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Uncovering the Challenges Faced by Primary School Science Teachers in Implementing Experimental Teaching: A Data Analysis Based on a Questionnaire Survey Conducted in Western China

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Abstract: Primary school science is a discipline grounded in experiments, and experimental teaching holds paramount significance in primary school science education in China. Nevertheless, the implementation problems of experimental teaching are frequently disregarded. This research endeavors to disclose the concrete challenges encountered by primary school science teachers in the western region of China during the implementation of experimental teaching, analyze their implications, and put forward corresponding mitigatory measures. Based on a questionnaire survey regarding the current state of primary school science experimental teaching in 21 areas of western China, it is unveiled that primary school science teachers in the western region of China confront deficiencies in scientific professional attainment, the necessity to enhance the attitude towards experimental teaching, and a partial shortage of experimental teaching resources. These hardships result in the deterioration of the quality of experimental teaching, the attenuation of students' learning interests, and the exacerbation of teachers' job burnout. Hence, measures should be initiated in aspects such as teacher training, resource development, and enhanced emphasis to assist primary school science teachers in the western region of China in implementing experimental teaching more effectively and elevating the quality of primary school science experimental teaching.

Keywords: Primary school Science teachers; Experimental teaching; Challenges

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1. Introduction

Recently, an increasing emphasis has been placed on strengthening science education for primary school

students, especially on the teaching of scientific experiments. The Ministry of Education in China has issued curriculum standard documents to optimize the structure of science courses and intensify science experiment teaching in the primary school stage, highlighting the importance of science education in cultivating students' scientific literacy and innovation ability [1]. However, in the actual implementation of science teaching, science teachers are often neglected. As Ryder and Banner [2] proposed, in the absence of an institution that represents all stakeholders, it is impossible to guarantee that multiple objectives are considered throughout the curriculum reform. Consequently, the implementation of science curriculum teaching cannot be thoroughly carried out. All stakeholders here comprise implementing teachers, professional curriculum designers, researchers, and professional scientists working at universities, among others. Therefore, paying attention to the teaching needs of science teachers is an essential part for the education department to ensure the implementation of science curriculum reform.

A great deal of research evidence shows that primary school teachers usually have limitations in terms of scientific background knowledge. This viewpoint was put forward as early as 1974 in the studies by Varley [3] and Symington [4], and has since been supported by relevant reports. For instance, primary school teachers (including pre-service teachers) tend to lack sufficient scientific content knowledge in the field of physical sciences [3,5]. In addition, in the literature research regarding teachers' conceptions, Brown and Hirschfeld [6] defined conception as a mental construct or representation of reality, which is communicated in diverse ways, whether through language or metaphor, encompassing beliefs, meanings, preferences, and attitudes, to explain complex areas of experience, such as assessment. By employing conceptions, teachers can circumvent some theoretical and operational challenges. This study aims to investigate and discover the current situation of primary school science teachers implementing experimental teaching in western China, analyze the existing difficulties, and propose some improvement strategies to promote the effective implementation of science teaching and experimental teaching.

2. Research methods

2.1. Research subjects

This study was conducted based on a questionnaire survey initiated in 2023. The survey subjects were primary school science teachers in some areas of western China. A total of 9,327 science teachers from 21 regions were surveyed. It should be noted that this survey is only an investigation and analysis of some areas in western China and only represents the educational and teaching status quo at the time in the sample locations.

2.2. Questionnaire compilation

The daily classroom teaching practices of science teachers are influenced by a variety of complex factors [7]. The questionnaire design refers to the requirements for experimental teaching in primary school science textbooks and combines relevant research to determine 16 items in four dimensions. The four dimensions are scientific professional literacy, attitude towards experimental teaching, experimental teaching resources, and degree of social support. Four items are designed under each dimension. According to their actual situation and feelings, the respondents made corresponding answers in each item option.

2.3. Validity and reliability

To ensure the validity and reliability of each item of the questionnaire in the expected content field and

research purpose, after initially compiling the questionnaire, the project team actively solicited the opinions and suggestions of experts in various fields in the form of multiple rounds of written discussions. According to the feedback from experts, they continuously optimized and adjusted the questionnaire content to ensure that each question can accurately capture key information and truly reflect the current situation and problems of science teachers implementing experimental teaching. This approach to thematic content analysis of the project ensures that links are established between empirical data and the claims made by experts [8,9].

3. Result analysis

3.1. Science teachers' poor attitude towards experimental teaching

The survey on interest in science teaching shows that 55.08% of science teachers are relatively interested in engaging in science teaching, of which 18.41% of teachers express high interest in engaging in science teaching. However, there are still 35.58% of teachers who have an indifferent attitude towards engaging in science teaching. 9.34% of teachers are not interested in science teaching. The data shows that 5.36% of teachers said they never conduct experimental operation demonstrations in science classrooms. Regarding the statistics on teachers' pressure in engaging in science teaching, the top three sources of pressure are the cumbersome preparation of experimental equipment or teaching aids, the difficulty of experimental operations, and the large number of non-teaching tasks. Teachers' attitudes towards science teaching have an important influence on the implementation of experimental teaching. Our research needs to pay close attention to this aspect.

3.2. Partial lack of scientific experimental teaching resources

The survey on teaching resources shows that 80% of teachers will choose two channels of teacher's reference books and online downloads to obtain teaching resources. However, in terms of the quality of resources and the degree of assistance to teaching, 40.53% think it is basically satisfied, and 35.55% think it is average. It can be seen that the construction of teaching resources for carrying out experimental teaching is still insufficient, particularly high-quality teaching resources are still relatively scarce. In terms of experimental sites, more than half of the teachers' schools have one or more breeding grounds. 70.3% of teachers' schools have special science laboratories. In addition, 18.86% of teachers' schools have laboratories shared with other subjects. Regarding the project survey on whether the school has laboratory technicians, 42.96% of the teachers' schools are not equipped with science laboratory technicians.

3.3. Weak social support

This study investigates four items: school attention, class hour guarantee, student participation, and parent attention. The survey results show that schools in various places have taken multiple measures to improve the professional literacy of science teachers, such as establishing primary school science teaching communities to carry out collective teaching, organizing professional subject training, and dispatching science teachers to participate in off-campus training, providing various supports for the professional development of science teachers. Regarding the survey on the guarantee of science class hours, 64.92% of teachers' science classes are not temporarily occupied, 29.98% of teachers' science classes are occasionally occupied, and only 5.1% of teachers' science classes are often occupied. From the perspective of other subjects in the implementation process of science experiment teaching, students and parents have a relatively high degree of participation. 85.55% of students complete science learning tasks after class on time. 51.66% of parents actively

communicate with teachers about their children's science learning situation and actively participate in the implementation of school science experiment teaching.

4. Impact discussion

4.1. Decline in the quality of primary school science experiment teaching

In the experimental teaching of primary school science classrooms, unstandardized and inaccurate teachers' experimental operations will inevitably lead to the same in students. Moreover, when facing unexpected problems encountered by students during the experimental process, teachers will lack experience in guiding practice, leading to the failure of experimental results. Additionally, teachers lacking professional literacy pay insufficient attention to the safety of experimental operations and do not take effective safety measures, exposing students to potential safety risks in experimental operations. Scientific attitude is an important dimension for students' perseverance in school science learning and interest in pursuing scientific careers [10,11].

Secondly, in terms of learning scientific concepts, teachers with insufficient professional literacy may have incorrect understandings of scientific concepts and thus mislead students' learning. In the long run, students' scientific understanding will become blurred.

4.2. Weakening of primary school students' interest in science learning

Students' attitudes towards science learning may have statistically significant correlations with their academic achievements and gains in content knowledge [12,13]. The survey shows that a certain proportion of teachers do not carry out experimental operation teaching in science experiment teaching. This means that there are relatively few scientific experiments and activities in primary school science classrooms. Excessive lecturing teaching will make science classes boring and difficult to stimulate students' learning interest. Secondly, in the process of teachers carrying out science experiment teaching, due to the lack of sufficient teaching resources, teachers need to spend more time collecting and organizing teaching resources and even need to make corresponding experimental teaching resources by themselves. This situation makes the task of teachers carrying out experimental teaching arduous and under great pressure, leading to insufficient patience and guidance for students. The difficulties and problems in experimental operations encountered by students in the learning process often cannot be effectively solved due to teachers' limited time and energy, which greatly suppresses their desire to explore science.

4.3. Increased job burnout among science teachers

Problems such as insufficient attention from schools, lack of support from parents, and insufficient learning initiative of students make it more difficult for primary school science teachers to implement experimental teaching and may exacerbate teachers' job burnout. On the one hand, the degree of attention schools pay to science teachers, especially in terms of recognition of their work, professional growth, and career care, will affect science teachers' sense of professional identity. The survey feedback shows that some regions and schools pay insufficient attention to science teachers, leading to an insufficient sense of professional identity among science teachers and thus experiencing job burnout. For example, some teachers think that "only teachers who cannot teach Chinese or mathematics well will take on the teaching task of science subjects" and "primary school science experiment teaching feels dispensable. Sometimes class hours that should be used for experiments will be utilized for learning other subjects." On the other hand, problems such as non-cooperation from parents and insufficient learning initiative of students also deeply trouble primary school

science teachers.

5. Discussion

5.1. Strengthening the cultivation of primary school science teachers

Teachers' conceptions of how to teach course content and how the content is learned by students have a significant influence on their classroom teaching methods and students' learning content [14]. Firstly, schools need to break through geographical limitations and develop online science teacher training programs to promptly conduct online training for all primary school science teachers. For instance, by establishing online network teaching, the latest experimental teaching concepts, methods, and experimental operation steps can be conveyed to every teacher, thereby generally enhancing teachers' scientific experimental teaching capabilities. Secondly, it is necessary to focus on key issues and carry out targeted offline training for key teachers. Schools should classify the teaching staff for investigation, deeply understand the professional growth needs of teachers, select a group of outstanding science teachers for key cultivation, and conduct targeted offline content training in aspects such as experimental operations, experimental teaching methods, and experimental teaching theories. Through the backbone teacher plan, each school in various regions can have some teachers with relatively high experimental teaching levels to lead the teaching development in their own regions, promoting the overall experimental teaching level in a point-to-area manner.

5.2. Improving the quality of scientific experimental teaching resources

Scientific experimental teaching resources are essential for primary school science teachers to carry out experimental teaching. The quality of these resources has a significant impact on the quality of experimental teaching. First of all, schools should establish an exchange platform for scientific experimental teaching resources. It is recommended that all regions attach great importance to the construction of experimental teaching resource platforms and open up services for uploading and downloading resources for science teachers to facilitate teachers to upload high-quality experimental resources they have collected or produced to the platform for exchange and also provide services for other teachers to download high-quality experimental resources. This can reduce the time spent by science teachers in collecting and screening experimental resources. Secondly, schools need to promote the construction of a community of experimental teaching teachers and improve the quality of existing experimental teaching resources. Primary school science teachers can form experimental teaching groups and jointly carry out the preparatory work for experimental teaching. Modifying existing teaching resources can enhance the quality of teaching resources and promote the effective implementation of experimental teaching.

5.3. Comprehensively strengthening the attention to scientific experimental teaching

After the increase in attention, students can fully utilize social interactions to develop knowledge together. This enables them to enhance their sense of social support and social interaction in school science. This would lead to a stronger experience of personal value [15,16]. Firstly, the status of scientific experimental teaching in school curriculums should be enhanced. All regions should pay great attention to the construction of scientific experimental teaching venues, the allocation of laboratory technicians, and the replacement of experimental equipment, etc., enhance the importance of scientific experimental teaching in school curriculum construction, and strengthen the evaluation of science subjects. Secondly, parents are invited to take part in science experiment teaching, strengthen their comprehension of experimental teaching, and

enable them to experience every aspect of experimental teaching and apprehend the teaching objectives of science experiments, thereby enabling them to truly value science experiment teaching [17].

6. Conclusion

To sum up, primary school science teachers face numerous difficulties in implementing experimental teaching, and these difficulties have a substantial impact on experimental teaching in primary school science. To address these issues, comprehensive measures need to be taken, including strengthening teacher training, improving the quality of teaching resources, and increasing the attention to scientific experimental teaching. Only in this way can we improve the quality of experimental teaching in primary school science, enhance students' scientific literacy, and promote the development of science education. At the same time, we should also realize that solving these problems requires the joint efforts of the government, schools, teachers, parents, and all sectors of society.

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