Research on Talent Training Mode of Information Technology Innovation in Universities—A Case Study of "HarmonyOS Micro-Major"

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Abstract. In response to the national call for innovation in information technology applications and to support the construction of the information technology innovation (Xinchuang) industry chain, universities urgently need to explore and implement new Xinchuang talent cultivation models. This study uses the "HarmonyOS Micro-Major" as an example to analyze its application in interdisciplinary integration, teaching model innovation, and university-enterprise cooperation. It proposes a micro-major curriculum design and implementation plan based on HarmonyOS technology, aiming to promote the construction of students' interdisciplinary knowledge systems to meet the rapidly changing technical and occupational demands. The research finds that the HarmonyOS Micro-Major can effectively facilitate the close integration of the education chain, talent chain, and industry chain, enhancing students' professional qualities and practical abilities. It provides new ideas for cultivating Xinchuang talents in universities and holds significant implications for educational innovation and industrial development.

Keywords: Innovation in Information Technology Applications; Talent Cultivation; HarmonyOS; Micro-Major;

1 Introduction

The rapid iteration of technology in the internet field continuously changes enterprises' demand for talent. Emerging technologies and skill sets become highly sought-after in a short period, while higher education typically focuses on general academic disciplines within professional fields, making it challenging to quickly adapt to the market demands of emerging technologies. This results in a mismatch between the skills of graduates and the actual needs of enterprises [1].

As global technological competition intensifies, the security and self-control of key technology areas become increasingly critical and urgent. In 2024, the Ministry of Industry and Information Technology of China issued the "Guide for Equipment Re-

M. F. A. Ghani et al. (eds.), *Proceedings of the 2024 4th International Conference on Education, Language and Art (ICELA 2024)*, Advances in Social Science, Education and Humanities Research 907,
https://doi.org/10.2991/978-2-38476-364-1_56

newal and Technological Transformation in Key Industrial Sectors," emphasizing the importance of enhancing the resilience and security level of the industrial chain supply chain, with a core focus on domestic substitution and self-control. On October 22, 2024, China's first domestically developed mobile operating system—Huawei's native HarmonyOS—was officially released. This makes it the third major mobile operating system globally, following Apple's iOS and Android. With the launch of the "pure" HarmonyOS, the pace of domestic substitution for operating systems has accelerated significantly, resulting in a substantial talent gap in the market [2].

To meet the changing market demands and connect with the Xinchuang industry chain, it is imperative to explore and reform the higher education training model in alignment with the HarmonyOS system.

2 Background

2.1 The Connotation of Xinchuang Education

The Xinchuang education industry originated in July 2021 when six departments, including the Ministry of Education, issued the "Guiding Opinions on Promoting the Construction of New Educational Infrastructure and Building a High-Quality Educational Support System." In recent years, the government has continuously deepened its policies in the field of Xinchuang, significantly strengthening the promotion of Xinchuang in education [3].

In light of the frequent "neck-holding" events in recent years, the accessibility of advanced external products and technologies has increasingly come under challenge. Developing domestically produced, self-controlled key core technologies has become a prevailing trend. The "14th Five-Year Plan for National Economic and Social Development and the Outline of Long-Term Goals for 2035" explicitly proposes the implementation of an industrial foundation reconstruction project to accelerate the resolution of bottlenecks in basic components and parts, foundational software, fundamental materials, basic processes, and the technological foundation of the industry.

Among these, operating systems play a crucial role as they coordinate and control hardware and software resources below, while providing a unified interface for developers and users above. Developing a domestically produced, self-controlled operating system has become an inevitable choice and a key entry point for Xinchuang education reform [4].

2.2 Current Status of Micro-Major Development

Micro-majors feature characteristics such as "small scale, specialized courses, high focus, and interdisciplinary nature," and have become a "catalyst" for many universities exploring the cultivation of composite talents. In order to better meet market demands and respond to the development needs of new technologies, new industries, new business models, and new patterns at the national and social levels, micro-majors aimed at fostering innovative and interdisciplinary talents have emerged. Many universities in China have begun to support "micro-major" pilot programs, focusing on

specific professional fields, research directions, or core competencies to cultivate students with corresponding interdisciplinary talent qualities [5].

For example, Peking University has launched a micro-major in International Organizations and Global Governance, aimed at helping students aspiring to work in international organizations to acquire the necessary skills and qualifications while completing their primary degree studies. In 2022, Guangdong University of Technology introduced its first micro-major in Smart Construction, allowing civil engineering students to select courses in automation, computer science, and mechanical electronics to provide interdisciplinary talent support for the economic development of Guangdong. Similarly, Hubei University of Technology established twelve micro-majors in 2022, including Synchronous Engineering Development Technology, Artificial Intelligence, New Energy Materials and Devices, Smart Decoration Design in Architecture, Big Data Technology and Applications, Network Video Directing, Cultural and Smart Product Design, Industrial Property Management, Applied English, Mathematical Modeling and Intelligent Computing, Pedagogy, and Digital Transformation.

Micro-majors emphasize interdisciplinary integration, offer cutting-edge courses that are highly aligned with industrial development, focus on practical application, and prioritize the cultivation of skills.

2.3 The Integration of HarmonyOS and Micro-Majors

HarmonyOS, released by Huawei, is a distributed operating system designed for the future, capable of operating across various scenarios including mobile office, sports health, social communication, and media entertainment. OpenHarmony, a general-purpose terminal operating system originating from China, is the only large-scale open-source project of its kind in the country. The exploration of innovative talent cultivation models around HarmonyOS has become a distinctive feature and hot trend in the development of academic disciplines in universities.

As a 100% domestic operating system, HarmonyOS has achieved an installation base exceeding 900 million devices. By the first half of 2024, 2,300 ecosystem enterprises had announced their inclusion in the HarmonyOS ecosystem. Additionally, the native HarmonyOS NEXT version was officially released on October 22, 2024, with performance surpassing that of the Android operating system.

The development of the industry relies heavily on talent support. OpenHarmony, as a new domestic operating system that has emerged in recent years, is currently experiencing a high demand for talent. The rapid rise of the HarmonyOS ecosystem has led to an explosive growth in related job positions. According to data, the number of HarmonyOS-related job positions has increased significantly year-on-year, and the number of applicants has also seen a substantial rise, indicating a strong market demand for HarmonyOS talent. The average monthly salary for HarmonyOS development positions exceeds 18,000 RMB, which is 9% higher than the overall industry average, and the salary growth rate has far exceeded expectations. Furthermore, the HarmonyOS ecosystem faces a talent shortage in the millions, with potential new job positions exceeding 3 million. As the application of the HarmonyOS system becomes

more widespread and its ecosystem continues to improve, the demand for HarmonyOS talent is expected to continue growing in the future.

The combination of HarmonyOS and micro-majors has become an important practice for universities in exploring the cultivation of composite talents in response to the "four new" initiatives. The planning and deployment of supportive industrial, academic, research, training, and innovation facilities for the talent ecosystem surrounding the HarmonyOS have emerged as a highlight and trending topic in the development of new "hot" disciplines and innovative talent cultivation. Consequently, an increasing number of institutions have begun to offer courses related to HarmonyOS.

In this context, Shenzhen University has established the world's first micro-major in HarmonyOS, collaboratively forming a teaching team and incorporating enterprise project cases from the Harmony ecosystem. This initiative covers the full-stack technology framework of HarmonyOS and jointly develops HarmonyOS courses. Since the launch of the Harmony micro-major, the curriculum has received positive feedback from both faculty and students at Shenzhen University, becoming an exemplary practice in the integration of new technologies and new industries with micro-majors.

Additionally, Chongqing University of Posts and Telecommunications, Hubei University of Automotive Technology, and Southwest University for Nationalities are also piloting the construction of Harmony micro-majors through industry-university cooperation, reforming and exploring new models for cultivating composite talents.

By 2024, the number of universities collaborating with the HarmonyOS system has further increased. Huawei's HarmonyOS has officially entered more than 130 universities, with students from 305 universities participating in HarmonyOS activities. Additionally, 135 universities have already offered HarmonyOS-specific courses and have developed over 150 industry-academia cooperation projects.

3 Construction Pathway for the Talent Cultivation Model of Harmony Micro-Majors

This micro-major aims to cultivate composite application talents who are adaptable to the needs of national and local economic and social development. Students will master knowledge related to the HarmonyOS and application development, possess skills in Harmony application development and teamwork, and be capable of engaging in application development, embedded development, and intelligent product development in related fields such as HarmonyOS, the Internet of Things, smart devices, and smart automobiles.

3.1 Ideas for Talent Cultivation Reform

- Demand-driven with Clear Objectives

With the release of the native HarmonyOS, the system base no longer relies on the AOSP open-source code and does not need to continue compatibility with Android applications. This achievement represents a complete independent development of the

system base, significantly enhancing the system's smoothness, performance, security features, and achieving autonomy and controllability for domestic operating systems. Consequently, the interconnectedness of multiple devices and scenarios, such as smartphones, tablets, and automotive cockpits, along with the launch of native application services, has created a substantial demand for application development talents skilled in the HarmonyOS. Focus on cultivating students' practical abilities and innovative spirit through the specialized training of small yet precise Harmony micro-majors, thereby enhancing their employability and competitiveness in the job market.

- Disciplinary Integration and Cross-Field Training

The HarmonyOS curriculum integrates relevant disciplines such as computer science, software engineering, artificial intelligence, and the Internet of Things, creating a multidisciplinary curriculum framework that promotes disciplinary integration. Adopt a project-driven teaching model that encourages students to participate in real-world projects, enhancing their interdisciplinary competencies and problem-solving abilities.

- Industry-University Cooperation and Resource Co-Construction

Establish long-term partnerships with companies related to Harmony technology to collaboratively develop courses and teaching resources, providing internship and employment opportunities. Invite industry experts to participate in teaching and guide student projects, ensuring that the curriculum content keeps pace with the cutting edge of technology and meets industry demands.

3.2 Curriculum System Reconstruction

- The Harmony micro-major curriculum meets the national standards for software engineering programs, emphasizing the cultivation of innovative talents and focusing on the construction of the "Harmony" curriculum system. It also includes practical internship and hands-on teaching components based on the "Harmony" curriculum system, ensuring seamless integration between academia and industry. Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity that you use in an equation.
- In response to the requirements for Huawei's HarmonyOS HCIA and HCIP application development certifications, we will collaborate with partner companies to jointly develop the curriculum, constructing the course system for the "Harmony Micro-Major," as illustrated in Fig.1.

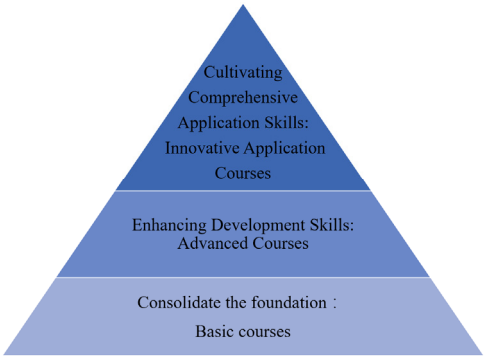

Fig. 1. Structure Diagram of the 'HarmonyOS Micro-major' Curriculum System"

- The Harmony micro-major curriculum is divided into three main modules: foundational courses, advanced courses, and innovative application courses, totaling 16 credits and 256 hours of instruction. These three course modules correspond to the credits of foundational courses, professional education, and the centralized practical teaching platform. The curriculum content ranges from introductory knowledge of the Harmony operating system, basic and advanced skills in upper-level application and kernel component development, to practical applications of Harmony innovation. This comprehensive learning path enables students to thoroughly master the relevant knowledge and development skills of the Harmony operating system, laying a solid foundation for practical application development.

  The content of the "Harmony Micro-Major" curriculum is shown in table 1.

Table 1. Course Replacement and Introduction of 'HarmonyOS Micro-major'

Course Module	Categories of Replacement Courses	Course Name	Credit & Study hours	Competency Training
Basic courses	Disciplinary Foundation Course	HarmonyOS	2 32	Get an overview of the HarmonyOS operating system
		Fundamentals of Northbound Application Development	2.5 40	Cultivate students to master the basic skills of HarmonyOS upper-layer application development
		Fundamentals of Southbound Device Development	2.5 40	Cultivate students to be familiar with the basic components of the HarmonyOS kernel and master the development skills of common driver components

Advanced Courses	Professional Education Course	Advanced Northbound Application Development	3 48	Improve students' upper-level application development and design ability and thinking
		Advanced Southbound Device Development	3 48	Improve students' familiarity with HarmonyOS complex kernel components and master the development skills of complex driver components
Innovative Application Courses	Concentrated Practical Teaching Course	HarmonyOS Innovative Applications	3 48	Combined with practical application scenarios, improve students' comprehensive application ability of HarmonyOS related skills

- The proposed course contents are as follows:

a. HarmonyOS

This course mainly supports the theoretical teaching of the basics of HarmonyOS northbound application development. It covers the design philosophy, architecture, and key features of the HarmonyOS operating system, helping students gain an overall understanding of HarmonyOS. The course includes the design background and objectives of the OpenHarmony operating system, an introduction to the LiteOS-m and LiteOS-a kernels, standard libraries and kernel abstraction, hardware architectures supported by OpenHarmony, adaptation and porting of OpenHarmony, and graphical programming frameworks.

b. Fundamentals of Northbound Application Development

This course primarily supports the theoretical teaching of the fundamentals of northbound application development for HarmonyOS. It covers topics such as an introduction to application development for HarmonyOS and OpenHarmony, getting started with application development, module management and application debugging, Java UI basics including layout and common components, and the ArkUI framework's web-like development paradigm based on JavaScript. The course includes practical lab manuals to enhance teaching outcomes, laying a solid foundation in northbound application development for subsequent courses, and equipping students with basic skills for developing upper-layer applications on HarmonyOS.

c. Fundamentals of Southbound Device Development

This course supports the theoretical teaching of the fundamentals of southbound device development for HarmonyOS. It covers the command-line interface subsystem, file subsystem, network subsystem, memory management subsystem, task management, inter-process communication, distributed soft bus implementation, dynamic linking, and stack backtracking. This course aims to familiarize students with the core components of the HarmonyOS kernel and equip them with the skills to develop common driver components, laying a solid foundation for more advanced courses on southbound device development.

d. Advanced Northbound Application Development

This course supports the theoretical teaching of advanced northbound application development for HarmonyOS, aiming to enhance students' skills and thinking in up-

per-layer application development and design. It introduces the transition from HarmonyOS to OpenHarmony application development, focusing on setting up the OpenHarmony development environment, standard system compilation, custom attributes, custom events, and lifecycle management. The course includes project case studies such as online classes and health code anti-epidemic cards to explain network interaction, distributed task scheduling, and AI-related knowledge points.

e. Advanced Southbound Device Development

This course supports the theoretical teaching of advanced southbound device development for HarmonyOS, aiming to enhance students' familiarity with complex kernel components and advanced driver component development skills. It covers embedded systems, microcontroller and OpenHarmony system programming, GPIO driver programming in OpenHarmony, SPI bus principles and LCD screen programming, I2C bus principles and temperature and humidity sensor programming, WiFi programming, and TCP/IP network communication programming within the OpenHarmony system.

f. HarmonyOS Innovative Applications

"Innovation Application Project Development" is based on the "Advanced Northbound Application Development" and "Advanced Southbound Device Development" courses. Using a complete IoT project—smart home integrated application development—as a case study, it aims to give students a comprehensive understanding of the basic knowledge and development methods for device layer, network layer, platform layer, and application layer of IoT. The course material supports the theoretical teaching of this project, enhancing students' ability to apply HarmonyOS-related skills comprehensively.

Possible practical projects:Development of smart home device layer based on HarmonyOS,Core module development for business services,Development of smart home apps based on HarmonyOS,Integration and testing of smart home projects based on HarmonyOS.s

3.3 Cultivation Model

- Teaching Format: The micro-major actively explores a school-enterprise collaborative training model. It introduces corporate project cases and industry faculty, with both the school and enterprise collaborating to form a teaching team that jointly develops the Harmony micro-major curriculum, covering the full stack of Harmony technology [6].
- Graduation Requirements: Students in the micro-major program must complete all courses to earn a total of 16 credits as stipulated in the micro-major curriculum. After review by the offering unit, the credits will be submitted to the academic affairs office for verification, and a micro-major certificate will be issued. The micro-major course grades are managed by the offering unit and will be reflected on the micro-major transcript.

- Credit Substitution: Credits earned from micro-major courses can be applied for substitution with corresponding foundational courses, professional education, and centralized practical teaching platform courses in related disciplines.

3.4 Teaching Operation Management

- The tuition fees for students in the pilot class at the undergraduate level will be consistent with those for students in the original Software Engineering program, and no additional fees will be charged.
- Policies on exemption from postgraduate entrance examinations, recommendations for employment resources, special practical projects, domestic and international exchange visits, and various scholarships and grants will be preferentially tilted towards the pilot class.
- Students in the micro-specialty program must complete all courses as per the micro-specialty course requirements, earning a total of 16 credits. Upon verification by the offering unit and approval by the Academic Affairs Office, a micro-specialty certificate will be issued.

3.5 School-Enterprise Management

- This project will collaborate with enterprises that have extensive experience in the HarmonyOS industry and education field. Both parties will leverage their respective advantages, stay abreast of HarmonyOS development trends, and incorporate new technical specifications, new service specifications, and new industry standards into the construction standards, establishing an innovative model that aligns the HarmonyOS micro-specialty program with industry needs. Additionally, enterprise project cases and faculty will be introduced. Both school and enterprise will jointly form a teaching team to create the HarmonyOS micro-specialty curriculum, covering the full-stack technology system of HarmonyOS.

3.6 Faculty Team Building

- The micro-major teaching team is jointly established by the university and partnering enterprises. The team leader is the designated "micro-major" director from the university. Team members primarily consist of relevant experts from enterprises and young faculty members from the university.
- The team leader must hold an associate professorship or higher (or a doctoral degree or higher). They should possess strong professional ethics, significant academic expertise, exceptional teaching abilities, extensive teaching experience, and

distinctive teaching characteristics. The leader should be highly capable in managing micro-major admissions, teaching, assessment, and overall administration.

4 Conclusions

The talent cultivation model for information innovation in universities, exemplified by the Harmony Micro-Major, clearly defines graduation requirements and credit substitution mechanisms through a collaborative school-enterprise construction approach. This model not only responds to the national call for innovation in information technology applications and supports the development of the information innovation industry chain, but also further promotes the close integration of the education chain, talent chain, and industry chain, enhancing students' essential skills to excel in the rapidly evolving technology landscape. The "Harmony Micro-Major" represents an important exploration in cultivating a new generation of innovative talents, better adapting to industry needs and contributing to the development of the domestic information innovation ecosystem.

Acknowledgment

2023 Wuhan Municipal Higher Education Institutions Teaching Research Project "Exploration of Innovative Talent Cultivation Model in Universities Based on Harmony Micro-Major" (Project No. 202335)

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