New Perspectives in Science Education
International Conference
NEW PERSPECTIVES in SCIENCE EDUCATION

Directions for inquiry-based teaching in China's new educational era.

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Abstract

This time, the inquiry-based education that China's new compulsory curriculum standards aim to provide was investigated mainly through a literature review.

On 21 April 2022, the Ministry of Education of China announced new compulsory education curriculum standards. In order to solve this situation, the new curriculum standards aim to deepen the reform of basic education and, at the same time, to enable students to grow healthily and happily, and to cultivate human resources with the three qualities required by the State: ideals, skills and responsibility. Three major changes can be seen in this course revision: the focus on key competencies, the emphasis on course synthesis and the practical nurture person. China has recognized the importance of education beyond knowledge learning for several years. In 2020, Shanghai promulgated the Compulsory Education Project-based Teaching Three-Year Plan (2020-2022), which focused on the practice and research of project-based teaching, aiming at creative problem-solving skills, and promoted it in schools across Shanghai. In addition, the Practical Exploratory Discussion on the New Curriculum Standards for Compulsory Education, held on 14 August, stated that the creation of lessons based on the new curriculum standards will require new lesson designs, re-organization of knowledge, curriculum redesign and educational design for students' independent learning. Thus, in the revision, China's desire to cultivate more holistic students, not only those who know only 'knowledge and skills', can be seen.

However, at present, there are many difficulties in implementing enquiry-based education in China. According to Ou (2004), first, there has been no such thing as 'student-led lesson design' in Chinese education. Therefore, most of the inquiry-based education up to now has been a class in which students try to solve problems by teachers continuously giving hints that lead to the solution of certain problems, and there were not many situations in which students were able to think. In addition, there is a lot of dissatisfaction with inquiry-based education in the field because teachers do not understand the concept of 'inquiry', do not know what is needed to conduct an inquiry class, and do not understand its meaning.

Keywords: scientific inquiry, STEAM education, scientific wisdom

1. Background

Education in the People's Republic of China has changed dramatically in recent years: six years after the first national standardised curriculum guidelines were published in 2011, a major reform of university entrance examinations and a revision of high school curriculum guidelines were carried out in 2017. And in 2022, the compulsory education curricula will also be revised. These revisions have one strong goal: to educate the whole person and develop key skills.The 2017 university examination outline emphasises "reflecting the direction of literacy planning" in addition to "insisting on overall stability and promoting reform and innovation" and "striving to optimise and improve the quality of examination content". In order to move from conventional education to holistic education, the Guidelines for High School Study fully promoted literacy education and education suitable for the new university entrance examinations, emphasised the ideological,

scientific, systematic, adaptive and operational nature of the guidelines, and advocated an independent exploratory learning method for students.

Traditional Chinese education was a cramming method of "a blackboard, a book, a piece of chalk and a mouth". The new Courses of Study called for a shift from such a passive, mechanical and accepting education to "students' independent, exploratory and collaborative learning method". Inquiry Education was introduced in many schools and brought an unprecedented sense of well-being to existing classrooms. However, in the process of implementing the new teaching method, misconceptions in the education system and mistakes in the way Inquiry Education is received can be seen. In addition, parents and teachers who had previously received cramming education complained about inquiry education itself, and China was still in the exploratory stage of inquiry education.

2. Methods

Official documents issued by the government and other bodies on inquiry education and related research were collected and organised to summarise the implementation methods of inquiry education in China. The People's Education Press recommends inquiry-based education (?). If it is a book, please put the number [3] or so below). The directions and problems of inquiry-based education in science education in China are discussed with reference to the following.

3. Results and discussion

One of the reasons why teachers reject inquiry-based teaching is that they are not confident that students will fully understand the content of the unit, or that they do not know if they can do what they want students to do properly. For this reason, there are still many experimental classes in which the teacher carries out the experiments and the students record the results. To improve this, it is important to organise what the teacher wants the students to learn from the experiments when conducting the experimental lessons.

For example, in a lesson on the study of organic compounds in chemistry proposed by Zhou (2017), the exploration activities shown in the table below could be implemented. The lessons in the table integrate the teaching of scientific inquiry awareness and methods for students. The aim is to obtain the exact structure of organic compounds based on the knowledge acquired by the students, by making analytical deductions from the facts obtained by experiment and the data obtained by measurement.

問題	有機物A水溶液がある。Aの構造を調べよ。	討論：分離精製，元素組成と相対分子量の確定，構造の確定
探究1	Aを分離精製する方法	Aと水の物理的性質特徴
	Aを元素分析する方法	討論：燃焼によってCO2と水が生成するか確認
	Aの相対分子質量を調べる方法	練習：相対分子量の計算方法 情報収集：質量分析法
探究2	Aの分子式から，Aの構造を確定する方法	討論：化学的性質から実験をデザインし，実験結果からAの構造を推測
	試薬を節約できる上，簡単で正確な方法	情報収集：赤外分光法および核磁気共鳴水素分光法による分子構造同定
まとめ	一般的な有機化合物研究方法と手順とは	まとめ：有機化合物を研究するための一般的な方法と手法について
応用	知識を基に，実際問題を解決	

Figure 1: Example of an organic chemistry class experiment

As the example shows, in recent years the questions related to inquiry in upper secondary school examinations have changed significantly. Instead of just giving material on the content of the experiment and answering questions based on reading and understanding the material, there are now more questions that are not directly related to the experiment, such as the basic operation and use of laboratory equipment, experimental principles, relationships between equipment, interpretation of phenomena, experimental design and evaluation of results. The subject matter of many of the problems is a combination of the experiments in the textbooks and their applications, the investigation of abnormal phenomena that occurred during the experiments, and problems related to the background of industrial processes, with the main aim of fostering a creative consciousness in the students. Therefore, in future education, it is important to teach students ideas and methods for combining appropriate knowledge for deeper exploration, and to aim to improve students' creative awareness by teaching students to move from "teaching exploration" to "letting students explore" and finally to "exploring".

The new curriculum standards emphasise the teaching of students' scientific enquiry skills. The methods used in scientific enquiry can be divided into three categories:.

(1) specialised methods within the discipline, such as isotope labelling and tracing methods in biological research, cell organelle isolation methods and dissection methods; and

(2) scientific research methods, which are common methods applicable to all scientific research, generalised from the study of physics, chemistry, biology and other natural sciences.

(3) the most common philosophical methods applicable to the natural, social and intellectual sciences, such as materialist dialectics and contradiction analysis.

The scientific enquiry competences addressed in the new course standards relate mainly to the common methods used in scientific research. The general methods used in scientific research cover two areas: methods of acquiring empirical material and methods of rational thinking (Fig 2).

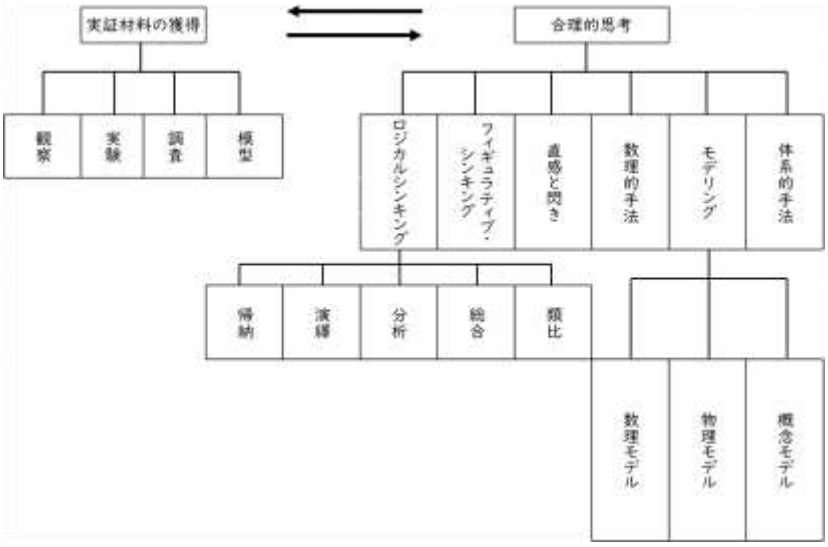

Figure 2: System of scientific research methods in the course standards of the People's Education and Teaching Press

The contents of the above scientific research methods are widely distributed in the compulsory units of each subject, and different methods are emphasised in different units to train students' scientific research skills in a more systematic way. For example, in the high school biology teaching materials of the People's Education Press, the compulsory unit 1 "Molecules and Cells" emphasises the observation-induction method, the compulsory unit 2 "Heredity and Evolution" emphasises the tentative-deduction method, and the optional unit 1 "Homeostasis and Regulation" emphasises the systematic analysis method. In terms of specific research methodologies, Compulsory 1 focuses on observation and experimental methods, Compulsory 2 on deductive reasoning methods, and Optional Compulsory 1 on survey methods and mathematical modelling.

Again, however, it is believed that the main problem with science education in China so far is that only the experimental classes can be called experimental classes, and most of the non-experimental content has only been taught. The biological teaching materials of the People's Education Press are said to contain about 33% of the total exploratory content, such as experiments, exploration, model building, extracurricular production, investigation, extracurricular practice, skills training, data collection and analysis, thinking and discussion.Classes in which students learn the necessary knowledge as preparatory work and then carry out inquiry-based learning in school under the guidance of teachers are considered to be highly independent and easy for teachers to implement. The most important part of inquiry-based learning is not going to the laboratory, but giving students the initial learning opportunity and authority to learn independently. The teacher's role is to listen, guide, inspire, help, support, encourage and facilitate.

Inquiry education is more time-consuming than cramming education, and it is difficult to control each student's learning situation, so it cannot be ruled out that the expected teaching effects may not be achieved. Therefore, in the future, it is important for researchers and teachers to cooperate with each other, design implementation plans for specific inquiry-based teaching and assessment criteria for each unit, fully incorporate them into the course standards, and systematically evaluate students' development in order to find appropriate inquiry-based teaching for Chinese students. For example, for each topic or unit, researchers and teachers jointly collect information materials for teaching and learning, design specific teaching and assessment methods, and prepare teaching materials such as investigation activity sheets, experiment sheets, work plan sheets for

students, and evaluation sheets for teachers to evaluate students' performance for the whole class and individual student activities. The researcher assists the teacher in the implementation and evaluation of the lesson, records the lesson from time to time for post-lesson analysis and discussion, conducts timely post-lesson analysis, analyses the benefits of the implementation process, problems encountered and next steps, formulates the implementation of the next lesson in a timely manner with reference to the lesson implementation plan, etc. etc. Collaboration between researchers and teachers is considered important.

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