To Meet the Trend of AI: The Ecology of Developing AI Talents for Pre-service Teachers in China

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***Abstract*—In answering the tremendous achievement and growing advancement in the age of Artificial Intelligence (hereafter AI) in China and across the world, China has issued a series of political statements on developing AI including its national guideline on the development of AI in 2017. In contrast to the grooming applications of AI technologies in the field of engineering, agriculture, medicine etc, the deficiency of qualified and certified AI teachers for all grades is one of the major barriers that China is now facing in promoting its national AI scheme. This paper analyses the current situation observed in the east part of Guangdong Province and proposes a model that integrates regional government, regional normal universities, elite universities, AI companies and local primary and secondary schools as a unified organisation with regional normal universities(normal universities are the universities specifically founded for nurturing teachers at primary and secondary school education) as the central coordinator facilitating the smooth cooperation between different parties. This model which addresses the development of AI talents for pre-service teachers has the potential to be applied to other less-developed regions in China.**

***Index Terms*—AI talents development, an innovative schema for pre-service teacher, Yuedong Model**

I. Introduction and Literature Review

With the issue of its national Artificial Intelligence (hereafter AI) agenda in 2017, China has fine-tuned its developmental schema into a fast track of AI orientation, with an emphasis of AI achievements in industries such as science, technology, engineering, transportation, medical service, agriculture and so on. The impetus behind this national AI agenda derives from the awareness that the advancement of AI technology will lead to the improvement of the livelihood of the whole society and the ensuring of the country to be the leader of the future. In this sense, AI talents in relevant industries are regarded as the shortcut to success in the era of AI. Therefore, the development of AI talents has been advocated in China's educational system, starting from primary school education to tertiary education and postgraduate education. For example, in November 2027, China issued its *National guideline on comprehensive practice courses for primary school education and junior secondary school education*[1], addressing that computer programming education, especially the visual programming education should be practiced in all primary and junior secondary schools in China with an emphasis on the improvement of computational thinking (p. 47) and a perpetration of a solid foundation of automatic controlling system (p. 55). At the senior secondary school education level, AI related knowledge such as data mining, computer programming and basic concepts of AI and its application has been blended with information and technology courses as one of the compulsory courses for all senior secondary school students, as requested by the newly issued national curriculum guideline for information and technology courses [2]. As for tertiary education level, the issue of *The Innovative Action Plan for Artificial Intelligence Education at Higher Education Level* [3] addresses that Chinese universities should be the leading force in the innovation and advancement of AI technology and AI talents in cutting-edge scientific frontiers should be raised.

Based on the above review, Fig. 1 provides a pictorial summary of the relationship between types of education and different requirements related to AI education across different grades.

The number of enrolled students is quoted from the official report on *Number of Students of Formal Education by Type and Level* newly released by Ministry of Education of the People's Republic of China [4]. As we can see from Fig. 1, the number of enrolled students is decreasing when type of education entering into higher levels, while the requirements of level of AI capability as stated by educational policies [1]-[3] are increasing, starting from just appreciating the AI phenomena in daily life at primary education to being the expert of sophisticating AI techniques at graduate level.

In contrast to the heat of advocating AI education across ages, the promotion of AI education is facing a number of difficulties, such as the shortage of funding, the need for standardized AI products and AI education platform and also the lack of policy backup from the government. The major difficulty is the deficiency of qualified and certified AI teachers, especially in primary

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and secondary school educational system, indicating that the AI education in China is still at the beginning stage and needs a holistic approach favouring not only the technological development and innovation in AI industry but also the longstanding educational system in which a scientific developmental ecology of AI teachers for primary and secondary schools will be addressed.

The deficiency of qualified and certified teachers to teach AI, computer science and computer programming has long been the major barrier when developing relevant education in primary and secondary schools even encountered by developed countries such as the US (the United States of America), the UK (the United Kingdom of Great Britain), Japan and developed regions such as HKSAR(Hong Kong Special Administration Region). For example, As requested by UNESCO (United Nations Educational, Scientific and Cultural Organization), Webb and her colleagues [5] surveyed the current curriculum development in the UK, Australia, New Zealand, Israel and Poland and found that the lack of qualified computer science teachers will result in the failure of computer science courses in both primary and secondary schools. Lafee [6] reported a survey conducted by "The School Superintendents Association" in the US, comprising subject of over 16000 educational stakeholders, including primary and secondary school students, parents, teachers and administrators of education. In that survey, the deficiency of qualified teachers and the shortage of fund are the two "chronic barriers" in promoting AI related education in the US. Sentance and his colleagues [7] interviewed 86 current computer science teachers in UK's primary and secondary schools about teachers' need. They found that as the UK is now turning its Information and Communication Technology courses into computer science courses due to the lack of professional training and a degree in computer science is troubling in-service teachers to be able to teach AI and Computer Science. Over 70 percent of the attendants are in wanting of professional training in AI and Computer Science. The similar situation is also found in China. As evidenced by Fig. 1, over 130 million of enrolled primary and secondary school students will be receiving AI education in their compulsory courses either as comprehensive practice courses for both primary school education and junior secondary school education, or blended with information and technology courses as in senior high school education. Compared with the 130 million of students requesting AI education as compulsory education, the number of qualified AI teachers, as reported by China Association of Children's Science Instructors [8], is far from satisfaction due to the lack of consistent and comprehensive training system. The current model of developing AI teachers is to provide teachers from subjects like music, information and technology, sports etc with a short-term training of basic AI knowledge and practice without a long-term plan delicately designed for nurturing teachers competence in content knowledge of AI, pedagogical knowledge of teaching AI and technological knowledge of comprehending of AI techniques. This short-term training, as categorised by Dewey [9] as the model of "Apprenticeship" has been adopted in China as this model allows trainees to simply follow what their AI trainers have practiced in AI training courses and replicate these practice in their own teaching. This "Apprenticeship" model did resolve the urgent insufficiency of AI teachers. For example, 60 teachers from different provinces have received AI training in 2017 offered by Chinese Institute of Electronics [10], focusing on automatics and robots coding training. Many other short-term intensive training camps organised by different organisers to improve in-service teachers understanding of AI knowledge have been found in different regions of China with a diversity of focuses such as visual programming, data mining, uncensored learning, machine learning and so on. The typical feature of these short-term intensive training camps is that the organisation of their curriculum and knowledge structure is based on the expertise of the course instructors not the alignment with the existing curriculum structure used in primary and secondary school education. Therefore, although "Apprenticeship" model like these training camps is a quick response to insufficiency of AI teachers, its influence is still limited, need less to say that "Apprenticeship" model has been criticisd for its avoidance of pedagogical knowledge and trainees have no thorough understanding of the essence of education [9]. In summary, the imbalance between the massive number of students wanting AI education and the number of qualified teachers will hinder the successful implement of China's national AI agenda, especially in the field of education. Apart from the current "Apprenticeship" model, a refined model supporting the nurturing of AI teachers to be qualified in long-lasting AI teaching is needed.

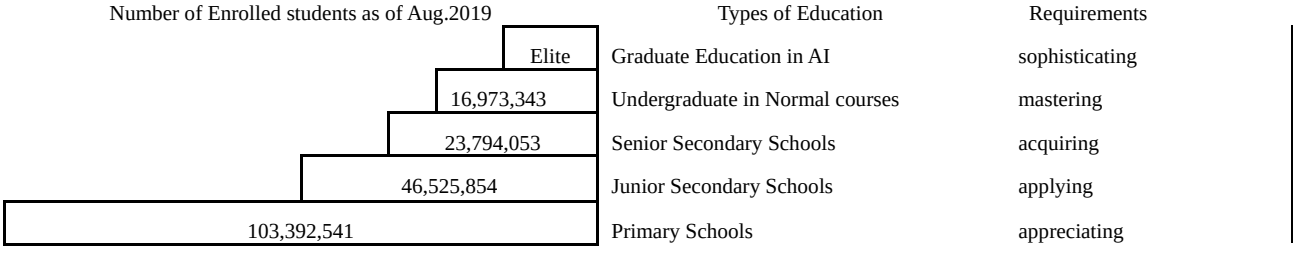

Figure 1. Relationship between types of education and different requirements related to AI education across different grades.

II. A Model to Develop Pre-service Teacher of AI Education: Yuedong Practice

Being the highland of AI, Guangdong Province (or Yue Province) has taken up over one-third of all AI related industries in China with an estimated industry scale of over 200 billion Yuan by the year 2018 [11]. However, contradictory to the overall AI achievement for the whole province, there still exists two main concerns to be mentioned. First is the imbalanced developmental progress among the four regions of Guangdong Province. Geographically speaking, there are four major areas in Guangdong Province: The Pearl River Delta Area, Yuedong Area (The East Part of Guangdong Province), Yuexi Area (The West Part of Guangdong Province) and Yuebei Area (The North Part of Guangdong Province) with similar amount of population. By 2017, the totality of GDP (Gross Domestic Product) by the Pearl River Delta Area is over 8 trillion, nearly four times larger than the rest three areas combined. As for the field of AI, there are more than 10 unicorn AI companies in the Pearl River Delta Area with none in the rest three areas. Also, several elite universities in the Pearl River Delta Area such as the Sun-Yat Sen University in Guangzhou and Southern University of Science and Technology in Shenzhen are now developing its AI related degrees and research with delayed development in the rest three areas. The other concern to is the lack of a systematic educational system, especially the lack of qualified AI teachers that students at primary and secondary schools will be benefited by their experience and expertise.

In China, teachers for primary and secondary school education are educated at normal universities and to be graduating with a bachelor degree in education. Being the highland for development of artificial intelligence (AI hereafter) talents in China, Chinese universities will provide both innovation system and curriculum system for the industry of artificial intelligence. Therefore, in view of the trend of AI, normal universities will be the places to develop future AI teachers for primary and secondary school education. At present, there is no such a university degree named "AI education teachers for primary and secondary school education" in China. In order to resolve the deficiency of qualified AI teachers for primary and secondary school education especially for less developed area compared with the Pearl River Delta Area in Guangdong, this paper report an on-going project conducted in the Yuedong area of Guangdong Province in China, highlighting the important role played by the local normal university: Hanshan Normal University. As endorsed by the policy support by Department of Education of Guangdong Province [11], being the key coordinator to promote AI education in East part of Guangdong Province, Hanshan Normal University launched its strategic plan of developing pre-service teachers for AI education specifically suitable for both primary and secondary education in Yuedong Area. A series of AI oriented courses such as:visual programming for beginners, introduction of AI, robots and AI etc, have been established with an emphasis of not only the technical knowledge of AI but also the pedagogy of how to teach AI in primary and secondary schools. The underlining principle of the curriculum structure of the courses provided to pre-service teachers follows the TPACK model (Technological pedagogical and content knowledge model) proposed by Mishara and Koehler(2006) [12], stating that content knowledge of AI, pedagogical knowledge of teaching AI and technological knowledge of comprehending of AI techniques should all be addressed when developing pre-service teachers competence in teaching AI.

Given that Yuedong Area is in short of both AI related companies providing AI products, AI teaching platforms and AI teaching materials and elite universities consisting AI scientists, AI experts and AI research projects, Hanshan Normal University has invented a synthesized model that inviting AI companies, elite universities as well as local government and local primary and secondary schools into an ecology with Hanshan Normal University as the coordinator to promote AI education at primary and secondary school education level in the Yuedong area. Fig. 2 outlines the Yuedong model with the inclusion of different functions played by different parties.In the model provided in Fig. 2, Hanshan Normal University is the core coordinator, responsible for the establishment of AI education courses in the University, the provision of a holistic development scheme for AI education pre-service teachers including: pedagogical development, knowledge development, training and internship.

Hanshan Normal University is also responsible for the liaison with other parties to consolidate the funding and policy support from the local government, introducing AI products from AI companies, and inviting AI experts to provide advisory support from elite universities.

Local government was positioned at a macro level, majorly providing policy support such as the issue of local AI related guidelines to ensure an atmosphere where AI education in this region is advocated.

Elite universities, which in this case is the Shenzhen University from the city of Shenzhen is now providing expert support such as developing post-doctorate innovative laboratory with Hanshan Normal University, allowing AI scientists to provide expert opinions and welcoming staff from Hanshan Normal University to be trained in Shenzhen University.

AI companies are now providing AI platform such as the visual programming platform and AI education management platform provided by the leading children coding education company: Shenzhen Dianmao Technology Company (Codemao). More supports are now provided by AI related companies, such as the publication of AI related textbooks, the innovative invention of AI products and also the co-development of AI talents in schools.

As for the local primary and secondary schools, they are now the internship places for AI education pre-service teachers developed in Hanshan Normal University. These schools ensure that pre-service teachers will receive supports in head count quota for future teachers, AI equipment and adequate training.

The model provided in Fig. 2 is derived from the practice by Hanshan Normal University, attempting to provide a practical model of developing AI education pre-service teachers based on the university's experience. This model has the potential to be promoted to places where in its own region the basis for AI industry is not strong enough and may seek for advice and support from elite universities and AI companies from other regions.

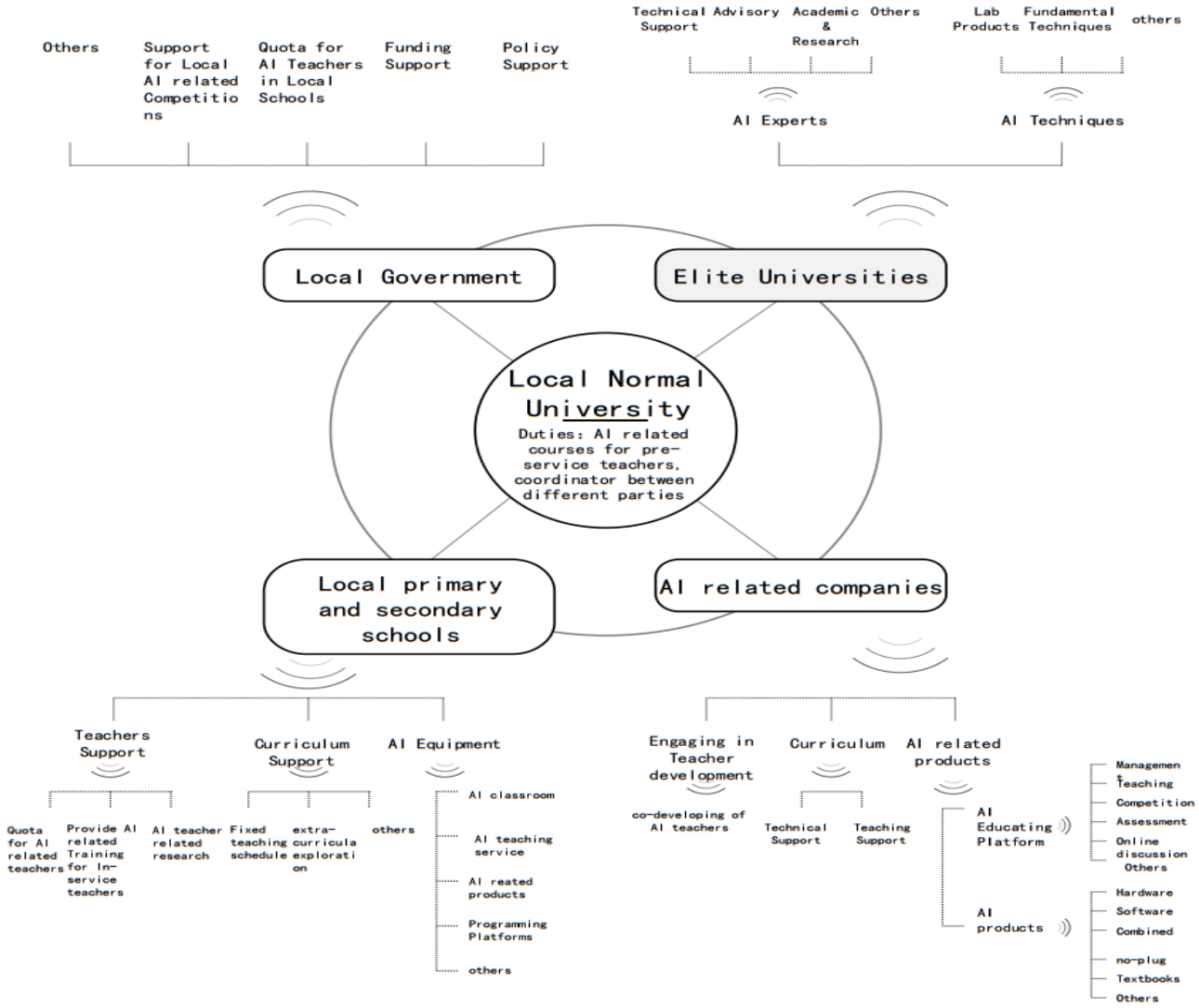

Figure 2. A synthesized model of Yuedong paradigm

This model has been practiced in east Guangdong province since 2018 with over 120 university students are now undertaking a minor major termed: AI Education and Maker Education. In that minor major, local government allocates sufficient funding to the university to ensure the purchase of AI products, AI platforms and AI textbooks, the stipend for courses teachers and the scholarship for out-performing students. About 93 local primary schools and secondary schools with more than 5000 primary and secondary school students have been beneficial from this Yuedong Model, with AI education being taught by students from Hanshan Normal University undertaking the minor major of AI Education and Maker Education. Twelve teacher developmental centres co-directed by Hanshan Normal University, elite universities and AI companies have been established inviting AI teachers for primary and secondary school education from diverse background and expertise.

III. Conclusion

In this paper, we started with the review of the heat of promoting AI in China followed by the review of the current situation of the deficiency of qualified AI education teachers world-widely and in China. Since the lack of qualified teachers, the promoting of AI education is not satisfactory enough. Based on practice from Hanshan Normal University, this paper provided a Yuedong Model in which local normal university, local government, elite university, AI related companies and local primary and secondary schools are synthesized with local normal university as the coordinator to promote AI education in its region. This model has now been practiced in east Guangdong province has influenced 93 primary and secondary school and more than 5000 students. This model has effectively promoted of AI

education in the region and has intimately included different parties concerned. This model has the potential to be publicized into similar regions where elite universities and AI companies could also participate.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Dr. Xia Li is responsible for the reviewing of literature, the proposal of the synthesized model and the draft of the paper. Prof. Zheng Gengzhong is the corresponding author of this paper. He is responsible for the implementation of the research in the specified area with the involvement of related parties and the suggestion of analysis. Both authors had approved the final version.

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