

An Interactive Model of Theory and Practice in the Promotion of Scientific and Technological Literacy of Chinese Kindergarten Teachers

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Keywords: Preschool teacher, Scientific literacy, Interaction, Theory, Practice

Abstract: Chinese kindergarten teachers' poor scientific literacy has weakened the education of children's science field and even their teaching contents that have violated the principles and practices of science and technology. Taking the combination of theory and practice, from the top design to the educational practice, this paper studies the science and technology literacy of the kindergarten teachers, proposing three unique manifestations in the early childhood science education activities to create a circular interaction concept analogy to Qian Xuesen's thoughts of technical science, which conforms to the constructivist education activities of kindergarten teachers. The model of "interaction between theory and practice" is constructed based on this concept with the implementation strategy of "reducing theory" in science and technology theory and "swelling practice" in scientific and technological experience through academic education and continuing education using resources of colleges, society and network. This model which has achieved good practice results provides a reference for improving the science-technology literacy for kindergarten teachers in developing countries.

1. Introduction

The development of science and technology plays an important or even decisive role in the development of the country. However, the key to the development of science and technology, which requires all aspects of education to focus on the cultivation of scientific and technological literacy and innovation, lies in the cultivation of innovative talents rather than just simple policies([1], [2], [3]). At the initial stage of school education, science education in early childhood is crucial to their growth of innovation. Because of the scientific thinking and scientific and technological interest promoted by science and technology education at this stage, it will play a sustained and original role in talent growth([4], [5]). China has entered a new era of high-quality development. The preschool education in the new era requires preschool teachers not only have a high quality of education, but also have high scientific and technological qualities[6].

Generally, due to the low level of science-technology related literacy of preschool teachers in China([7], [8]), kindergarten teachers have been weakened and even have abandoned the teaching of science[9], which makes the science education in early childhood ineffective, while the traditional academic education and training model is difficult to work in the past two decades[10]. The researches and practices on the improvement of science-technology related literacy of kindergarten teachers are insufficient. It was found that in an educational activity of a well-known kindergarten in China, there were many teaching contents and examples that violate scientific principles and do not conform to scientific and technological facts[11]. Even experts in the field of pre-school education have no active awareness of this issue. While in many general early childhood education institutions, the science-technology related literacy of teachers is generally too low to carry out standardized early childhood science education activities. Qualitative method is used to study the types and characteristics of preschool teachers' scientific education knowledge in order to help teachers realize what they have, and point out that it is necessary to develop from the perspective of dynamic development[12]. Subsequently, a high-performance training model was

proposed for the professional literacy improvement of preschool teachers[13]. Educational goals, contents, methods, evaluations, and other "children" solutions have been proposed to solve the current problems of kindergarten science education, one-sided attention to children's intellectual development, and emphasis on teachers' leadership[14]. Not only that, in the study of improving the science-technology related literacy of kindergarten teachers, it also proposes a teacher-based development, which aims to inspire teachers' intrinsic motivation, pay attention to the participation experience of the whole process of training for trainees, and establish a new model of long-term training system[15]. However, the above limited researches and practices are more of a theoretical description, lacking model construction, targeted strategies and approaches. Regarding the existing training models for kindergarten teachers, the science-technology related literacy training strategies have not been highlighted. Even if there are some new models, there is no effective implementation strategy.

2. Research background and theoretical basis

In view of the importance of science-technology related literacy and the uniqueness of preschool children, children's science and technology education has the following unique characteristics.

2.1 Research background

Early childhood science education is the initial and basic stage for a person's future scientific and technological literacy. In the growth of young children, teachers need to build a bridge between children and technology based on their own daily experience. Due to the cognitive characteristics of young children, children's science education should not only conform to the rigor of science of science itself, but also need to be empirically and life-oriented (in accordance with the cognitive characteristics of young children), both of which are in the process of education.

Compatibility and balance is one of the unique manifestations of early childhood science education. The material of science curriculum comes from the thousands of phenomena in life. New ideas, new technologies and new industries happen all the time, while how to effectively use these dynamic curriculum resources, adapting to various new appearances and generating courses according to children's interests in a timely manner, this requires teachers to have pedagogical professional ability, scientific literacy and ability for continuing learning. This interdisciplinary comprehensive knowledge is the second manifestation of the uniqueness of early childhood science education. Because of the differences in the individual and growing environment, it is necessary to take into account individuality and universalization in the implementation of the concept of teaching in accordance with their ability. This is the third manifestation of the uniqueness of early childhood science education.

Then as a preschool teacher, the science-technology related literacy is directly related to the quality of the science curriculum for preschool children. Constructivism regard teachers in the classroom as the role of presenters, observers, questioners and designers, environmental organizers, public relations managers, children's learning archivists, classroom culture contributors, theoretical constructors, etc. which all preschool teachers are responsible for its. Therefore, the effect of the course is not only influenced by the course itself, but also by the self-study of the preschool teachers.

Based on the unique characteristics mentioned above, the idea about scientific nature of teachers will significantly affect their teaching performance. Science teachers are representatives of the scientific community in the classroom while teachers' words and deeds have a subtle influence, not to mention children's strong teacher-oriented nature. Therefore, teachers' scientific literacy has a crucial influence on the effect of early childhood science education, the scientific nature of teachers' knowledge and the logic of thinking all affect the formation of young children's scientific thinking and the generation of scientific interest. In short, what kind of unique characteristics will decides what kind of scientific education effect.

2.2 Theoretical basis (Qian Xuesen's scientific and technological thought)

Qian Xuesen pointed out that natural science activities are the theoretical basis of engineering and technical activities. Engineering and technical activities are the application of natural science activities, but the application of natural science to engineering technology combination of scientific theory and engineering technology is a highly difficult and creative work, more appropriately, instead of a simply applied and deductive work. This scientifically based engineering theory is not the natural science itself, nor the engineering technology itself, but an independent discipline between natural science and engineering technology, namely technical science, as shown in Figure 1. This idea can be understood as a media-based technical science activity.

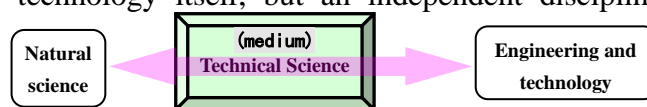


Figure 1. Qian's thoughts on technical Science

3. The concept of circular interaction in early childhood science education activities

Early childhood science education activities are not simply to transfer scientific and technological knowledge to early childhood classrooms, nor to add scientific common sense to the implementation of early childhood curriculum. Technical knowledge, logical thinking and scientific methods are infiltrated into all aspects of early childhood education based on the law of children's psychological development which is done creatively by preschool teachers.

Analogy Qian used the idea of technical science to link natural science activities and engineering technology activities, the concept of circular interaction between science and technology is proposed associated with early childhood science education activities, as shown in Figure 2. Early childhood science education is an independent medium, which combines scientific and technological activities

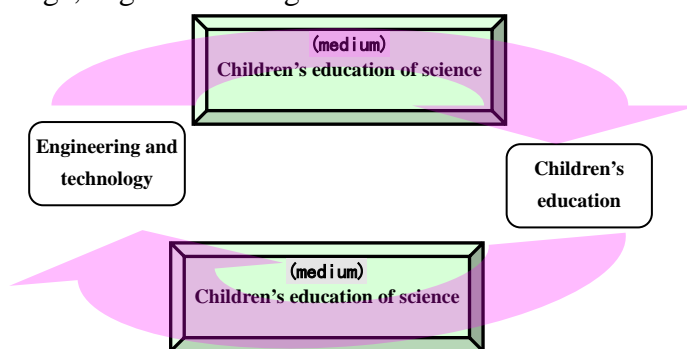


Figure 2. The concept of interaction

with early childhood education activities. Science and technology activities “go” to early childhood education practice to enhance the scientific nature of early childhood science education activities while early childhood education activities “go” to early childhood science education activities to make children's science education activities more childification. The bilateral interactive cycle of early childhood education activities and scientific and technological activities is achieved by the science and technology education activities of kindergarten teachers.

This concept has the following requirements for the creative work of kindergarten teachers in early childhood science education activities: according with the existing experience of young children, the phenomenon full of abstract and logical knowledge of adult world is designed to suitable curriculum based on the cognitive characteristics of young children which need implementation skills and good technical literacy.

4. New model and strategy and approach

4.1 Enhancement mode: the interaction between theory and practice

Guided by the circular interaction concept of preschool teachers' scientific and technological literacy improvement, aiming at the development of preschool teachers, from the interaction of theoretical cognition and practical experience, guarantying of various educational resources, the theory and practice of building lifting mode: bilateral interaction between theory and practice, and its implementation path and strategy which are shown in Figure 3.

The concept of interaction is implemented in the science-technology related literacy promotion activities of kindergarten teachers. On the one hand, under the premise of ensuring the systematic and scientific nature of science and technology theory, reduce the difficulty and height of the existing scientific and technological theories which kindergarten teachers learn in order to improve the cognition of science and technology for kindergarten teachers. On the other hand, relying on social resources, university resources, network resources, etc., promote the cyclical interaction between the science and technology cognition of the kindergarten teachers and the technological experience through academic education, continuing education and other means for elevating the sublimation of experience and realizing the combination and interaction of its "technical theory cognition" and "scientific and technological practice experience". Through this model, we finally realize the improvement of science-technology related literacy of kindergarten teachers from the three dimensions of "science and technology theory knowledge", "scientific inquiry method and process" and "scientific interest and experience".

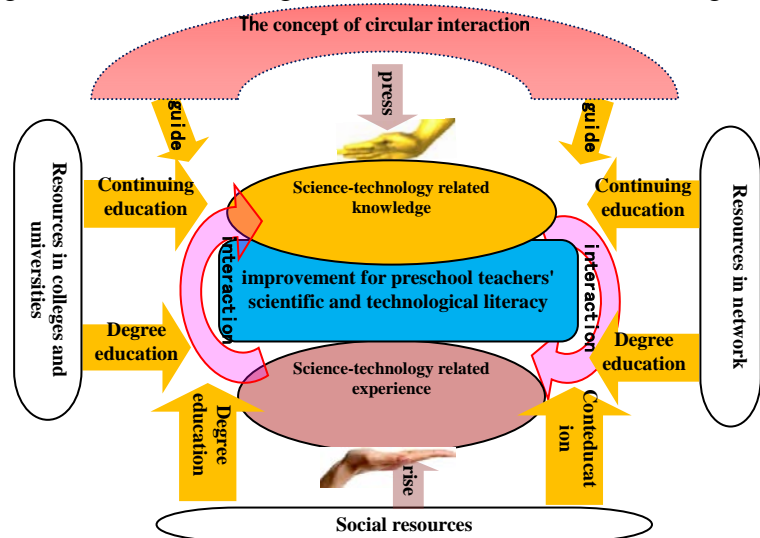


Figure 3. Mode of interaction between theory and practice

4.2 Implementation strategy

From the two sides of science-technology and theory-experience of kindergarten teachers, on the one hand, reduce the difficulty of scientific and technological theory learning, connect with reality, increase application and interest, and promote the effective study of science and technology theory and knowledge by kindergarten teachers with liberal arts background, so as to better grasp children. Help kindergarten teachers dare to face the implementation of early childhood science education. On the other hand, increase the depth and breadth of the experience of science and technology, promoting the sublimation of empirical cognition from life, application and experience, and construct features transform knowledge, realizing the integration of practice and theory.

(1) Reducing cognition of scientific and technological theory

The possession of systematic scientific and theoretical knowledge is the starting point for the improvement of the science-technology related literacy of kindergarten teachers. Einstein believed that "whether you can observe the phenomenon at hand depends on what theory you use, and the theory determines what you can observe". In reality, kindergarten teachers often neglect the phenomenon of science and technology in life because the depth and breadth of science field is too difficult to understand. The reason why the kindergarten teachers reduce or even abandon the science and technology education activities, and narrowly understand science education as mathematics education is that the preschool teachers lack scientific and technological theories .

In the past, talent training for a long time, there is no difference between the kindergarten teachers and other personnel in learning the content, mode, system and requirements of scientific and technological theoretical knowledge, which leads to the low level of science and technology in kindergarten teachers. The scientific requirements, the technical principles and other scientific and technological theories, which will need to be reduced, so that the science and technology theory from the higher education institutions, textbooks, expert laboratories to life and become easier for the kindergarten teacher to understand scientific facts, phenomena, and laws. It is more willing to comprehend the scientific spirit and more fully grasp the scientific methods.

The scientific and technological theory recognizes the operational recommendations of "falling down". How to transfer complex scientific and technological theories to the kindergarten teachers

clearly and concisely, and to make the theory go to life? According to Vygotsky's theory of recent development zones on individual development (real development level and potential development level), we choose to reduce the complexity of the complex scientific knowledge. In the relevant courses and trainings for improving the science-technology related literacy of kindergarten teachers, make the potential level of teachers turn into a realistic level of development, and the theory fall to the height that the kindergarten teachers can get. The "fall" is not fragmenting and simplifying the theory of science and technology roughly but keep the systematic study of scientific and technological theories. The purpose of examination and mathematical logic are diminished while the framework of the theoretical system of science and technology is generally grasped. When the logic operation is diluted, not all of accuracy is abandoned, but the key that description of the amount of nodes is retained.

(2) Raising the experience of science and technology practice

At present, the development of science and technology theory focuses on the exploration and application of universal and abstract scientific laws, is parallel with the development with the science and technology practice experience activities of kindergarten teachers, lack of communication and gaps, which makes the scientific and technological theoretical research far away from the kindergarten teachers' experience of science and technology practice. Therefore, it is necessary to increase the depth and breadth of the science and technology experience from kindergarten teachers, and to promote the sublimation of empirical cognition from life, application and experience which will help the improvement of science-technology related literacy of kindergarten teachers and the integration of practice and theory.

The improvement of the science-technology related literacy of kindergarten teachers cannot stay in the acquisition and understanding of scientific and technological theories but further self-digestion is needed. Only by effectively incorporating the scientific and technological theories and the practical experience of science and technology into the thinking, the preschool teachers can construct their own logic and systems in order to apply the basic theories they have learned. The experience of scientific and technological practice must be related to the theory of science and technology. Otherwise, the experience of science and technology, which is complicated, redundant and system-free, will increase the learning burden of the kindergarten teachers and discourage their enthusiasm for learning. In the training, not only the kindergarten teachers should be presented with various scientific and interesting phenomena, but also the scientific knowledge and principles contained in various phenomena should be explained scientifically and concisely.

Raise the scientific and practical experience of the operation recommendations. Deepen the depth and breadth of various science and technology practice experiences of kindergarten teachers, and raise them into deep understanding to create localized and characteristic courses, which is also needing first-line kindergarten teachers sharply capture scientific phenomena in teaching practice, getting the essence through phenomena, and then effectively use scientific and technological theories to guide practice.

4.3 Ways to improve the science-technology literacy of preschool teachers

Among the various types of colleges and universities in China, there are abundant and diverse courses and other resources covering various disciplines of arts, culture, industry, and agriculture. Pre-school teachers can make full use of various resources of the university in their pre-service academic education to improve their basic science-technology related literacy. The in-service teachers can choose their own science-technology resources according to their needs, then go to the university campus to experience the fun laboratory, participate in science-technology activities and update knowledge and ideas.

There are abundant social resources such as science-technology museums, research institutes and experience museums with science-technology knowledge and scientific-technological atmosphere where is interesting and it will be loved by kindergarten teachers and children. In teacher training, we should try to explain the nature of science-technology lying in the phenomenon and realize the combination of theory and sensibility, rather than stay at shallow understanding the phenomenon.

In the era of "Internet +", resources such as online courses, distance education and new learning methods have broken the limitations of time and space, realizing free and independent learning which create the new engine for kindergarten teachers' learn no matter pre-service and post-employment . Since 2012, large-scale online open courses have become popular in colleges and universities around the world, which have had an important impact on global higher education. Nowadays, network resources such as MOOCs, Spoc and online courses are generally accepted for all types of learning. For example, American universities have launched the three major MOOC platforms, Coursera, EDX and Udacity, attracting many famous universities from all over the world to open high-quality online education resources and services to global learners. In 2013, 109 famous universities opened 679 courses on this platform, 7696 thousand students enrolled in the platform to study. Many well-known universities in China have joined the MOOC platform to build a global online course network with world-class universities such as Harvard, Stanford, Yale, and MIT.

5. Conclusion

In the face of the low status of the science and technology literacy of kindergarten teachers and their poor cultivation effects, the research team took action supported by the project in the Shaanxi Provincial Preschool Education Research Major Project and the Teaching Research Project of the University Physics Curriculum Teaching Steering Committee of the Ministry of Education. The concept of interaction has constructed a "two-way interaction between theory and practice" to improve the science and technology literacy of kindergarten teachers. From 2016 to 2019, relying on the two project cooperation kindergartens, it took more than one year of training for 20 kindergarten teachers and strategies such as "down one drop" and "rise one liter" had been implemented. The new model is further affecting the ability of kindergarten teachers to implement in educational activities in the field of early childhood science.

Aiming at the general situation of early childhood education in China, this paper puts forward three unique manifestations of early childhood science education activities, analogy to the way of Qian Xuesen's technical scientific thoughts, and puts forward the concept of circular interaction of kindergarten teachers' educational activities, and under the guidance of this concept, design The model of improving the science-technology related literacy of preschool teachers the "two-way interactive cycle of theory and practice", suggesting the practical strategy of "reducing one drop" and the experience of science and technology practice "up and down", as well as universities, society, and networks. The specific implementation of the three major resource utilization and achieved good results in the three years of practice, significantly improved the science-technology related literacy of kindergarten teachers.

Acknowledgments

This work was partially supported by the key project of Xi'an Social Science Planning Fund (JY119), the Teaching Research Project of Xi'an Technological University (18JGZ02), as well as the Soft Science and Social Development Project of Weiyang District of Xi'an (201944).

References

- [1] Taylor, A.R., Jones, M.G., Broadwell, B., Oppewal, T. Creativity, inquiry, or accountability? Scientists' and teachers' perceptions of science education. *Science Education*, 2008, 92(6):1058-1075
- [2] Jiang, Z.M. Report of the 15th National Congress of the Communist Party of China . Beijing: People's Publishing House, 1997. 11
- [3] Ni, G.W., Wang, Y.S. *Physics and Culture* . Beijing: Higher Education Press, 2009. 7
- [4] Eshach, H., Fried, M. N. Should science be taught in early childhood[J]. *Journal of Science Education and Technology*, 2005, (3):315-336

- [5] Trnova, E., Trna, J .Formation of science concepts in pre-school science education[J]. Procedia-social and Behavioral Sciences, 2015,197: 2339-2346
- [6] Xi,J.P. Decisive victory to build a well-off society in an all-round way to win a great victory in socialism with Chinese characteristics in the new era——Report at the 19th National Congress of the Communist Party of China . Beijing: People's Publishing Hous,2017.2
- [7] Zhou, J.F.Discussion on the training mode of different levels of early childhood science education teachers.China Adult Education, 2012,(9):91-93
- [8] Li,Y.P. Scientific Literacy of Preschool Education Students. Culture and History Vision,2010, (3):82-83
- [9] Wang,P. The Status Quo and Development Countermeasures of Scientific Literacy of Preschool Education Students in Normal Universities. Studies in Preschool Education, 2008,(3): 25-27
- [10]Wang, S.J. Analysis of the scientific literacy of preschool teachers. Forum on Science and Technology in China,2007,(3):140-144
- [11]Zhang, H.O. The formation mechanism of neon and rainbow and its application in the practice of early childhood education. Science & Technology Vision,2017,(11):114
- [12]Yang,C.X.,Pang Li,J.Types and Characteristics of Science Education Knowledge of Preschool Teachers. Studies in Preschool Education, 2009,(7):25-28
- [13]Jin, Y. Research on the Theory and Countermeasure of Improving the Professional Quality of Preschool Teachers. Adult Education,2012, (1):61-62
- [14]Li,Y.P. The Problems and Solutions of Current Kindergarten Science Education. Studies in Preschool Education, 2010, (7):60-62
- [15]Yu,T.Exploration of Creating a New Model of Preschool Teacher Training.Adult Education,2012,(8):84-85