

The Design and Research of Diversified High School Chemistry Homework in the Context of "Double Reduction"



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Abstract: Homework, is a dispensable part on stimulating students' curiosity and developing their thinking in the subject, providing a reference basis for teachers to optimize teaching methods and evaluate students' daily learning activities. Chemistry homework is an auxiliary form of chemistry teaching. The design of high school chemistry homework should be efficient, artistic, creative, and interesting, according to the Double Reduction policy issued by the Chinese Ministry of Education. The problems of high school chemistry homework at present are analyzed, and the research progress of domestic and foreign high school chemistry homework design is introduced briefly. In order to better improve the quality of current high school chemistry assignments, four novel and diversified homework cases are designed, including the interesting life homework "the Neutralization Reaction of Acid and Base", the game-based practical homework "Chemical Reaction Aeroplane Chess", the oral expression homework "Chlorine and Its Compounds" and the interdisciplinary homework "Chemical Fertilizer", using constructivist learning theory and multiple intelligence theory as guiding ideas. Through the systematic research and practice, it is found that high school students are passionate about the assignments, and their passion and enthusiasm for learning chemistry can gradually increase. The useful and effective chemistry homework can fundamentally trigger students' interest to learn chemistry.

Keywords: Secondary School Chemistry; Homework; Double Reduction

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1 Introduction

In 2021, the General Office of the Central Committee of the Communist Party of China (CCCPC) and the State Council issued firstly a policy on education - "Opinions on Further Reducing the Burden of Homework and Off-Campus Training for Students in Stage of Compulsory Education" (the "Double Reduction" policy). This policy aims at reducing the burden on students in

stage of compulsory education. Homework is an essential supplement to classroom teaching activities and an invisible bridge for effective communication between teachers and students. The design and layout of traditional homework may have potential risks and possibility of "Grade Theory", reducing the in-school burden while increasing its counterpart outside, which is not conducive

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to the overall development of students and even threatens physical and mental development of students. In such a setting mentioned above, the issuance of the "Double Reduction" policy is significant to students' overall individualized and diversified development. Under the influence of the "Double Reduction" policy, chemistry teachers are expected to keep farsightedness of scientific thought, methodology, and worldview as the starting point, reducing the quantity, improving quality and efficiency in homework design, and using information technology to design attractive and multi-disciplinary chemistry homework. By applying scientific learning methods, students can better improve their awareness of using chemical knowledge, develop the ability to construct learning, and promote the spirit of innovation or practical skills.

2 Research Background of Secondary School Chemistry Homework

Chemistry homework is an auxiliary form of chemistry teaching [1-3], and The Ministry of Education officially issued - the "Double Reduction" policy in July 2021. In fact, the policy on "Reducing the Burden," issued by the Ministry of Education in 1982, is related to the "Notice on Several Issues of Current Primary and Secondary Education". The policy proposes that "no cutting of courses, no early ending of courses, no significant number of review questions, and strict control of the amount of homework. The circular also strictly regulates duration of students' daily sleeping and exercise, reflecting that China has attached great importance to reducing students' burdens and ensuring physical and mental health of students.

Homework, is a dispensable part on stimulating students' curiosity and developing their thinking in the subject. In the meanwhile, homework provides a reference basis for teachers to optimize teaching methods and evaluate students' daily learning activities. In this sense, proper amount of homework has its unique educational functions and values. As an essential part of the teaching process, chemistry homework builds an invisible medium to achieve effective communication between teachers and students. Traditional chemistry homework is based on a "Paper-and-Pencil Model", which drawbacks students'

learning interests, and probably lead to phenomena of being boring, tedious, heavy homework, and seriously detached from applications in daily life situation. With the further development of science, technology and the optimize of national education policies, the study of chemistry homework in secondary schools has been draw a great number of scholars' attention, and its trend is also expected to move forward and faster. Homework has not only emphasized the active construction of knowledge objects by student subjects and promoting students' diversified and personalized development, but also emphasized the effect of homework and proper application of chemistry. Since the issuance of the "Double Reduction" policy, the design of extra-curricular homework for secondary school students has remained one of the hot issues in society. The study on the "Double Reduction" policy and homework design this year has attracted massive the attention of educators and researchers and it is still a topic worth exploring.

The earliest research on the guidance of chemistry homework in China can be traced back to 1954. Domestically, most of the studies have been working on school-oriented homework, tiered homework, front-end homework, and homework evaluation in secondary school. Due to the late introduction of the "Double Reduction" policy, there is less research on chemistry homework for the policy. Usually, front-line teachers put forward suggestions in the seminar of homework design, while few specific homework design models are presented. Internationally, homework is presented in various forms. For example, the Real-life Homework [4] in the United States and the Johns Hopkins University Family Research Center in the late 1990s proposed a type of homework to guide parents in helping students to grasp the appropriate time and method for completing homework TIPS [5-6]. TIPS is a mechanism for parents to establish interaction between students, parents, and teachers while clarifying the assignment's goals, skills, and specific tasks. Parents' guide the students in implementing the homework and the lessons learned. In addition, teachers in the UK often take a humanistic approach to students. Real-life situations are widely integrated into the homework, considering the different individual characteristics among students. Giyoo Hatano, a Japanese scholar, found in 1989 that there are two paths to human growth. "Adaptive expertise" is one of the two and it is

indicated by a student's preference for completing homework at their cognitive level and moderate difficulty. Students tend to complete homework that meets their cognitive level.

"Education is no borders". Research on chemistry homework continues to evolve among educational scholars in various countries. Cooper [7-8], an American scholar, divided homework functions into four main categories: help and guidance for students to consolidate their in-classroom knowledge, improvement of students' learning skills, cultivation of students' independence and responsibility, and emphasis on home-school cooperation. In addition, the functions of homework in developing scientific literacy [9-11], educating people, and linking subjects with science and technology and social relations have been proposed by domestic scholars.

3 Diversified Design of Secondary School Chemistry Homework Cases

This part examines the homework design principles of Real-life Homework and Teachers Involve Parents in Schoolwork (TIPS) in the United States. Based on the theories of constructivism [12-14] and multiple intelligences [15-16], we designed and successfully carried out the following four homework cases for teachers' reference.

The Design of Interesting Life Homework: Take "The Neutralization Reaction of Acid and Base" as An Example:

1)The teacher assigns students the task: students use pH test paper to determine the pH of shampoo and conditioner used daily and record the data. Besides, students compare their experience of the difference between using only shampoo and shampoo followed by conditioner. Finally, students consider the reasons for using conditioner while shampooing in conjunction with the web resource pathway. pH test paper is new to students. It keeps students curious about the microscopic world of chemistry and allows them to learn about pH test paper and the application of acid-base neutralization reactions

in life and industrial production. Furthermore, it helps students gain insight into the value of chemistry as a subject.

2)The teacher assigns students the task: students mark the names of liquid items of interest at home on pH test papers and use the marked paper to test them. Students put together a picture of the color-revealing pH test paper according to their creativity. Howard Gardner 's theory of multiple intelligence suggests that each person has at least eight intelligences, of which bodily-kinesthetic intelligence is one. This intelligence involves the ability to use both hands to create and manipulate an object and is an example of using the body or bodily cognition. The students use the characteristics of the measured pH test papers to show different colors and make a collage according to their creative thinking. It aims to develop students' bodily-kinesthetic intelligence while providing insight into the acidity and alkalinity of common liquids in their lives.

The Design of Game-based Practical Homework: Take "Chemical Reaction Aeroplane Chess" as An Example:

To improve students' understanding of chemical substances, we have created a homemade collaborative learning game using traditional Aeroplane Chess as a masterpiece (see Figure 1) [17]. The game covers chemical substances that are required to be mastered or commonly found in 9th-grade chemistry textbooks. Chemical Reaction Aeroplane Chess incorporates critical elements such as whether a chemical reaction can occur between two random substances and the writing of chemical equations. It focuses on training students' reverse reasoning skills and developing divergent thinking, based on the fact that students are used to thinking in the forward direction. The novel game form abandoned the traditional form of repeatedly copying and memorizing, which can increase students' interest in learning chemistry and promote cooperation and independent learning among students. According to the feedback, most students said the game is entertaining and academic. They effectively consolidated their chemistry knowledge by repeatedly practicing substances' chemical formulae and reaction equations during the game. The students' interest was high (see Figure 2), and the concept of learning for fun was successfully realized.



Figure 1 The layout about Chemical Reaction Aeroplane Chess designed originally



Figure 2 Some middle school students playing Chemical Reaction Aeroplane Chess intently in class

The Design of Oral Expression Homework: Take "Chlorine and Its Compounds" as An Example:

Students use the Internet to search and collect news about the misuse of cleaning agents and try to summarize the principles of chemical reactions and the lessons

learned from them. Students invite their parents to help them shoot the video and submit their work as a video file. In recent years, improper mixing of cleaning agents has led to various accidents and injuries. The homework lets students understand the main components of common cleaning agents used at home. Students can further develop their awareness of chemical knowledge to solve problems and thus avoid accidents. Parents can also learn that cleaning agents should not be mixed while helping their children to shoot the video so that both sides can benefit from learning.

The Design of Interdisciplinary Homework: Take "Chemical Fertilizer" as an Example:

The teacher guides students to use the theme of "Vegetable Cultivation" to integrate the knowledge points of "observation of the cell structure and plant level, seed germination and plant growth" in biology and "chemical fertilizer" in chemistry into an inquiry-based project. The project is inquiry-based and easy to practice. Students prepare and investigate the effects of different fertilizer

solutions on the growth of vegetables by cultivating. Students observe and compare the effects of different fertilizers on the growth of vegetables. It facilitates the teacher's ability to diagnose the level of student knowledge acquisition and understanding of the value of the chemistry subject. It also helps to improve students' ability to integrate multidisciplinary knowledge and apply knowledge to life and develop the effectiveness of students' comprehensive problem-solving skills.

4 Conclusion

Chemistry homework is an auxiliary form of chemistry teaching and one of the effective ways for students to consolidate their chemical knowledge. When they design chemistry homework, teachers should not only meet the requirements of the current policy and follow the "Double Reduction" policy, but also pay more attention to the development of student's ability and control the difficulty reasonably. Focusing on developing students' abilities and controlling their difficulties is also essential. The diverse form of homework can mobilize students' motivation to learn, and it is better than traditional homework in terms of learning effect. However, teachers should also realize that homework functions as a medium for transmitting information and cannot completely take over how learners process and assimilate information. Any homework lacks a core, even if it is rich in form, will not fundamentally trigger students' interest to learn chemistry. The design of diversified, interesting, and practical homework can achieve "Reduce the Burden". In the context of "Double Reduction", the function of reshaping homework to educate students is an inseparable form, which in-depths thinking and study of educators and researchers. Only by innovating the substantive content of chemistry homework can we effectively promote the exercise of students' disciplinary thinking and chemical literacy.

References

- [1] Richards-Babb M, Curtis R, Ratcliff B, et al. General chemistry student attitudes and success with use of online homework: Traditional-responsive versus adaptive-responsive [J]. *Journal of chemical education*, 2018, 95 (5): 691-699.
- [2] Malik K, Martinez N, Romero J, et al. Mixed-methods study of online and written organic chemistry homework [J]. *Journal of Chemical Education*, 2014, 91 (11): 1804-1809.
- [3] Smithrud D B, Pinhas A R. Pencil-paper learning should be combined with online homework software [J]. *Journal of Chemical Education*, 2015, 92 (12): 1965-1970.
- [4] Boers D, Caspary P. Real-Life Homework [J]. *Executive Educator*, 1995, 17 (3): 37-38.
- [5] Hoover-Dempsey K V, Walker J M T, Jones K P, et al. Teachers involving parents (TIP): Results of an in-service teacher education program for enhancing parental involvement [J]. *Teaching and teacher education*, 2002, 18 (7): 843-867.
- [6] Epstein J L. TIPS: Teachers Involve Parents in Schoolwork. Language Arts and Science/Health. Interactive Homework in the Middle Grades. Manual for Teachers [J]. 1992.
- [7] Cooper H, Jackson K, Nye B, et al. A Model of Homework's Influence on the Performance Evaluations of Elementary School Students [J]. *Journal of Experimental Education*, 2001, 69 (2): 181-199.
- [8] Patall E A, Cooper H, Robinson J C. Parent Involvement in Homework: A Research Synthesis [J]. *Review of Educational Research*, 2008, 78 (4): 1039-1101.
- [9] Jufrida J, Basuki F R, Kurniawan W, et al. Scientific literacy and science learning achievement at junior high school [J]. *International Journal of Evaluation and Research in Education*, 2019, 8 (4): 630-636.
- [10] Rusilowati A, Kurniawati L, Nugroho S E, et al. Developing an instrument of scientific literacy assessment on the cycle theme [J]. *International Journal of Environmental and Science Education*, 2016, 11: 5718-5727.
- [11] Vieira R M, Tenreiro-Vieira C. Fostering Scientific Literacy and Critical Thinking in Elementary Science Education [J]. *International Journal of Science & Mathematics Education*, 2016, 14 (4): 659-680.
- [12] Gao R. The vocabulary teaching mode based on the Theory of Constructivism [J]. *Theory and Practice in Language Studies*, 2021, 11 (4): 442-446.
- [13] Wink D J. Chemistry education and the post-constructivist perspective of Bruno Latour [J]. *Journal of Chemical Education*, 2020, 97 (12): 4268-4275.
- [14] Wink D J. Constructivist Frameworks in Chemistry Education and the Problem of the "Thumb in the Eye" [J]. *Journal of Chemical Education*, 2014, 91 (5): 617-622.
- [15] Winarti A, Yuanita L, Nur M. The Effectiveness of Multiple Intelligences Based Teaching Strategy in Enhancing the Multiple Intelligences and Science Process Skills of Junior High School Students [J]. *Journal of Technology and Science Education*, 2019, 9 (2): 122-135.

[16] Clapson M L, Gilbert B C T, Musgrove A. Race to the reactor and other chemistry games: game-based and experiential learning experiences in materials and polymer chemistry [J]. Journal of Chemical Education, 2020, 97 (12): 4391-4399.

[17] Li J, Yang M A, Xue Z H. CHEMTrans: Playing an Interactive Board Game of Chemical Reaction Aeroplane Chess [J]. Journal of Chemical Education, 2021, 99 (2): 1060-1067.