidance tasks for lecturers and allowing them to devote more energy to project design, technical expansion and personalised guidance; teaching efficiency has increased by over 50 per cent. The establishment of a dynamic course content update mechanism ensures that teaching content keeps pace with developments in the HarmonyOS ecosystem and the AI technology industry, achieving a deep integration of theoretical knowledge and practical application, and effectively resolving the issue of outdated teaching content. At the same time, the teaching and engineering practice capabilities of the teaching staff have improved in tandem. Through collaboration and exchange with industry partners, as well as exploring the integration of AI technology with teaching methodologies, the course team has gradually mastered ‘AI + HarmonyOS’ teaching methods and practical development skills, transitioning from ‘traditional classroom teachers’ to ‘dual-role teachers’; by participating in real-world enterprise project development, teachers have kept abreast of the latest industry technologies and talent requirements, further enhancing their engineering practice capabilities and gradually forming a professional teaching team that combines teaching, research and engineering practice competencies. The mechanism for collaborative talent development between the university and industry has also been

continuously deepened. Through measures such as introducing real-world industry projects, establishing off-campus practical teaching bases, implementing a dual-mentor system, and engaging industry engineers in teaching evaluations, the university has strengthened its cooperation with HarmonyOS ecosystem enterprises such as Huawei. This has resulted in a talent development model characterised by ‘integration of industry and education, and university-industry collaboration’, as well as a virtuous talent development ecosystem based on ‘university training and industry selection’, thereby achieving a deep integration of industry and education. From the perspective of curriculum development, the reform has also facilitated the continuous accumulation of case studies, project portfolios, practical training platforms and assessment criteria, endowing the courses with strong replicability and value for wider adoption. Through diverse sources of evidence—including questionnaire surveys, project defences, competition results and feedback from enterprises—the course team found that students’ interest in the ‘AI + HarmonyOS’ integrated projects had significantly increased, whilst classroom participation and the quality of project delivery had steadily improved. Enterprise mentors generally observed improvements in students’ awareness of engineering standards, communication and collaboration skills, and practical problem-solving abilities; some students were able to integrate relatively quickly into enterprise development teams following their work placements, indicating that the curriculum reform has had a positive impact on the quality of talent development.

5. Distinctive Features of the ‘AI + HarmonyOS’ Course Reform

This curriculum reform has yielded distinctive features and innovations in three key areas. Firstly, technological integration and innovation have led to the establishment of a tripartite teaching system comprising ‘theory—tools—practice’. AI technology has been deeply integrated with HarmonyOS development instruction, systematically combining fundamental AI theory with HarmonyOS development scenarios. AI tools are incorporated throughout the entire project development process, and a substantial number of ‘AI + HarmonyOS’ project case studies have been

introduced to achieve an organic integration of ‘AI knowledge + HarmonyOS + practical training projects’. Unlike simply adding separate AI or HarmonyOS courses, this system emphasises embedding AI capabilities into HarmonyOS application development and adapting AI algorithm implementations to HarmonyOS device specifications and ecosystem standards, enabling students to both understand algorithmic principles and master practical engineering implementation methods. Secondly, innovation in teaching models has established a dynamic curriculum system that keeps pace with industry developments. Overcoming the shortcomings of static, unchanging course content, a dynamic content-updating system has been established that responds to HarmonyOS version upgrades and advancements in artificial intelligence technology. By benchmarking against the Huawei Developer Community and enterprises utilising HarmonyOS applications, the programme promptly obtains the latest case studies and project information, ensuring that teaching content keeps pace with industry developments and remains in real-time alignment with industrial progress. At the same time, AI-assisted project-based teaching, personalised learning pathways and intelligent Q&A systems enable teaching to shift from a standardised pace to differentiated development, from a closed classroom environment to an open platform, and from one-off instruction to continuous iteration. Thirdly, innovation in the integration of moral and civic education achieves an organic combination of professional education and the cultivation of patriotism. Capitalising on the characteristics of the HarmonyOS system as a domestically developed, independently controlled technology, the curriculum incorporates content on the HarmonyOS R&D process, the significance of ecosystem development, and the current state of domestic independent technology. Through case studies and updates on industry trends, students are guided to recognise the importance of independent technological innovation for the nation’s digital economic development. This fosters a sense of responsibility towards science and technology, national pride and national confidence, thereby achieving an organic integration of professional education and moral and civic education. These innovations not only enhance the course’s technical depth and

industry relevance but also reinforce value-based guidance, enabling students to develop a sense of responsibility towards serving national strategies and industrial development whilst mastering development skills. From the perspective of promotional value, this reform adopts a project-driven approach as its explicit focus, AI empowerment as its underlying thread, and the integration of moral and civic education as its value-driven axis, thereby forming a trinity of ‘technology-teaching-student development’ in curriculum design. It offers valuable insights for curriculum reform in programmes such as Software Engineering, Internet of Things Engineering and Applied Artificial Intelligence Technology at applied undergraduate institutions.

6. Conclusion

Against the backdrop of the deep integration of AI technology with the development of a domestic, independent operating system ecosystem, this study’s project-driven ‘AI + HarmonyOS’ curriculum reform represents a significant exploration by applied undergraduate institutions to align with industry needs and cultivate multi-skilled development talent. With project-driven learning at its core, the reform has effectively addressed the key challenges in traditional HarmonyOS mobile application development courses, achieving precise alignment between teaching content and industry needs, as well as deep integration between teaching models and the development of students’ competencies, thereby producing replicable and scalable outcomes of teaching reform. In the future, the course team will continue to monitor developments in the HarmonyOS ecosystem and AI technology, further refine the project repository, case study repository and assessment criteria, deepen the university-industry collaborative talent development mechanism, strengthen the application of AI tools in personalised teaching and formative assessment, and drive the continuous upgrading of course content, teaching methods and practical platforms, thereby providing support for the cultivation of more high-calibre ‘AI+HarmonyOS’ multidisciplinary professionals.

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