

UK Improving Primary Science Guidance Report 2023: Analysis and Enlightenments

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Abstract. In 2023, the Education Endowment Foundation (EEF) of the UK released a new primary science education guidance. This study summarizes the core concepts and methods of this guidance into six points: remedial teaching, collaborative teaching, procedural teaching, situational teaching, feedback evaluation, and continuous development, and analyzes each point in detail. Then, combining the analysis of China's national conditions and the status of primary science education, it discusses the enlightening significance of the UK guidance for China's primary science education reform from the perspective of "six powers" including students' communication and expression skills, scientific inquiry skills, information evaluation skills, and teachers' reflection and improvement skills, lifelong learning skills, and resource mining skills.

Keywords: Science education guidance, Scientific core literacy, Teaching model, Teaching evaluation and feedback, Educational development.

1. Introduction

The advancement of human civilization has been greatly aided by science and technology, which is continuously altering people's lifestyles and ways of thinking. Innovation in science and technology has a crucial role in enhancing global competitiveness and is crucial to the long-term growth of the nation. "We must firmly implement the strategies of revitalizing the nation through science and education, strengthening the nation through talents, and innovation-driven development," stressed General Secretary Jinping, Xi. "We must uphold the principle that science and technology are the primary productive forces, talents are the primary resource, and innovation is the primary driving force." We will continuously generate fresh impetus and new development benefits, as well as open up new regions and development tracks. Innovation in science and technology in the modern day should be founded on the development and enhancement of scientific literacy among all people, not just a select group of scientists and elites. Society must develop citizens who can address problems in the future and adjust to the society of the future.

Developing science education is a potent lever to accomplish this goal. More and more scientific and technological resources are accumulating in the field of education because of the ongoing development of the strategy to revitalize the country through science and education and the growing need for creative talent. This is giving science education in primary and secondary schools new life and exhibiting a wider variety of implementation forms. At the same time, China is also actively exploring the reform path of primary science education to enhance national scientific literacy and promote the strategy of revitalizing the nation through science and education. It should be acknowledged, nevertheless, that China currently lacks a strong incentive for innovation. When considering the full educational life cycle, scientific instruction in elementary school carries the significant responsibility of illuminating knowledge and unlocking potential. Its distinctive enlightenment and wide range of applications are crucial in igniting pupils' interest and fostering their creativity. Therefore, in order to encourage the general improvement of scientific literacy in future societies and provide a powerful boost to the prosperous development of society, we should reexamine and place a high value on the crucial role that science education in primary schools plays in enhancing the scientific literacy of the entire population.

Primary scientific education began to receive more attention in Western industrialized nations earlier. Using the United Kingdom as an example, scientific instruction has been a fundamental

component of the curriculum in primary and secondary schools since the Education Reform Act of 1988. As we move into the twenty-first century, science education gradually shifts from imparting traditional information to developing a broad scientific literacy. The UK now has a comprehensive science education system in place [1]. A revised version of the primary science teaching guidelines was published in November 2023 by the UK's Education Endowment Foundation (EEF) [2]. This guidance, which is based on several research findings, offers six helpful recommendations to assist educators in improving their methods of instruction and motivating students to get a deeper comprehension and application of scientific information. This study summarizes the six recommendations and examines their implications based on a thorough understanding of the guidance's substance. The issues with science education in Chinese primary schools are then examined based on the recommendations' content, and the insightful importance of the UK's recommendations for China's primary science education reform in light of China's unique circumstances is explained.

2. Analysis of the UK 2023 Primary Science Education Guidance

Six recommendations are made from the three perspectives of teaching, evaluation, and development in the UK 2023 Primary Science Education Guidance. Each recommendation is then further developed to provide creative and improved teaching concepts, multifaceted assessment techniques, and the required steps for ongoing improvement. It brings new energy to the subject of science education by forming a life cycle of science education in primary schools with strategic and practical importance. These six recommendations—remedial teaching, collaborative teaching, procedural teaching, situational teaching, feedback evaluation, and continuous development—are compiled in this part along with an analysis of their main problems and ways of implementation.

2.1. Remedial Teaching

Finding and filling up the gaps in students' preexisting knowledge is essential while teaching scientific concepts. The use of everyday language words in scientific situations can sometimes cause misunderstanding, as scientific concepts are frequently esoteric and challenging to comprehend. For instance, in everyday speech, the term "quality" can refer to the caliber of a product, but in a scientific context, it refers to the quantity of matter an object has, which is comparable to but distinct from the idea of "weight" in daily life. Even while quality is tangible, it cannot be seen, which makes it frequently hard for pupils to comprehend. Instructors should identify these conceptual gaps and assist students in bridging them.

Teachers should consider the breadth and depth of concepts as well as the knowledge base of elementary school students when deciding which science concepts to teach first. There are three levels of training in science subjects. The first level uses simple, common terms such as "push," "pull," and "slide," which are easy to understand but may be ambiguous. The second level includes methodological concepts such as "predict," "compare," and "observe," which are essential to scientific inquiry. Level 3 involves specialized terminology under a specific topic, such as "magnet" and "magnetic pole" under the topic of "magnetism" that need to be memorized. Scientific ideas are presented from the simple to the complex and from the outside in. In general teaching, concepts are divided into three groups so that students can better understand the reasoning.

There are four ways to present scientific concepts. The first is to use vivid phrases based on phenomena, such as explaining "north pole" and "south pole" through the attraction and repulsion of magnets. The second method is to use students' daily experiences to introduce scientific principles, for example, the concept of "herbivore" through the example of rabbits eating grass. The third strategy is to combine graphics and practical experience to help students understand abstract concepts, for example, by showing images of the digestive system. The fourth method is to deepen understanding through frequent review, and teachers should constantly consolidate students' memories and provide scenarios for applying these concepts.

In summary, the purpose of remedial teaching is to help students first clarify the scientific concepts in life, then learn and understand new scientific concepts, and accurately understand and use concepts to apply them in different situations.

2.2. Collaborative Teaching

Collaborative learning can help students remember, arrange, and communicate their thoughts as well as enhance their comprehension and scientific thinking. The two categories of collaborative methods are excellent writing and discussions. Because it does not restrict the expression of viewpoints by writing ability, this guide favors classroom debates.

Three things need to be considered when teaching collaboratively. In order to encourage students to communicate and think critically, teachers must first create a positive collaborative environment and set an example. Second, it's important to anticipate potential conversation scenarios and keep an eye on kids who don't participate as much. Daily scenarios should be used to assist pupils from diverse backgrounds speak in a natural way. For instance, the instructor can state, "I like white chocolate because it is very sweet," which is very simple for all students to understand, when explaining the scientific method's requirement that "views need to be supported by evidence." This allows it to be used in scientific contexts. The third is to formulate important questions beforehand, such as "how did you do it," "why is it like this," etc., and then continue to use guiding questions to further the conversation and get other students to consider the specifics, like "who can think of another reason," "does anyone agree," etc.

2.3. Procedural Teaching

When teaching science, teachers must integrate new knowledge with students' understanding of fundamental scientific concepts, procedures, and techniques. For example, when measuring body temperature, students need to complete a series of actions, including reading the thermometer, recording the reading, and drawing a graph. While it is easy to focus on these tasks themselves, the goal of developing critical thinking is often overlooked.

This approach outlines a seven-step teaching process that includes reviewing prior knowledge, outlining instructional strategies, modeling appropriate conduct, assessing mastery, assisting students in practicing on their own, and offering chances for reflection. In Figure 1, their particular meaning is displayed. In practice, there will be some repetition and integration even if the procedures are presented in order. The processes of discussion and reflection can be used throughout the entire process, and teachers may need to check more regularly to see if pupils understand some important and challenging aspects. Teachers must consciously delegate classroom management to students at the same time.

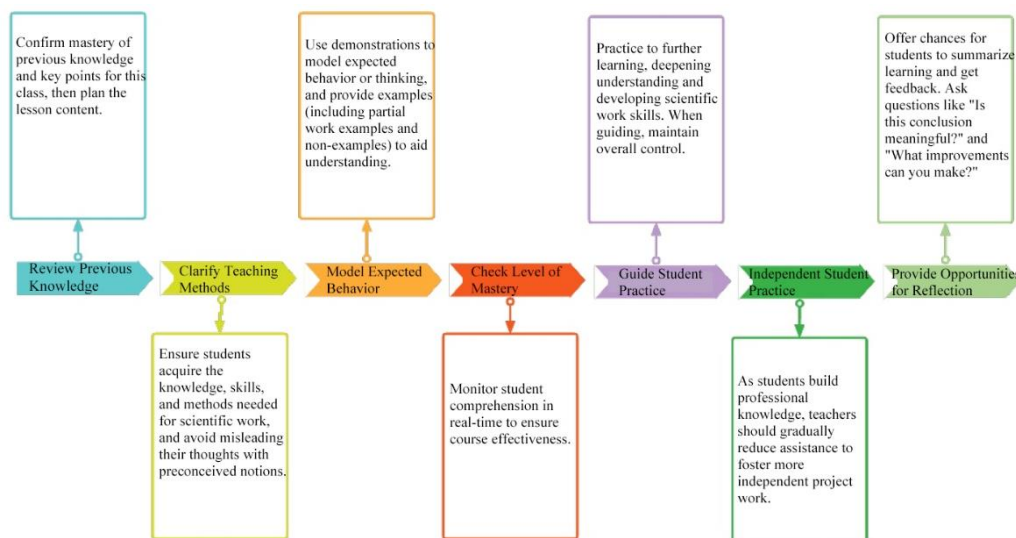


Figure. 1 Seven-Step Method of Procedural Teaching

2.4. Situational Teaching

The goal of situational education is to demonstrate how concepts, ideas, or abilities can be applied in the real world. By combining science teaching with real-life scenarios, students' abilities to apply science and develop a scientific attitude can be improved. However, educators must adapt and set the context according to the unique characteristics of their students.

There are two ways to create context. The first is to combine science teaching with real-world situations, helping students to deepen their understanding, mastery and memory of scientific knowledge through personal experience and establish a connection between science and life. For example, teachers can choose a local green space as a context, allowing students to understand and classify the organisms in their local environment, for example by observing the invertebrates in the green space and using a classification table to classify them. When designing the curriculum, teachers need to anticipate possible risks and develop contingency plans, while balancing the relationship between time, resource investment and specific learning objectives. The second approach is to use virtual models to supplement teaching. When it is not possible to conduct classes in real environments, teachers can use virtual models to help students understand abstract concepts. Virtual models can take the form of simulations, analogies, illustrations, or examples. For example, constructing an online system of gears or pulleys can be used to study the impact of changing the size and number of pulleys, or 3D models can be used to demonstrate the orbits of celestial bodies such as the sun and the earth. These virtual models help connect abstract ideas, concepts, or processes to the physical world.

2.5. Feedback Evaluation

Both teachers and students benefit from scientific evaluation and feedback. Students can better comprehend their learning outcomes, reflect on them, and determine whether they need to modify their learning practices with the aid of feedback and evaluation data. Teachers can use feedback and evaluation findings to better understand students' learning status and level of mastery, inform their next lesson plan, and guide their instruction.

Based on the time dimension, classroom evaluation and feedback can be separated into three categories: diagnostic, formative, and summative. In order to better understand students' thoughts and comprehension and modify the lesson plan in time to enhance learning, a diagnostic assessment is conducted prior to class. Two skills are involved. Predicting such scenarios in advance and reviewing or discussing frequent biases and misunderstandings of the research issue with colleagues are the first steps. The second is to assess students' foundation by using techniques like mind mapping, explaining predictions, and questioning to determine whether the memory method is successful and whether prior knowledge needs to be reviewed. Formative evaluation is a type of classroom assessment that is conducted as the class moves forward with the goal of assisting teachers and students in identifying areas of learning that need improvement and modifying their teaching or learning strategies accordingly.

The rigorous assessment technique known as the Primary School Science Teacher Evaluation (TAPS) study has been shown to improve pupils' learning outcomes over a two-month period. At the conclusion of a unit, semester, or school year, TAPS provides a summary report on students' general understanding based on data gathered from formative evaluation. Figure 2 illustrates a pyramid that can be used to explain this approach, which is known as the "generative to summative" evaluation model.

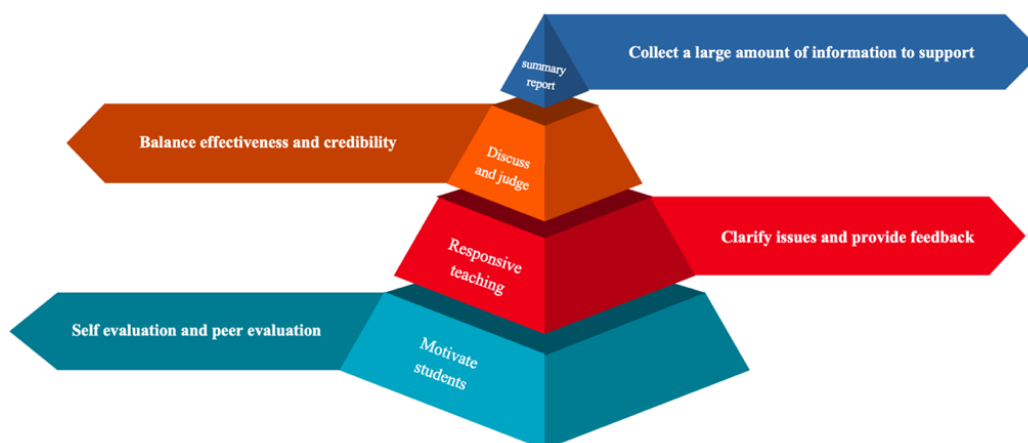


Figure 2. Generative to Summative Evaluation Model

2.6. Continuous Development

Enhancing the teaching capacity of science teachers is the key to reforming science education. Professional development provides systematic support for this, including the development of teaching plans, the implementation of systematic assessments, and continuous follow-up and improvement. At the same time, the effective transformation of science education depends on scientific leadership, which is mainly reflected in the reasonable investment of time and funds. Before fully implementing changes, the current state of education should be assessed, development needs identified, and the most cost-effective improvement strategies prioritized. For example: Which teaching improvements have the greatest impact on student learning outcomes? Which scientific concepts and skills need to be strengthened? What additional support do teachers need? Is this support in line with the school's development plan?

In response to these questions, this study proposes four core areas to promote teachers' professional growth. The first is knowledge construction, which is to clarify the teaching focus and measure students' understanding based on scientific assessments. The second is teacher motivation, which is to encourage teachers to set personal development goals and provide corresponding incentives to enhance their motivation for professional growth. Third is the improvement of teaching skills, which helps teachers optimize teaching methods and improve the effectiveness of classroom teaching through feedback mechanisms, peer support, and practical training. Fourth is practical application, which ensures that improvement measures are implemented in teaching, while maintaining a sense of responsibility and continuously tracking progress. To ensure the scientific nature of decision-making, multiple data sources, such as curriculum planning documents, classroom observation records, and teacher survey feedback, need to be fully utilized to achieve sustainable optimization and improvement of science education.

3. Current Status of Primary School Science Education in China

There are still certain issues with primary science education in China, despite the state's efforts to develop policies in this area. These issues include outdated educational concepts, a lack of teaching and evaluation methods, a shortage of teaching staff, and subpar experimental facilities. These issues contribute to a lack of scientific literacy in the end by depriving pupils of scientific concepts, creative thinking, and inquiry practice skills. There are two main ways to sum up the possible issues with Chinese elementary scientific education: Issues with micro-teaching models and macro-resource scarcity.

3.1. Outdated Teaching Models

China's primary science classrooms are still in the exploratory and developmental stage, and more innovation is needed in both teaching and assessment strategies. The educational philosophies of

"focusing on knowledge and neglecting practice" and "focusing on scores and neglecting abilities," which embrace conventional lecture-based teaching techniques, are still in use in some Chinese primary schools today. These instructional strategies are monotonous, uninspired, uninteresting, and unable to pique students' attention and creativity. For instance, in science experiment classes, instructors teach students how to utilize experimental equipment, offer a lecture on scientific knowledge in accordance with the curriculum, and then assign scores. This kind of instruction appears to be effective. In actuality, though, the majority of teachers set up their classes in a way that suits them, and very few consider whether the pupils have internalized the material or have merely learned it by heart. Even fewer teachers consider whether this class has enhanced their students' skills and decide how best to present the material based on this. For example, they may consider whether students have learned a particular question or have acquired the ability to apply what they have learned to new scenarios. In primary school science education, this type of teaching approach results in an overemphasis on knowledge transmission while ignoring the development of pupils' scientific core literacy. In reality, such ostensibly perfect seminars are merely task-based instruction, and students are likely to remain in the cognitive and comprehending stage, unable to apply what they have learned in a meaningful way, and possibly forgetting it a few days later. It should be mentioned that test scores continue to be the key evaluation criterion for certain primary school scientific curricula, making them overly singularistic. This flawed assessment approach causes pupils to place an undue emphasis on honing their test-taking techniques while downplaying the significance of scientific research and creative thinking. At the same time, this evaluation method is also difficult to fully reflect students' scientific literacy and development potential.

3.2. Relative Scarcity of Educational Resources

There are significant regional variations in the popularity of primary scientific education. The development of science education is severely hampered in certain isolated cities by a shortage of science education teachers, inadequate money, and little awareness of science education. In contrast, resources are more plentiful in industrialized cities. First, there is a shortage of primary science teachers in remote locations, either due to a lack of qualified science teachers or a lack of scientifically literate current teachers who are unable to satisfy the demands of science instruction. At the same time, some schools do not pay enough attention and support to the training and further education of science teachers, resulting in the stagnation of these teachers' professional literacy, which cannot meet the requirements of the times. Second, scientific experiments and project-based learning are important components of primary school science education, but the experimental facilities and tools in some schools are not yet perfect, with insufficient quantity and low quality, which cannot meet the needs of inquiry and practice. This not only affects the effectiveness of science teaching but also restricts the development of students' practical ability and innovative thinking. Third, in such an environment, parents' attention to science education will also be affected, and there is no awareness of the importance of science education. On the one hand, most parents focus more on their kids' academic achievement and living issues than they do on the value of science education, which currently makes up a small percentage of their grades. However, some parents lack support and investment in their children's science education because they are constrained by their own level of scientific literacy, lack knowledge and understanding of science education, and are unable to completely appreciate the potential significance of science education for their children's future development.

4. Enlightenment of the UK Guidance for Primary School Science Education in China

One important and challenging problem is how to support the high-quality growth of primary scientific education in China by drawing on the pertinent experience of the UK primary science education guidelines. Learning requires critical development of its benefits based on a thorough understanding of learning theory and experience, not copying and pasting and complete

Westernization. In order to make these experiences more appropriate for China's educational environment and cultural background, it is also vital to take into account the current state of primary science education in China and think about how to localize them.

Accurate scientific information and effective teaching strategies are all intended to foster students' capacity to innovate, investigate, and resolve scientific issues on their own. Primary science education should strive to develop students' scientific literacy. The first dimension of scientific core literacy, according to the Programme for International Student Assessment (PISA), is the ability to explain phenomena scientifically; the second is the ability to create and assess scientific inquiry designs and critically explain scientific data and evidence; and the third is the ability to conduct research, assess, and apply scientific information to decision-making and action [3]. This paper expands from micro classrooms to macro backgrounds, explains the innovations that primary school science teachers can make in their teaching design to help students' scientific literacy, and summarizes scientific literacy into three "powers," namely, communication and expression skills, scientific inquiry skills, and information evaluation skills. Furthermore, it elaborates on the self-development that primary school science teachers can focus on in their work to enhance their teaching abilities and condenses teachers' own teaching literacy into three "powers," namely, reflection and improvement skills, lifelong learning skills, and resource mining skills, from the classroom to the teachers themselves. Combining the two aspects, a "six powers" model for the development of primary school science education in China is obtained, as shown in Figure 3.

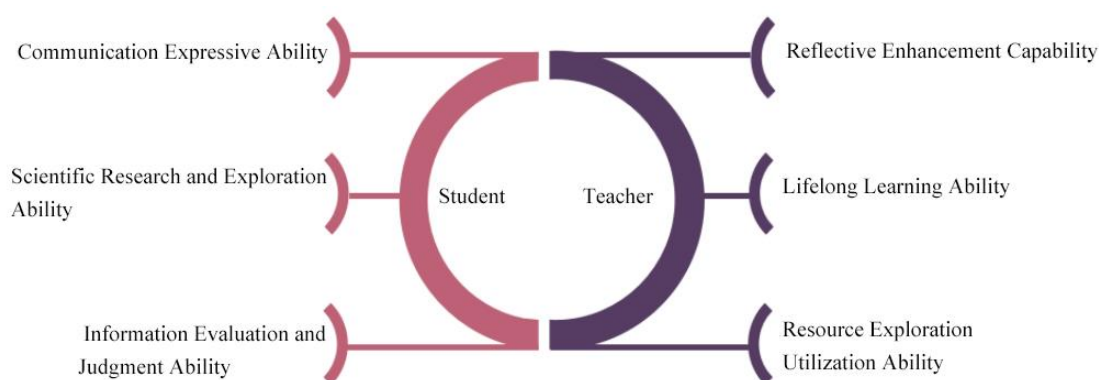


Figure 3. The 'Six Forces' Model of the Development of Science Education in Primary Schools in Our Country

4.1. Communication and Expression Skills: Building Collaborative Spaces and Stimulating Expressive Desires

A crucial component of teaching science is group cooperative learning. It is a teacher-led, cooperative, communicative, and supplementary learning approach that is also essential for assisting students in expressing their opinions in a scientific manner. The practical value of cooperative inquiry is lost, and its effectiveness is significantly diminished due to the formalistic group cooperative learning that is frequently used in classrooms today. This type of learning is superficial and fails to address the root of the issue. In response to the problem of formalization of group learning, Guiping Chen [5] proposed five indispensable "degrees": "problems should have angles, discussions should have depth, problems should have gradients, participation should have breadth, and regulation should have strength." Huimin Wang [6] proposed the method of "scientific division, enriching teaching, and expanding discussions."

According to this publication, scientific group cooperative learning should focus on three factors: "member division, question selection, and teacher regulation." First, group cooperative learning is based on the scientific division of groups. Teachers should precisely identify the characteristics of the students in the class, ensuring that each learning group has a balanced strength, and thoroughly comprehend and apply the idea of "heterogeneity within groups and homogeneity between groups" when splitting groups. Second, in science education, teachers often use problem-based teaching to

introduce the class, with the problem being the core of the entire lesson. If the problem is too direct, students can answer it too easily, which not only fails to stimulate students' desire for knowledge but also makes the discussion and cooperation lose its meaning. If the problem has a single perspective and no room for exploration, it is neither conducive to the cultivation of divergent thinking nor to the role of cooperation. Furthermore, the gradient of problem setting should be deepened as students get older and their skills improve. This means that problems should go from shallow to deep, from appearance to essence, from concrete to abstract, and gradually get harder until they approach the essence of the problem. This not only complies with students' cognitive laws but also fosters divergent thinking in them. Third, although the main body of group cooperative learning is students, the rhythm, progress, and atmosphere of the entire discussion process need to be controlled by teachers. Chinese students are generally relatively shy, and some groups will have no one speaking. In order to inspire students, teachers must now brighten up the classroom environment and implement engaging strategies like showing off experiments, playing quick films, etc. Additionally, some kids will have extreme viewpoints, and teachers should provide them with the right kind of advice. Teachers should be aware of their students' job completion and logically assign extra work when some groups complete the assignment ahead of schedule and discuss subjects irrelevant to the lesson. Throughout the process, teachers need to give students enough opportunities to express themselves to exercise their reasoning, argumentation, and expression skills. Since each student is different and their way of thinking is different, the way they express their views is also different. Teachers need to help extreme ideas return to the right track and encourage students to extend their own ideas. The collision of opposing viewpoints fosters divergent thinking and advances scientific literacy by strengthening students' speculative abilities as well as their expressive abilities.

4.2. Scientific Inquiry Skills: Breaking Through Misconceptions and Creating Real-World Situations

The development of scientific inquiry skills is predicated on well-defined scientific concepts. According to the "Compulsory Education Science Curriculum Standards (2022 Edition)," assessing students' understanding of 13 core ideas and 54 branch concepts is the major assessment method, and scientific knowledge is one of the key components of primary school science learning evaluation. Therefore, focusing on the teaching of scientific concepts has become a new trend in primary school science education in recent years. According to Shengjie Han [4], some students do well at memorization of scientific concepts, but they tend to disregard scientific principles and rely on their personal experiences in unexpected situations. This is known as a misperception. Examining the causes in detail reveals that students' learning frequently builds upon prior experiences, and this preconception is essential to the creation of knowledge. While some ideas are accurate but comparatively superficial, others are at odds with scientific principles and require immediate correction. For example, when students find that leaves fall slowly and basketballs fall quickly, they will develop the misconception that "heavy objects fall faster." In response to this problem, teachers need to understand students' preconceived notions and identify and correct errors in a timely manner during teaching. In addition to asking questions and conducting tests, teachers should also anticipate possible misunderstandings among students and help them resolve these problems. According to the suggestions of the UK guidance, teachers can divide scientific concepts from broad to narrow to carry out teaching from shallow to deep. First, tell life-oriented and easier-to-accept concepts by primary school students, such as oxygen and hydrogen in chemistry. Secondly, tell broader descriptive concepts, such as comparison, observation, prediction. Lastly, identify the specific scientific concepts that must be understood in accordance with the course material. For example, by observing particular experiments, it is discovered that oxygen is made up of oxygen molecules, and that an oxygen molecule is made up of two oxygen atoms. The concepts of oxygen molecules and oxygen atoms are then introduced appropriately. To put it briefly, to help students comprehend and master scientific concepts more thoroughly, teachers must discover the ideal balance between their teaching objectives and the cognitive structure that already exists in their pupils.

The UK guidelines recommend using situational teaching methods to connect scientific concepts with the real world, stimulate students' desire to explore through virtual models or real scenarios, and cultivate their ability to solve real-world problems with a scientific attitude. However, situational teaching in Chinese primary school science classrooms is rarely designed. The first is that teachers prefer to lecture using traditional methods because they save time and effort; the second is that schools don't pay enough attention and don't invest enough money, which means that many courses and experiments can't be carried out in real-world situations; the third is that social resources don't interact well and parents are too restrictive.

Two facets of hardware and software can be used to address the aforementioned issues. Regarding hardware, educational institutions ought to invest more in the development of pertinent situational platforms and experimental hardware facilities. Simultaneously, it is feasible to enhance the interaction of social resources, i.e., to form partnerships between educational institutions and establishments like zoos, planetariums, and science and technology museums. This would allow students to experience more realistic and expansive scenarios, stimulate their senses, enhance their curiosity, and enhance their embodied experiences. In terms of software, many science teachers still use the simplest teaching mode, that is, to make courseware according to the teaching syllabus and then lecture on knowledge. This teaching mode is easy for teachers, without spending too much time and effort, but it is not good for students' long-term development. Students only learn abstract and boring theories, which are easy to forget and do not generate curiosity and desire for science. Therefore, schools should strengthen teachers' teaching training, popularize the latest and most effective educational concepts, and adopt incentive mechanisms to recognize teachers who use new concepts to teach. For example, when teachers design a module of "celestial motion," they can consider cooperating with planetariums and using situational teaching methods. When leading students to visit planetariums, they explain the knowledge in the books. Students will be more inclined to investigate the cosmos once they see more realistic motion trajectories that planetariums simulate with their own eyes. It should be noted that the entire process also requires the assistance of parents. Parents may be unduly worried about possible safety risks during experiments and travel. Schools can now encourage some parents to participate so they can see firsthand how situational education has far more benefits than minor risks. They can also make sure that teachers anticipate and avoid potential risks in lesson plans to ensure student safety.

4.3. Information Evaluation Skills: Teaching Scientific Methods and Supporting Critical Thinking

Information evaluation skills refer to the ability of students to effectively screen, evaluate, and judge various information when they are faced with it. In the era of information explosion today, cultivating students' information evaluation skills has become an important part of science education. On the one hand, educators must help students learn how to ask questions, push them to consider the motivations, goals, and potential biases of the information, and teach them to critically evaluate material rather than take it at face value. On the other side, teachers must teach more scientific ways to enable pupils ask legitimate questions, as stated in the UK guidance's procedural teaching method. It is just as wrong to raise questions blindly as it is to accept them mindlessly. Students' questions lose their meaning and may even make them reluctant to ask them again if they are not backed up by specific scientific evidence and support. This is very detrimental to the development of critical thinking skills. For example, teachers design a theme to help students distinguish between true and false news. First, the teacher shows students a news report about "a magical animal appearing in the park" and asks students whether they believe this news report, and then guides students to think about how to verify the authenticity of this news report. Students will undoubtedly have questions throughout the process, but it's crucial to figure out how to demonstrate that the inquiries are accurate. Teachers can therefore lead students through two scientific methods: first, perform a thorough analysis; second, help students carefully read the news report's content; third, ask students if the location, time, and event described in the report are accurate; and fourth, determine whether the news

report's source is an official channel or reputable news agency. After that, verification analysis can be done, and educators can instruct pupils on how to use search engines to find pertinent material or ask reliable individuals (such parents or instructors) to confirm the news report's veracity. Detailed analysis and verification analysis are two scientific methods that students need to internalize, which help students raise questions rationally and evaluate the accuracy of information. Therefore, when teachers design teaching, they should be guided by the cultivation of students' abilities, think about how to approach speculative themes, and how to promote scientific methods.

4.4. Reflection and Improvement Skills: Innovating Evaluation Strategies and Breaking Traditional Shackles

Students will undoubtedly have questions throughout the process, but it's crucial to figure out how to demonstrate that the inquiries are accurate. Teachers can therefore lead students through two scientific methods: first, perform a thorough analysis; second, help students carefully read the news report's content; third, ask students if the location, time, and event described in the report are accurate; and fourth, determine whether the news report's source is an official channel or reputable news agency. After that, verification analysis can be done, and educators can instruct pupils on how to use search engines to find pertinent material or ask reliable individuals (such parents or instructors) to confirm the news report's veracity. Most scientific instructors in China currently solely use summative assessments, and they only use one kind. According to this paper, evaluating teachers should be done from three perspectives: breadth, width, and depth, with time as the axis. This means that the evaluation should be thorough but also detailed, assess teachers as well as students, and consider the assessment of practical ability in addition to cognitive level. The basis of the entire class is diagnostic evaluation, and in order to master first-hand knowledge, establish the course's emphasis and progression, and plan suitable classroom activities, teachers must perform various types of learning scenario inquiry before to class [7]. Formative evaluation often appears in class, and teachers can adopt methods such as in-class quizzes or questioning. Of course, in the context of situational teaching, the form of formative evaluation can be richer, such as students' practical operation ability, expression ability, cooperation ability, speculative ability, etc., providing opportunities for the evaluation of core literacy. When conducting summative evaluation after class, teachers not only need to consider the results of formative evaluation but also compare diagnostic evaluation and formative evaluation, and consider the progress of students. Since every student starts from a different place, it is more accurate to focus on trends rather than outcomes. Teachers should identify issues during the process, compile their experiences, and continuously improve their teaching methods and classroom setup based on evaluation comments. For instance, teachers can determine that pupils lack the capacity for self-learning when they observe that certain students hardly think for themselves and instead follow the teacher's lead when asking questions. At this time, teachers need to reflect on whether there is excessive guidance in teaching, and can learn from the gradual release of responsibility (GRR) teaching model [8], which requires teachers to gradually transition from being fully responsible to letting students take responsibility for tasks in the process of completing tasks. This teaching model can help teachers gradually release power and slowly transition from "teachers do" to "students do it themselves." Guide students to gradually establish the ability to think independently and solve problems.

4.5. Lifelong Learning Skills: Improving Professional Ability and Expanding Educational Horizons

A teacher will soon find it difficult to adjust to societal developments if their understanding of science and technology stagnates. For this reason, lifelong learning is essential for educators. On the one hand, it is necessary to create learning channels. In addition to autonomous learning through online courses, micro-videos, and workshops on popularizing science, collective learning can be accomplished through the education department's training programs, school-to-school observation, and teaching and research activities conducted within the school. The content of learning should be

carried out in accordance with the TPACK framework, namely technological knowledge, pedagogical knowledge, subject content knowledge, and the integration of the three [9]. In the realm of technological knowledge, we should continuously monitor the state-of-the-art in technological development, particularly in the areas of artificial intelligence and big data, which have the potential to disrupt conventional production and lifestyle. We should also consider and investigate ways to incorporate these technologies into science education. Emerging teaching models like project-based learning and flipped classrooms should be considered and implemented in the field of pedagogical knowledge. At the same time, we should consider the application of traditional educational theories like curriculum and teaching theory and educational psychology, and we should summarize the results of particular studies. In the field of subject content knowledge, we should pay attention to the cutting-edge of scientific and technological development, especially advanced scientific theories, major technological innovations, and typical engineering cases, and combine these with concepts and situations in teaching to maximize students' curiosity and imagination.

At the same time, teachers' sustainability and the accurate application of policies are equally crucial. On the one hand, laws should be passed by the state to ensure science instruction in elementary and secondary schools and to increase society's long-term focus on science education. The United States, for instance, has created the "Computer Science Education Act," which aims to advance computer science and technology education nationwide and mandates that students in elementary and secondary schools acquire both theoretical and practical computer skills in order to meet the demands of the information age [10]. On the other hand, the government needs to maintain a steady increase in the number of teachers. First, teachers' salaries and benefits should be improved and better welfare guarantees should be provided to attract more talents to join the ranks of teachers. Second, it is necessary to improve the working environment of teachers, providing better teaching facilities and resources can reduce teachers' work pressure, and also provide a good platform for teachers to innovate teaching models, thereby attracting more people to choose this profession. Third, the government should promote the values of the teaching profession, create an atmosphere of respecting teachers and educating people, improve teachers' social status and reputation, and let more people recognize the importance of the teaching profession, stimulate more people's enthusiasm and dedication to education, and provide lasting momentum for the vigorous advancement of the teaching profession. Fourth, the training of normal students majoring in science education in colleges and universities should be promoted and improved, closely combining social needs, broadening the breadth of courses, focusing on practical education, and opening innovative courses, so that science teachers can experience advanced teaching methods and evaluation methods before they start their careers, and can better apply them in primary school teaching.

4.6. Resource Mining Skills: Optimizing Resource Allocation and Leveraging Technological Development

Teaching is a huge undertaking that calls for constant research to make the most of the few resources available. It is crucial to make the most of current policies and resources, distribute them sensibly, upgrade school gear and software, and enable the implementation of innovative teaching techniques, particularly in regions with more underdeveloped educational systems. This will significantly raise the caliber of instructional materials by drawing in more exceptional educators and skilled professionals. For instance, the "Three Supports for One" policy aimed at outstanding college students not only provides them with good employment prospects but also injects new vitality into the educational cause in underdeveloped areas. In addition to the government's macro-control and investment, assistance between schools also helps to narrow the information gap in education. Leveraging the example role of high-quality schools and enhancing the cooperation and support mechanisms between schools can boost the creation of future high-quality schools. This sustainable solution helps to resolve societal issues, promote justice and fairness, and achieve balanced development of high-quality educational resources. Furthermore, the internet's convenience might lessen the annoyance brought on by regional variances. The widespread use of the internet has

expanded the boundaries of education, allowing for the integration and sharing of educational resources globally, eliminating geographical barriers. This provides students with a broader range of learning opportunities, enabling them to access world-class courses, research materials, and academic achievements. A multitude of teaching resources and examples are available on the internet for educators, which improves the caliber and efficacy of instruction. The only way to effectively address the historical problem of resource scarcity is to break the current educational impasse and effectively utilize available resources.

5. Conclusion

In terms of educational philosophy, teaching design, teaching techniques, and evaluation feedback, scientific education in Chinese primary schools is currently undergoing a period of in-depth investigation. Six recommendations are offered in the UK's 2023 guidelines for scientific instruction in primary schools, which are based on teaching design, assessment feedback, and sustainable development. These recommendations are really useful and practical. This paper examines the insights provided by the UK standards for the advancement of science education in Chinese primary schools, taking into account the country's existing state, which is characterized by conservative teaching styles and a dearth of educational resources. Starting from the "six powers" — students' communication and expression in science literacy, scientific inquiry ability, information evaluation ability, and teachers' reflective improvement in teaching literacy, lifelong learning ability, and resource exploration ability — the paper integrates advanced concepts with local characteristics, analyzes practical paths, and aims to propel China's primary school science education into a new period of vibrant development. This will lay a solid foundation for cultivating innovative talents for the entire society.

References

- [1] Zhu Huaixin. Science Education Policy Considerations in British Primary and Secondary Schools: Based on Literacy. *People's Education*, 2022(18): 71-74.
- [2] THE EDUCATION ENDOWMENT FOUNDATION. Improving Primary Science Guidance Report [EB/OL]. [2023-12-25]. <https://d2tic4wvo1iusb.cloudfront.net/production/eef-guidance-reports/primary-science-ks1-ks2/improving-primary-science-guidance-report-ks1-ks2.pdf>.
- [3] OECD. PISA 2025 Science Framework (Second Draft) [EB/OL]. [2023-12-25]. https://pisa-framework.oecd.org/science-2025/assets/docs/PISA_2025_Science_Framework.pdf.
- [4] Han Shengjie. From "Mystery" to "Thought": Strategies for Transforming from Misconception to Scientific Concept. *Heilongjiang Education (Education and Teaching)*, 2023(09): 76-78.
- [5] Chen Guiping. Several "Degrees" that are Indispensable in Group Cooperative Learning. *New Curriculum Review*, 2020(12): 59-53.
- [6] Wang Huimin. On the Strategies of Group Cooperative Learning in Primary School Chinese. *Proceedings of the 2020 Primary and Secondary School Teaching Innovation Reform Seminar*. Beijing: Chinese Academy of Management Science Education Research Institute, 2020: 721-723.
- [7] Hong Shuying. An Applied Study on Improving Junior High School Students' English Autonomous Learning and Collaborative Abilities through Group Cooperative Learning. Wuhan: Central China Normal University, 2021.
- [8] Shu Qike. Precisely Grasping Learning Conditions to Promote the Internalization of Scientific Concepts. *Primary School Teaching Research*, 2023(33): 68-70.
- [9] MISHRA P, KOEHLER M J. Technological Pedagogical Content Knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6): 1017-1054.
- [10] Guan Songlin. Experience and Enlightenment of Science Education in Developed Countries' Primary and Secondary Schools. *Educational Research*, 2016, 37(12): 140-146+154.