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Research on Innovative Training of Localized STEM Teachers Grounded in Shared Commitment

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Abstract: The high-quality development of a country driven by talent necessitates comprehensive and practical STEM (Science, Technology, Engineering, and Mathematics) education. The goal of localizing STEM education is to cultivate comprehensive innovative technology talents that meet the needs of the new era. STEM teachers play a core role in this concept, and the quality of teacher training directly determines the development trend of STEM education and the quality of future talents in the country. Therefore, based on the current situation and existing problems in STEM teacher training, the shared commitment to "high-quality STEM teacher training" is employed as a guiding principle, highlighting the role of various elements in the STEM teacher training process. The practical path for STEM teacher training is proposed from four aspects: top-level design goal orientation, resource integration to solve supply imbalance, curriculum construction to improve the teaching system, and sustainable development to enhance professional ability. This study hopes to provide guidelines for innovative training of localized STEM teachers in China.

Keywords: STEM teachers; The theory of plural subjects; Interdisciplinary education; Teacher training; Modernization of Chinese style education

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1. Introduction

The report of the 20th National Congress of the Communist Party of China clearly states that building a new development pattern and promoting high-quality development are the primary tasks at this stage. Education, technology, and talent are important supports for the comprehensive construction of a socialist modernized country, and higher requirements are put forward for cultivating a high-quality teacher team. Therefore, it is necessary to promote high-quality education development and comprehensively improve talent cultivation. STEM, first proposed by the National Natural Science Foundation of the United States, is an effective form of education that integrates science, technology, engineering, and mathematics. It emphasizes the comprehensive ability of learners to face practical problems, and its proposal is also in line with China's national conditions [1]. Therefore, in order to cultivate innovative scientific and technological talents who can solve complex problems and enhance the overall competitiveness of the country, China continues to explore the development of localized STEM

education. The innovative implementation of STEM education requires specific courses as the foundation, hence highlighting the importance of having specialized STEM teachers. In 2017, the Chinese Academy of Educational Sciences released the "White Paper on STEM Education in China," which pointed out that the biggest bottleneck in the implementation of STEM education in China is the issue of teachers. In April 2022, the "Compulsory Education Curriculum Plan and Curriculum Standards" [2] issued by the Ministry of Education stated that "interdisciplinary themed learning" has become a new turning point in the development of STEM education. Cultivating teachers tends to improve interdisciplinary abilities and literacy, and assists frontline teachers to transform into STEM teachers [3].

2. Review of the current situation and problems in STEM teacher training

1.1. Imperfect relevant policies

Qualified STEM teachers are the main force driving the development of STEM education. Based on the practical needs of cultivating composite innovative talents, the development of technology and knowledge updates in the digital age have intensified interdisciplinary integration. Subject teachers face a wider coverage of course content and more diverse teaching forms, so the lack of comprehensive policies and regulations is the primary issue in STEM teacher training and development [4].

1.2. Weak professional institutions

In recent years, STEM teaching has generally been offered in science courses, information technology courses, comprehensive practice courses, or other school-based courses with limited class hours and a shortage of teachers [4]. As a result, there is a small number of STEM teacher training professional institutions and most of their training is limited to schools, leading to limited integration of STEM-related resources. They can only rely on their own or small-scale peer exchanges to develop and design STEM resources, thus being unable to adapt to the current development of society.

1.3. Unclear course development objectives

STEM represents the four fields of science, technology, engineering, and mathematics, emphasizing the integration of multiple disciplines. Its educational approach is not a simple combination of four disciplines, but rather an organic connection between them to more effectively cultivate students' innovation and practical skills [5]. However, in the process of localization, STEM education is often misunderstood as interdisciplinary education, while ignoring its core features such as technological integration, problem orientation, and practical cooperation [6].

1.4. Unclear professional positioning of teachers

STEM teachers are not a mixed version of four university subject teachers, nor are they required to be proficient in all stages of knowledge as versatile teachers. However, there are still some educators who have misconceptions about STEM teachers' professional abilities. This not only leads to biases in the development of STEM teachers' abilities, resulting in disparities in their skills, but also instills fear in many teachers about engaging in STEM education due to high expectations of skill requirements, which leads to difficulties in expanding the STEM teaching team [7].

3. Innovative training model for localized STEM teachers based on shared commitment

In the late 1980s, Margaret Gilbert proposed from the perspective of cognitive subjects that interactions and conflicts between different subjects in society are driving forces for social change and progress. The theory of plural subjects attempted to reveal the complexity and diversity of society and provide a framework for explaining social phenomena and problems [8]. Gilbert's theory of plural subjects proposed two core concepts based on shared beliefs or actions: shared goals and shared commitments. Shared beliefs or actions require mutual participation and active action as one subject, and their occurrence requires the existence of a goal, which should be a common goal of each subject rather than an individual goal, and belong to members of plural subjects [9]. The existence of shared goals provides the initial elements of collective formation in the sense of dividing and aggregating individuals. The shared goal will drive individuals to develop a consensus, ultimately forming a shared commitment, that is, participating in two or more individuals achieving consensus on a certain action or concept, which is the source of force for obligation constraints.

4. Innovative training practice path for localized STEM teachers based on shared commitment

3.1. Establishing target direction for top-level design

While aligning with the global STEM teacher training standards, China needs to emphasize the transformation and development of subject teachers. Multidisciplinary teachers need to rely on the guidance of national education policies, engage in innovative STEM teaching practices, and promote deep changes in STEM curriculum teaching [10]. Based on the actual conditions in our country, we can establish special funds at the national and local policy levels to support and promote the progress of STEM education, and encourage higher education institutions, research institutions, and basic education schools to conduct research and practice on STEM education [11].

3.2. Resource integration breaks supply imbalance

The main participants in STEM resource integration include government, enterprises, and schools. As the main venue for teacher training, schools should play a key role in the collaborative work process of multiple subjects, providing resource supply and integrating the abilities of all parties, providing STEM teachers with broader and richer resources [12]. Only through collaborative cooperation among multiple entities can the supply of resources meet the needs of STEM teacher training. In our country, we can advocate for establishing cooperative relationships between schools at all levels, social enterprises, public welfare organizations, etc., sharing educational resources, and jointly promoting the progress of STEM education [13].

3.3. Course construction and improvement of teaching system

The government is responsible for formulating educational policies, providing educational resources, and ensuring the fairness and quality of education. Schools serve as the implementers of education and are responsible for developing and managing effective curricula in accordance with government policies and tailored to their unique circumstances. Moreover, teachers are at the forefront of education, and their direct contact with students is the key to achieving educational goals. Therefore, the government, schools, and teachers need to work closely together to leverage their strengths and jointly promote the construction of STEM courses [14].

3.4. Continuously developing and enhancing professional abilities

The improvement of STEM educators' professional abilities does not solely rely on the support and shaping of external environments such as government, enterprises, and schools, but more importantly, the improvement of teachers' professional literacy and skills. On the one hand, teachers need to cultivate and continuously strengthen STEM awareness. In today's rapidly developing digital world, traditional single-subject teaching methods are no longer able to meet students' diverse learning needs. On the other hand, teachers' ability in STEM teaching practice is also an area that needs urgent improvement. Teachers need to possess comprehensive abilities to coordinate and implement STEM teaching, including designing and executing STEM courses, guiding students in interdisciplinary learning, and evaluating students' interdisciplinary abilities [15].

5. Conclusion

Although there has been much discussion in the academic community on the localized development of STEM education, the training of STEM teachers in China is relatively incomplete. As a key component, teachers play a crucial role in breaking down barriers and collaborating to cultivate STEM teachers through multiple main forces to prepare teachers to face the increasingly complex social environment and international challenges in the future. Cross-disciplinary education is bound to be the trend in the future, and STEM education, as a typical interdisciplinary model, will inevitably become mature. Consequently, the training mechanism for teachers will also evolve and improve with the efforts of all parties.

Disclosure statement

The authors declare no conflict of interest.

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