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Research on the "Three Education Integration" Primary School Education Model: Labor Education, STEM Education and AI Enlightenment Education

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Abstract

To implement the requirements of national policies such as the "Outline for the Construction of an Education Power" and the "Opinions on Strengthening Science Education in Primary and Secondary Schools in the New Era", and to address the current pain points in primary education where labor education, STEM education, and AI enlightenment education operate independently and are disconnected in terms of student development, this study, guided by the cultivation of core competencies, employed methods such as literature review, questionnaire survey, and action research to clarify the internal logic and value implications of the integration of the three educations. It also investigated the current status and problems of the integration of the three educations in primary schools and constructed a "one core, three dimensions, and five paths" model for the integration of labor, STEM, and AI education in primary schools. Through the cooperation with the Zhichuang Luban project schools, a one-semester practical verification was carried out within the same school. The research found that this educational model can effectively enhance primary school students' innovative practical abilities, labor literacy, and AI core literacy, providing a preliminary replicable and scalable practical model for the implementation of interdisciplinary education and the cultivation of innovative talents adaptable to the AI era in the primary school stage.

Keywords

Integration of Three Educations, Primary School Labor Education, STEM Education, AI Enlightenment Education, Education Model

1. Introduction

1.1. Research Background and Significance

The new era education policy system sets out systematic requirements for interdisciplinary integration and practical education. The state has successively issued the "Opinions on Comprehensively Strengthening Labor Education in the New Era for Primary, Secondary and Tertiary Schools" and the "Guidelines for Labor Education in Primary, Secondary and Tertiary Schools (Trial)" (Ministry of Education, 2020) clearly incorporating labor education into the entire process of talent cultivation, emphasizing the educational value of creative labor and practical experience; The "Science Curriculum Standards for Compulsory Education (2022 Edition)" (Ministry of Education, 2022) incorporates engineering practice, artificial intelligence, and interdisciplinary exploration into the core content, promoting the transformation of science education towards comprehensiveness and practicality; The "Guidelines for Artificial Intelligence Education for Teenagers" further clarifies the target positioning and implementation paths for the initial stage of artificial intelligence education in primary and secondary schools, proposing to promote the deep integration of artificial intelligence with subject teaching and practical activities, and the three policies work in concert to jointly aim at the collaborative education of labor education, science education, technology education, and artificial intelligence enlightenment, providing top-level design and institutional basis for the integration of "labor education - STEM education - AI enlightenment education" in primary school stages. Currently, the labor education, STEM education, and AI enlightenment education in primary school stages present a reality of disciplinary fragmentation, fragmented implementation, and weakened educational functions. Labor education mostly remains at the level of simple manual, physical labor, and cleaning, with insufficient content of creative labor and technical labor. STEM education is limited to club activities and competition projects, difficult to enter regular classrooms and with project design divorced from students' life experiences. AI enlightenment education mainly consists of single programming courses and robot operation, emphasizing skills training over quality cultivation, and is disconnected from labor practice, scientific inquiry, and other aspects (Xie, 2019). The three do not have coordinated planning in curriculum design, teaching implementation, resource allocation, and teacher supply, resulting in the lack of practical fields, poor course connection, and insufficient cross-disciplinary capabilities of teachers, making it difficult to form a teaching synergy and unable to meet the early cultivation needs of primary school students' innovative qualities. The theoretical significance of this study lies in systematically explaining the internal logical connection among labor education, STEM education, and AI enlightenment education, constructing a theoretical framework for the integration of the three in primary school stages, complementing the limitations of current single-domain research and pairwise integration research, enriching the theoretical system of interdisciplinary education and practical education in primary schools in China, and providing theoretical support for the connotative development of basic education in the new era; The practical significance is to base on the actual teaching of primary schools, construct an operable, replicable, and promotable three-way integration education model, forming a complete implementation system including curriculum, teaching, field, teachers, and evaluation, providing a practical model for primary schools to carry out integrated education, promoting the simultaneous improvement of students' labor quality, scientific thinking, engineering ability, AI literacy and innovative spirit through collaborative education, laying the foundation for the early enlightenment of outstanding and innovative talents.

1.2. Current Research Status at Home and Abroad

In terms of overseas research, countries in Europe and America have established a mature K12 STEM education system, integrating interdisciplinary practice and engineering thinking cultivation throughout the entire primary to high school stage, and forming a complete curriculum system and implementation path (Anne, 2019). Among them, the "AI4K12 Framework" of the United States and the "AI Literacy Framework" of the European Union clearly defined the core goals, content dimensions and implementation requirements of AI enlightenment education in primary and secondary schools, focusing on four core aspects: basic AI cognition, algorithmic thinking, intelligent application and technological ethics. These provide clear guidance for AI enlightenment education in primary and secondary schools. At the same time, some foreign scholars have explored the integration path of labor practice and STEM education, integrating content such as handicrafts, vocational experiences and production labor into STEM projects, strengthening the cultivation of practical hands-on skills and the ability to solve real problems. However, overall, research on the systematic integration of labor education, STEM education and AI enlightenment education for primary school students is still scarce, and no complete theoretical system or practical model that can be implemented has been formed. Most related research has only been at the level of shallow exploration of two-way integration (European Commission & OECD, 2025).

In terms of domestic research, currently, most of the related studies in China focus on a single area such as labor education, STEM education, or AI enlightenment education, or they conduct practical explorations that combine two of these areas. However, there is no yet a systematic research framework that integrates these three aspects comprehensively (Wang & Xu, 2020). In single-domain research, the study of labor education mainly focuses on the redefinition of its essence, practical challenges, curriculum construction, and the cultivation of labor skills. The research on STEM education emphasizes curriculum design, innovation in teaching models, and the application of science classrooms (Zhou, 2018). The research on AI enlightenment education centers around curriculum development, programming teaching, and robot education, etc. In the two-way integration research, the exploration of the integration of labor education and STEM education, as well as STEM education and AI enlightenment education, has gradually increased, resulting in some phased practical achievements. However, there is a significant gap in systematic research on the small-scale educational model that fully integrates the three aspects of labor education, STEM education, and AI enlightenment education. There is a lack of replicable and scalable practical models, as well as supporting courses, teachers, evaluation systems, etc., making it difficult to support the regular and standardized implementation of the integrated teaching of the three aspects of education in primary schools (Zhang, 2019).

1.3. Research Approach and Methods

1.3.1. Research Thought

This research is based on theoretical analysis and reviews and sorts out relevant policies and academic materials on labor education, STEM education, and AI enlightenment education. It analyzes the core connotations, research status, defines core concepts, clarifies research gaps, lays a theoretical foundation and points out the research direction. Starting from the current situation investigation, through questionnaires and interviews, it conducts a survey among teachers, students and parents of 29 primary schools in 8 provinces, to grasp the current implementation status, real needs and actual problems of the integration of the three educations, and clarify the research focus. Combining the age and cognitive characteristics of primary school students and the requirements for quality cultivation, a scientific and feasible model for the integration of the three educations is constructed, and its core goals, constituent elements and implementation process are clarified. Multiple practical schools are selected to conduct a semester of action research, continuously optimize the model to verify its feasibility and effectiveness, and finally summarize experiences, sort out problems, propose implementation guarantee strategies, forming a complete research loop of "theoretical review - current situation investigation - model construction - practical verification - strategy optimization", providing a reference guidance plan for the practice of the integration of the three educations in primary schools.

1.3.2. Research Method

This research comprehensively employs various research methods to ensure the scientificity, rigor, and comprehensiveness of the study: Firstly, through the literature research method, it systematically searches and retrieves core databases at home and abroad, sorts out relevant literature on labor education, STEM education, and AI enlightenment education, clarifies their connotations, research status, and internal connections, laying a theoretical foundation for the research and clarifying the innovation direction; Secondly, it adopts the questionnaire survey method and interview method, conducts large-scale surveys among teachers, students, and parents in multiple provinces and cities' primary schools, and conducts in-depth interviews with frontline educators to grasp the implementation status and practical problems of the integration of the three educations; Then, it conducts action research with three primary schools as pilot projects, forms a special team to carry out a cycle of teaching practice around the integration project for one semester, continuously optimizing the curriculum and implementation path; Finally, it uses statistical analysis methods, uses SPSS software to conduct statistical analysis of quantitative data, and combines qualitative data for comprehensive judgment, quantitatively verifying the effect of the education model, providing a reliable basis for the research conclusions and mode optimization.

1.4. Research Innovation Points

The innovation points of this research are mainly reflected in two aspects: theory and practice.

Firstly, theoretical innovation. Currently, most domestic related studies focus on a single field among the three or their mutual integration, lacking systematic integrated research. This study, by sorting out the core connotations and development laws of the three, clarifying the internal logical connection among their educational goals, functional positioning, and implementation paths, breaks through the research limitations, constructs a "labor as the carrier, STEM as the framework, AI as the empowerment" theoretical model for the integration of three educations in primary schools, clarifies the core mechanism and integration path of collaborative education, enriches the theoretical system of interdisciplinary and practical education in primary schools, fills the theoretical gap of systematic integration of the three, and provides new perspectives and frameworks for subsequent research.

Secondly, practical innovation. Based on the "Smart Create Lu Ban" project, it breaks through the barriers of disciplines and the separation of three educations, combines the actual teaching of primary schools and the cognitive characteristics of students, proposes a complete three-education integration education model with six core elements, forming an integrated implementation system of "goals - courses - teaching - field - teachers - evaluation". Through the practice and refinement of multiple types of pilot schools, an adaptable interdisciplinary education model suitable for different types of primary schools and replicable for promotion is formed, providing operational references for frontline teaching, solving various problems in practice, and having strong practical value and promotion significance.

2. Core Concepts and Theoretical Basis

2.1. Definition of Core Concepts

Primary school labor education (Liu, 2019) focuses on cultivating students' labor literacy as its core. It takes into account the age characteristics and cognitive patterns of primary school students, emphasizing creative labor and practical experience. It covers various contents such as traditional craftsmanship, handicraft making, and production labor, and pays attention to guiding students to establish a correct view of labor and labor values. It respects labor and laborers, and enhances students' practical skills, innovative consciousness, and responsibility through practical operations. It is a fundamental educational activity for implementing practical education.

Primary school STEM education (Zhao, 2018) is centered on interdisciplinary project-based learning. It breaks through the disciplinary barriers of science, technology, engineering, and mathematics, integrates multiple disciplines' knowledge and thinking methods, focuses on solving practical problems in real-life scenarios, and pays attention to guiding students to actively explore and collaborate for innovation. It focuses on cultivating students' scientific thinking, engineering thinking, and comprehensive problem-solving abilities. It is an important carrier for cultivating students' innovative literacy.

Primary school AI enlightenment education (Cao, 2023) is an AI literacy enlightenment education for primary school students, not centered on advanced programming techniques and complex algorithm learning. It focuses on cultivating students' basic AI cognition, algorithm thinking, innovative application, and technological ethics awareness. It guides students to correctly understand the essence and value of AI technology, learn to use AI tools to solve simple problems in study and life, and establish a correct view of technology and ethics.

The integration of three educations aims to cultivate students' core literacy as the common goal. It clarifies the functional positioning of the collaborative education of the three, takes labor education as the practical carrier, providing real practical scenarios and value guidance for STEM education and AI enlightenment education; takes STEM education as a cross-disciplinary framework, providing scientific thinking and inquiry tools for labor practice and AI application; takes AI enlightenment education as a technology empowerment and thinking upgrade path, providing digital support for labor innovation and STEM projects. Ultimately, it achieves the deep integration and collaborative education of the three.

The education model is a systematic implementation plan formed by integrating various educational resources, including a target system, curriculum system, teaching model, evaluation system, and guarantee mechanism, with integrity, specificity, and operability. It can provide clear guidance and support for the educational practice of the integration of three educations in primary schools, ensuring the implementation and effectiveness of the educational goals.

2.2. Theoretical Basis

This research is supported by four core theories, providing a solid theoretical basis for the construction and practice of the integrated education model for the three aspects of education in primary schools. The details are as follows:

Piaget's cognitive development theory serves as an important foundation for the adaptation of the integrated education model to the cognitive characteristics of primary school students. During the primary school stage, students are in a critical period of transition from the concrete operational stage to the formal operational stage, with their thinking mainly dominated by concrete and image-based thinking, and abstract logical thinking gradually emerging. They have a strong demand for concrete and practical activities. The integrated education model focuses on hands-on operations, object creation, and situational exploration as its core activity forms. Through labor practice, STEM project creation, and AI practical experience, it guides students to extract abstract thinking from concrete practices, aligning with the cognitive development pattern of primary school students from concrete to abstract, and providing theoretical guidance at the cognitive level for the implementation of the integrated education model.

Constructivist learning theory provides the core thinking for the design of the integrated education model. This theory emphasizes that learning is not a passive process of accepting knowledge, but rather a process in which learners actively explore, collaborate, and experience in real situations, autonomously constructing knowledge and abilities. The integrated education model is oriented towards real-life problems, creating a complete context combining labor practice, scientific inquiry, and AI application, guiding students to actively integrate labor skills, STEM knowledge, and AI tools in groups to achieve autonomous construction of knowledge and abilities, which is highly consistent with the core concept of constructivist learning.

Dewey's "learning by doing" theory is the core theoretical support for the practice-oriented education of the integrated education model. Dewey proposed the core viewpoints of "education is life" and "education is the continuous reorganization and transformation of experience", advocating that education should be based on children's practical activities, with children's active operation as the center, allowing students to acquire knowledge and develop abilities through practical experiences. The integrated education model takes project practice, labor production, and technology creation as core carriers, practicing the educational philosophy of "learning by doing, using by doing, and creating by doing", enabling students to integrate labor literacy, STEM thinking, and AI capabilities in hands-on practice, achieving the accumulation of experience and the enhancement of literacy, fully embodying Dewey's educational thought of practice-oriented education.

The theory of Chinese students' core development literacy clarifies the educational goal orientation of the integrated education model. This theory focuses on cultivating "a well-rounded person" (Ministry of Education, 2016), covering three dimensions: cultural foundation, autonomous development, and social participation. Among them, key competencies such as scientific spirit, practical innovation, and responsibility and commitment are the core cultivation goals of the integrated education model. The goal positioning, content design, and implementation path of the integrated education model all revolve around the cultivation of core literacy, strengthening the foundation of responsibility and commitment through labor education, cultivating scientific spirit and practical innovation abilities through STEM education, and enhancing digital literacy through AI enlightenment education. This is a specific practical path for implementing the core literacy of Chinese students and achieving the fundamental task of cultivating virtue through education.

3. The Inherent Logic and Value Implications of Integrating the Three Aspects of Education in Primary Schools

3.1. The Inherent Logic of Integrated Education

The internal logic of the integration of three educations is the core support for the deep collaboration and organic coupling among the three. The intrinsic correlation mainly manifests in three core aspects.

Firstly, the consistency of educational goals. Although the three types of education (labor education, STEM education, and AI enlightenment education) belong to different fields and have different focuses, they all aim at "cultivating innovative talents who can adapt to future development" (Kang, 2021), always emphasizing the cultivation of practical orientation, problem-solving ability, innovation ability, and comprehensive literacy. In terms of educational value orientation, they are highly consistent and resonate at the same frequency, which is the core foundation for the deep integration of the three and provides a goal-oriented guidance for collaborative education.

Secondly, the complementarity of functional positioning. During the collaborative education process, the three types of education perform their respective duties and support each other, forming a complete educational cycle. Labor education serves as the practical carrier and value background of the integration of three educations, providing a real and tangible practical scenario for STEM education and AI enlightenment education, while also transmitting the spirit of labor and permeating the values of labor, achieving the unity of value guidance and practical experience; STEM education serves as the cross-disciplinary method framework of the integration of three educations, integrating multiple disciplines such as science, technology, engineering, and mathematics, providing scientific thinking and inquiry methods for labor practice and AI technology application, solving technical and thinking problems in the practical process; AI enlightenment education serves as the technological empowerment and thinking upgrade path of the integration of three educations, providing digital tool support and innovative direction guidance for labor practice and STEM projects, promoting the transformation of traditional labor and interdisciplinary exploration towards intelligence and innovation, the three functions are complementary and integrated organically, forming a collaborative educational force.

Thirdly, the compatibility of implementation paths. From the perspective of teaching implementation methods, the three have natural integration feasibility and all adopt project-based learning and practical exploration as the core implementation methods, abandoning the traditional single classroom lecture mode. All three can rely on real interdisciplinary projects to integrate labor practice, STEM exploration, and AI application organically, allowing students to achieve content integration, method intercommunication, and goal coordination in the process of completing real tasks and solving real problems, which not only implements the requirements of labor practice but also cultivates STEM thinking and AI literacy, making the integrated education take root and be effective.

3.2. The Value Connotations of Integrated Education

The value implications of the integration of three educations extend across three levels: students, schools, and the country, highlighting the multi-faceted value of interdisciplinary collaborative education.

Firstly, it has value for students' development. The integration of three educations breaks through the barriers of traditional disciplines, creating an integrated educational scenario of "practice + thinking + technology", allowing students to achieve the coordinated development of practical operation skills, scientific thinking, innovation ability, labor quality, and AI quality in real cross-disciplinary practices. At the same time, through labor practice, correct labor concepts are instilled, and through AI enlightenment, scientific ethical awareness is cultivated, helping students establish correct labor concepts, scientific concepts, and ethical concepts, and comprehensively enhancing their core competencies, laying a solid foundation for lifelong development and future growth.

Secondly, it has value for school development. The integration of three educations promotes schools to break away from the traditional single-discipline curriculum system, constructing a systematic and structured cross-disciplinary integration curriculum system, enriching the school's educational connotation, creating a distinctive school brand, and enhancing the school's educational competitiveness. At the same time, integrated teaching places higher demands on teachers' interdisciplinary literacy, which can force teachers to actively improve their professional capabilities, promote the transformation of teachers from "single-discipline type" to "comprehensive type", and facilitate teachers' professional growth, thereby comprehensively improving the school's educational quality and educational level.

Thirdly, it has value for national development. The integration of three educations closely follows the strategic requirements of building an education power, a science and technology power, and a talent power. In the primary school stage, it lays a foundation for engineering enlightenment, technology enlightenment, and innovation talent cultivation, through early cultivation of students with labor spirit, scientific literacy, intelligent literacy, and innovation ability, providing front-end support for the country to cultivate high-quality talents suitable for the AI era. At the same time, through collaborative education, the fundamental task of fostering moral education is implemented, helping to cultivate era a new generation who can take on the responsibility of national rejuvenation, injecting lasting momentum for the long-term development of the country.

4. A Current Situation Investigation and Problem Analysis on the Integration of Physical Education, Moral Education, and Intellectual Education in Primary Schools

4.1. Design of Survey

This study adopted a combined approach of questionnaire surveys and in-depth interviews. The research sample was determined through multi-stage stratified sampling, and the investigation covered 29 primary schools in 8 provinces and municipalities across the country. Among them, the sample schools were stratified and selected based on the regional educational development level, school level, and the foundation of the integration of the three educations. The respondents of the questionnaire were sampled in clusters by stratification within the sample schools according to grade and position, ultimately covering 186 teachers, 3200 students, and 2800 parents. The interviewees were selected using typical sampling from the sample schools, and 12 principals and key teachers were interviewed semi-structurally to systematically understand the implementation status, cognitive level, resource conditions, and practical difficulties of the integration of the three educations.

4.2. Survey Results and Key Issues

Based on the results of the questionnaire survey and in-depth interviews, there are five core issues in the current practice of integrating the three types of education in primary schools. They are as follows.

Firstly, the educational philosophy is fragmented, lacking a top-level design for integration. 87.2% of the schools only offer separate courses such as labor education, science education, or AI club courses, without systematic planning and design for the integration of the three types of education. Only 12.8% of the schools have attempted the integration of the three types of education; from the perspective of teachers' understanding, 91.4% of the teachers lack clear understanding of the connotation, core goals, and specific implementation paths of the integration of the three types of education. At the school level, there is no systematic integration education planning, institutional arrangement, and promotion mechanism, resulting in the integration of the three types of education being in a spontaneous and scattered implementation state.

Secondly, the curriculum system is fragmented, lacking systematic integration content. Currently, the relevant courses in primary schools are mostly simple aggregations of single-subject content such as labor education, STEM education, and AI enlightenment education, without breaking through the disciplinary barriers and lacking a progressive and structured curriculum system that is suitable for the age characteristics and cognitive laws of primary school students. In terms of resource supply, 76.3% of the schools do not have corresponding integrated curriculum textbooks and teaching resource packages. The existing course content is fragmented and has poor coherence, making it difficult to support the orderly implementation of integrated education.

Thirdly, the teaching staff's ability is insufficient, and cross-disciplinary teaching skills are lacking. The cross-disciplinary literacy of the teaching staff is difficult to adapt to the needs of integrated education, and only 28.5% of the teachers have received specialized training in cross-disciplinary teaching. Specifically, 90.3% of the labor education teachers lack knowledge reserves related to STEM and AI, and are unable to integrate technological elements into labor education. 85.7% of the information technology teachers lack teaching abilities related to labor practice and engineering design, and are unable to guide students to carry out creative labor practices. Overall, they are unable to undertake the teaching work of integrated education.

Fourthly, the practice field is lacking, and the supply of supporting resources is insufficient. Practice venues and equipment are important supports for the implementation of integrated education. 63.6% of the schools do not have dedicated science and technology practice workshops, unable to provide students with regular cross-disciplinary practice platforms. In terms of equipment configuration, only 15.2% of the schools have equipped the necessary equipment for integrated education such as woodworking practice, 3D printing, and intelligent sensing. The resource gap is more prominent in rural schools, with a lack of venues, equipment, and tools, severely restricting the effective implementation of integrated teaching.

Fifthly, the evaluation system is single, and there is a lack of a comprehensive education evaluation mechanism. The current evaluation of the integration of the three types of education in primary schools is still dominated by traditional evaluation models. 92.5% of the schools still use the core evaluation methods of final works and examination results, ignoring the attention to students' learning processes. In terms of evaluation content, there is a lack of comprehensive coverage of core competencies such as labor literacy, engineering thinking, innovation ability, and AI literacy. No process-based, comprehensive, and developmental evaluation mechanism has been established, and the guiding, motivating, and diagnostic functions of the evaluation cannot be fully exerted.

5. The Construction of a Comprehensive Primary School Education Model Integrating Three Aspects of Education

Currently, there is a "fragmented" problem where primary school labor education, STEM education, and AI enlightenment education operate independently, which not only hinders the complementarity of each domain's advantages but also leads to fragmented educational goals and ambiguous paths. Labor education lacks technological empowerment, STEM education neglects the cultivation of labor skills and the infiltration of AI ethics, and AI enlightenment education is disconnected from practical carriers. The integrated practices of some schools merely involve the simple addition of three types of educational content and forms, lacking systematic design and internal synergy, making it difficult to demonstrate effectiveness and fulfill educational value, and unable to comprehensively cultivate the core innovative practical abilities of primary school students. Therefore, based on the internal logic of the integration of the three types of education, combined with the cognitive development laws of primary school students and the requirements for core literacy cultivation, as well as the preliminary research results, theoretical analysis, and practical needs of this study, four principles have been summarized and refined: orientation towards qualities, practice-oriented, progressive, and inclusive accessibility. These principles serve as a guide to construct a "core, three-dimensional, five-path" integrated education model for the three types of education, achieving deep collaboration among them, breaking down educational barriers, integrating resources, and optimizing paths, providing a systematic and operational practical framework for interdisciplinary education in primary schools.

5.1. The Core Principles of Pattern Construction

Based on the cognitive development laws of students and the requirements for cultivating core competencies, this study has distilled four principles: orientation towards core competencies, practice-oriented, progressive, and accessible to all. These principles serve as the core guidance for constructing the "one core, three dimensions, five paths" educational model, ensuring the scientificity, targeted nature, and operability of the model design.

Among them, the orientation towards core competencies is the primary principle. The core lies in closely aligning with the core competency development goals of primary school students, integrating the cultivation of labor skills, STEM abilities, and AI core competencies throughout the educational process. All teaching and practical activities are designed around the educational goals, avoiding formal integration, and effectively ensuring the effectiveness of education. The principle of practice-oriented emphasizes using real project practice as the main carrier. Considering the age characteristics and cognitive laws of primary school students, practical tasks that are close to life and suitable for their abilities are designed. Students can achieve knowledge integration and ability improvement through "learning by doing and creating by doing". The principle of progressive learning requires building a gradient educational system based on the lower, middle, and higher grades of education, following the laws of students' physical and mental development, and achieving a step-by-step development from initial perception, skill improvement to innovation application. The principle of accessibility and availability fully considers the resource endowment differences between urban and rural schools. In the model construction, the implementation threshold is lowered to form a feasible and replicable implementation plan, ensuring that primary schools with different conditions can carry out the integration of three types of education, and helping to achieve educational equity.

5.2. The Core Framework of the "One Core, Three Dimensions, Five Paths" Education Model

The "one core, three dimensions, five paths" education model focuses on cultivating the core innovative and practical abilities of primary school students as its core objective. It is supported by three major dimensions: labor education, STEM education, and AI enlightenment education. The implementation paths include the curriculum system, teaching mode, practical field, teacher training, and evaluation system, forming a closed-loop educational pattern of "target guidance, three-dimensional collaboration, and five paths as support", achieving the normalization, systematization, and deepening of the integration of the three types of education.

5.2.1. Gradient-Oriented Educational Goal System

Taking into account the age characteristics and ability development patterns of primary school students at the lower, middle and higher grades, a hierarchical and progressive educational goal system is constructed to ensure the targeted nature and operability of the goals. For the lower grades (1-2), the core goal is to cultivate basic perception and awareness, focusing on developing students' basic labor habits and basic practical abilities, initiating scientific interest and basic AI cognition, guiding students to establish a sense of labor and stimulate their interest in technology, and initially understanding the basic concepts and simple application scenarios of AI. For the middle grades (3-4), the core goal is to enhance skills, concentrating on the systematic cultivation of labor skills and the improvement of simple interdisciplinary project practical abilities, strengthening basic engineering thinking training, guiding students to master the simple application methods of AI tools, and achieving the initial integration of labor practice with STEM and AI enlightenment. For the higher grades (5-6), the core goal is to cultivate students' creative labor abilities and complex interdisciplinary problem-solving abilities, shaping systematic engineering thinking, strengthening AI innovation application abilities and AI ethics awareness, promoting the deep implementation of the integration of three educations, and achieving the educational goal of "promoting creativity through labor and empowering with skills".

5.2.2. Three-Layer Integrated Curriculum System

The new primary school science curriculum standard clearly states that the subject should incorporate interdisciplinary theme-based learning. Teachers should pay attention to the connections between different subjects and make full use of the advantageous resources from related subjects to carry out comprehensive teaching (Shu, 2025). The integrated education model for primary schools focuses on the goal of gradient education and constructs a three-layer integrated curriculum system of "basic type + extended type + practical type", achieving comprehensive and deep integration of the three types of education content, while also taking into account the systematicness and hierarchy of the courses. The basic type integrated curriculum focuses on the cross-disciplinary reconfiguration of national curriculum, strictly aligning with national curriculum standards, and integrating the concept of integrated education into daily classroom teaching to achieve regular education. In the labor class, content such as woodworking, structural design and 3D modeling is integrated, allowing students to master basic engineering structure knowledge through labor practice; in the science class, intelligent sensing, data collection and AI analysis are integrated to guide students to use scientific knowledge to solve practical problems; in the mathematics class, engineering measurement, algorithm logic and other contents are integrated to provide mathematical support for STEM practice and AI application. The extended type integrated curriculum uses club classes and after-school services as carriers, focusing on the individual development needs of students, and creating a "smart creation Lu Ban" five-level progressive curriculum system. The lower grades focus on making Rubik's cubes, building bamboo and wood Lego, etc., for basic labor and STEM enlightenment; the middle grades focus on designing intelligent ancient building models and applying simple AI modules; the higher grades focus on creating AI metaverse scenes and protecting ancient buildings digitally, for advanced content such as these, to achieve systematic advancement of the integrated education. The practical type integrated curriculum uses campus projects, study tours and science and technology competitions as carriers, designing real problem-oriented practical tasks, promoting "learning by doing, knowledge and action integration", such as projects like "Campus intelligent facility renovation" and "Digital protection of hometown ancient buildings", guiding students to apply STEM knowledge and AI technology to solve practical problems in labor practice, and achieving comprehensive improvement of the three types of education abilities.

5.2.3. Six-Step Closed-Loop Project-Based Teaching Model

Project-based learning, as a cross-disciplinary practice method, emphasizes that students should actively engage in learning, practical application and exploration. It has gradually gained attention from the education community (Li, 2025). Based on the constructivist learning theory and the interdisciplinary teaching concept, a six-step closed-loop project-based teaching model of "project-driven - scenario creation - practical exploration - technology empowerment - outcome presentation - reflection and iteration" has been constructed to achieve immersive and in-depth teaching that integrates the three aspects of education. In the project-driven phase, real project tasks are proposed in line with the educational goals of the grade level, and three-dimensional educational goals of labor, STEM, and AI are clearly defined, enabling students to clearly grasp the learning direction and practical requirements. In the scenario creation phase, through cultural explanations, case presentations, and scene simulations, a realistic learning scenario is created to stimulate students' interest in exploration and participation, helping them understand the educational value and practical significance of the project. In the practical exploration phase, students are guided to carry out group-based collaborative work, conduct exploration designs based on mathematics, science, and other knowledge, complete the initial form of the project through labor practice, and achieve the deep integration of labor education and STEM education. In the technology empowerment phase, students are guided to optimize the project design by using 3D modeling, AI programming, etc., to upgrade the works and enhance AI literacy, promoting the comprehensive integration of the three aspects of education. In the outcome presentation phase, project defenses and work displays are organized to allow students to share their design ideas, practical processes, and innovation points, improving their expression ability and self-confidence. In the reflection and iteration phase, teachers and students jointly review the problems and shortcomings in the project implementation, guide students to optimize the project design, improve the knowledge system, cultivate reflection ability and innovative thinking, and form a "practice - reflection - optimization" educational closed-loop.

5.2.4. A System of Practical Fields Combining Reality and Fiction

The diverse practical space is not merely a spatial division; it does not strictly correspond to the activity venues where students participate in different stages of project-based learning. What the author refers to as "diversity" means providing various conditions and venues, which possess the convenience and flexibility that traditional classrooms do not have (Lin & Zhang, 2024). The practical field is the key support for the implementation of the integrated education model of the three aspects of education. By constructing a practical field system that combines "inside the school, outside the school, and online", which integrates virtual and real elements, we break through the limitations of time and space and provide students with diversified practical scenarios. The internal field focuses on creating a multi-functional practical space called "Smart Woodworking Workshop", equipped with tools for woodworking, 3D printers, intelligent sensing devices, AI programming software, etc., to achieve the integration of traditional craftsmanship and modern technology, meeting the needs of daily teaching, club activities, and project practice. At the same time, using idle spaces on campus to create labor practice bases and science and technology innovation display areas, it provides students with platforms for labor practice and result display. The external field focuses on resource integration, jointly building study and practice bases with universities, science and technology innovation enterprises, traditional handicraft workshops, and science and technology museums, inviting university experts to provide technical guidance and organizing students to visit enterprises to understand the practical application of AI technology, and visit traditional handicraft workshops to experience traditional manual labor, achieving the integration of traditional labor and modern technology, and broadening students' horizons. The online virtual field relies on platforms such as Paracraft Metaverse, 3D One design software, and AI programming platforms to build online virtual teaching spaces, realizing virtual design, digital twin, and remote collaboration. Students can conduct virtual project design, AI programming practice and other activities online, breaking the limitations of time and space, achieving integrated practical teaching online and offline, and enhancing the convenience and fun of practice.

5.2.5. Closed-Loop Teacher Training System

Under the guidance of the new educational philosophy, in order to cultivate well-rounded new talents, comprehensive practical activities have increasingly gained the attention of educators (Zhou, 2025). The teaching staff is the core guarantee for the implementation of the three-education integration education model. A closed-loop training system of "training - research - evaluation - examination - assistance" has been constructed to enhance teachers' interdisciplinary teaching abilities and build a professional interdisciplinary teaching staff. Layered training focuses on the differences in teachers' capabilities, providing key training on basic concepts and skills for novice teachers to help them master the basic concepts and teaching methods of the three-education integration; conducting key training on teaching design and innovative practice for experienced teachers to enhance their ability to develop interdisciplinary courses and provide project guidance; and offering key training on research ability and leadership ability for subject leaders to guide them in conducting research related to the three-education integration and play a leading role. School-based teaching research relies on interdisciplinary teaching teams, consisting of teachers from subjects such as labor, science, mathematics, and information technology, to carry out regular activities such as collective lesson preparation, lesson case refinement, teaching reflection, and topic research. Through peer assistance, they solve difficult problems in teaching practice and optimize teaching design. School-enterprise collaboration combines universities and innovative enterprises to provide technical training and practical opportunities for teachers, inviting experts to conduct special lectures, organizing teachers for on-the-job training, and establishing a "university experts + enterprise engineers + outstanding front-line teachers" guidance team to provide regular guidance support. The incentive mechanism incorporates cross-disciplinary teaching achievements, curriculum development, and research projects into the core scope of teachers' excellence and priority evaluation, as well as professional title evaluation, and sets up a special reward fund to stimulate teachers' enthusiasm and initiative.

5.2.6. Diversified Comprehensive Evaluation System

Evaluation not only enhances students' language skills and deepens their cross-cultural understanding, but also cultivates their ability to independently plan and reflect on their learning (Jiang, 2026). Construct a diversified comprehensive evaluation system featuring "process + conclusion" and "multiple subjects + multi-dimensional content", break away from the single evaluation model, and leverage the diagnostic, motivating and guiding functions of the evaluation to comprehensively reflect the development level of students' comprehensive qualities. The evaluation content covers six dimensions: labor quality, STEM ability, AI quality, innovation ability, cooperation ability, and reflection ability. Labor quality mainly evaluates labor habits, labor skills and labor attitude; STEM ability mainly evaluates engineering thinking and interdisciplinary problem-solving ability; AI quality mainly evaluates basic knowledge of AI, tool application and ethical awareness; innovation ability mainly evaluates innovative thinking and innovative points of works; cooperation ability and reflection ability mainly evaluate group collaboration performance and self-improvement ability. The evaluation methods take into account both process-based evaluation and conclusion-based evaluation, and adopt various forms such as growth portfolios, work evaluations, project defenses, practical operations, and process records. The growth portfolios comprehensively record students' learning processes, labor achievements and reflection summaries; work evaluations and project defenses focus on practical abilities and innovation levels; process records track students' participation attitudes and growth changes. The evaluation subjects integrate self-evaluation by students, peer mutual evaluation, teacher evaluation, parent evaluation, and social evaluation, forming a diversified and collaborative evaluation situation, ensuring the comprehensiveness, objectivity and scientificity of the evaluation results.

6. The Practical Verification of the Education Model—Taking the Cooperative Schools of the "Smart Create Lu Ban" Project as an Example

To test the scientificity, operability and effectiveness of the "one core, three dimensions, five paths" integrated education model, this study conducted a special practical verification based on the "Smart Create Lu Ban" project partner school—Huafeng Primary School in Jinwan District, Zhuhai City, Guangdong Province. Through controlled experiments, outcome analysis, reflection and optimization, it provided practical support for the improvement and promotion of the model, and ensured the practical value of the research results.

6.1. Practical Design and Implementation

This practice strictly followed the norms of educational experimental research. A total of 86 students from two classes of the fifth grade at Huafeng Primary School were selected as the research subjects. Among them, 43 students were in the experimental class and were taught using the "one core, three dimensions, five paths" integrated education model constructed in this study; 43 students were in the control class and were taught using the traditional subject-based teaching model. There were no significant differences in gender, age, learning foundation, and family background between the two groups after statistical analysis, ensuring the scientificity and objectivity of the experiment. The practice period was one semester (18 weeks), with the "Smart Create Lu Ban" ancient architecture + AI series courses as the core carrier, covering all three types of integrated courses: basic, expansion, and practical. The teaching was carried out in accordance with the six-step closed-loop project-based teaching model, and diversified practical fields were established through the school's smart creation woodworking workshop, the off-campus intangible cultural heritage workshop, and the online virtual platform. At the same time, a closed-loop teacher training system and a diversified comprehensive evaluation system were implemented. During the practice, a special research ledger was established, and student learning data, work achievements, evaluation feedback, and teachers' teaching reflections were collected regularly to provide detailed basis for the analysis of practice effects and model optimization.

6.2. Analysis of Practical Effect

After the practice is completed, various methods such as comprehensive assessment, outcome statistics, questionnaire surveys, and interview research are employed to conduct an analysis of the effect from three dimensions: students' comprehensive qualities, practical outcomes, and teachers' capabilities. This comprehensive examination is carried out to fully assess the implementation effectiveness of the educational model.

6.2.1. The Comprehensive Quality of Students Has Significantly Improved

Through conducting comprehensive quality assessment tests on the students of the experimental class and the control class, the data shows that the rate of students in the experimental class achieving the engineering practice skills standard has increased from 38% before the practice to 100%, an increase of 62 percentage points; the average score of the innovation thinking assessment has increased by 27.3 points, and the average score of the AI literacy assessment has increased by 65%. The improvement rates of these two indicators are significantly higher than those of the control class (the rate of students in the control class achieving the engineering practice skills standard has increased by 15 percentage points, the average score of innovation thinking has increased by 8.6 points, and the average score of AI literacy has increased by 12%). At the same time, the questionnaire survey results show that 89% of the students in the experimental class stated that their interest in learning about labor, science and AI has significantly improved, and 78% of the students were able to actively participate in interdisciplinary practical projects. The students' labor habits, hands-on practical ability, innovation thinking and cooperative awareness have all been significantly improved, fully demonstrating the effectiveness of the integrated education model of the three educations in cultivating students' core competencies.

6.2.2. The Students' Practical Achievements Are Abundant and of High Quality

During the practice period, the students in the experimental class worked in groups to conduct interdisciplinary practical exploration focusing on real problems. They completed a total of 21 high-quality interdisciplinary innovative works, covering various categories such as intelligent Lu Ban locks, ancient architecture intelligent models, and AI garbage classification reminder devices. The works were characterized by labor practicality, STEM innovation, and AI technology. They achieved the educational goal of "building a foundation through labor and empowering with technology". Among them, 2 works won the second and third prizes in the Zhuhai Science and Technology Innovation Competition respectively, and the "Intelligent Ancient Architecture Lighting Device" successfully obtained a utility model patent authorization. This effectively realized the closed loop of "course learning - innovation practice - transformation", fully verifying the cultivation effect of the educational model on students' innovative practical abilities, and demonstrating the practical value of the integration of three types of education.

6.2.3. The Teachers' Comprehensive Interdisciplinary Teaching Ability Has Been Significantly Enhanced

The 8 teachers who participated in this practice achieved a significant improvement in their cross-disciplinary teaching design capabilities. The rate of reaching the standard increased from 52% before the practice to 91%. They have developed a total of 8 high-quality integrated education lesson cases, among which 3 were rated as district-level excellent lessons, and 3 related teaching papers won awards in the teaching paper competition of Zhuhai City. Through interviews and surveys, it was found that the teachers' teaching concepts of integrated education have been significantly updated, and their abilities in cross-disciplinary course development, project guidance, and problem-solving have been comprehensively enhanced. A professional and multi-disciplinary teaching team has gradually been formed, providing core support for the continuous implementation of the education model.

6.3. Practical Reflection and Optimization Direction

This practical verification has fully demonstrated that the "one core, three dimensions, five paths" integrated education model of three aspects of education is highly scientific, operable and effective. It can effectively solve the problem of the separation of three aspects of education and achieve the dual improvement of students' core literacy and teachers' teaching ability. However, based on the specific circumstances during the practical process, some problems that urgently need to be optimized were still found, providing a clear direction for the improvement and promotion of the model.

Firstly, the urban-rural adaptability needs to be improved. This model has certain basic requirements for school hardware equipment and teaching staff strength. Rural schools are affected by insufficient funding, incomplete hardware facilities and weak teaching staff capabilities, making it difficult for the model to be implemented and achieving the same level of integrated teaching as urban schools. Subsequently, it is necessary to focus on developing lightweight implementation plans for rural schools to lower the implementation threshold, integrate inclusive resources, and promote the implementation of the model in rural schools. Secondly, the difficulty gradient of the curriculum needs to be further optimized. The content of some courses does not match the cognitive level of primary school students sufficiently. Especially in the high-level AI innovation application courses, some programming content is too difficult, making it difficult for some students to keep up with the teaching progress, affecting the learning experience and educational effect. Subsequently, it is necessary to adjust the difficulty of the curriculum content further and improve the gradient design to ensure the applicability and effectiveness of the curriculum. Thirdly, the evaluation system needs to be continuously improved. Although a diversified comprehensive evaluation system has been established, the participation of social evaluation in the practice process is relatively low, and the operability of the evaluation standards needs to be improved. It is difficult to comprehensively and accurately reflect the development level of students' comprehensive literacy. Subsequently, it is necessary to refine the evaluation standards, broaden the participation channels of evaluation subjects, and enhance the scientificity and targeting of evaluation.

7. Conclusion and Prospect

This research conducts a systematic study on the "trinity integration" of labor education, STEM education, and AI enlightenment education in primary schools. Through various research methods, it thoroughly clarifies the internal logic of the trinity integration. Relying on the "ZhiChuang LuBan" project, it comprehensively investigates the current implementation status and core pain points of the trinity integration in primary schools. It constructs a "one core, three dimensions, and five paths" trinity integration education model for primary schools and completes a one-semester practical verification in the same cooperative school, to a certain extent, filling the gap in systematic research on the trinity integration in primary schools. The research clearly states that labor education, STEM education, and AI enlightenment education have distinct internal synergies, forming an educational logic of "labor as the foundation, STEM as empowerment, and AI as guidance". The three are highly consistent and mutually permeable in terms of educational goals, content, and processes, and can form a collaborative educational force to promote the all-round development of students' core competencies. The "one core, three dimensions, and five paths" educational model constructed is centered on the core of primary school students' innovative practical core competencies, supported by the three educations and implemented through five aspects, following four principles, and is in line with the cognitive laws of primary school students. It has strong scientificity, systematicness, and operability. After a one-semester practical verification in a single school, this model can effectively solve the problem of the separation of the three educations, significantly improve students' labor literacy, STEM abilities, and AI literacy, update teachers' educational concepts, and enhance their interdisciplinary teaching abilities. It has initial replicability and promotion potential, providing a phased practical reference model for interdisciplinary education in primary schools. However, the subsequent optimization and implementation of this model and its wider promotion cannot be achieved without comprehensive guarantees in five dimensions. To better improve this educational model and enhance the value of research results, in light of the research limitations, it is necessary to expand the practical scope, optimize the curriculum and teaching model, improve the evaluation system and digital support, deepen theoretical research and results promotion, continuously optimize the model's adaptability and effectiveness, and promote the high-quality development of primary education in the new era, cultivating innovative talents for the AI era.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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