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Four Melds and Four Melts: Research on Effective Promotion Strategy of Chemistry Experiment Teaching in Senior Two

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Abstract

Experimental chemistry is the most distinctive part of high school chemistry teaching. The development and promotion of chemical experiments can deepen students' understanding of knowledge and promote their scientific inquiry thinking and the improvement of their quality of seeking truth and rigor. This article is based on a questionnaire survey and dialogue interviews to approach the current situation of experimental teaching in the second year of high school. With the help of the concepts of textbook integration, module integration, situational integration, and application integration, this article aims to promote the effective promotion of experimental teaching in the second year of high school through miniaturization, greening, life oriented, and application oriented experiments.

Keywords

Experimental Teaching; Effective Promotion; Strategy.

1. Introduction

Chemistry is a natural discipline based on experiments, and experiments play a crucial role in high school chemistry teaching. Chemical experimental can help students learn to have a more dialectical and objective understanding of the world, which is of great significance for cultivating students' rigorous scientific attitude and excellent qualities of mutual assistance and cooperation. In the context of quality education, the cultivation of core competencies in various disciplines has become a teaching goal, and the core competencies in chemistry mainly manifest in solid mastery of chemical knowledge, standardized operation of chemical experiments, scientific cultivation of chemical thinking, and the exercise of scientific research spirit.

In current high school chemistry teaching, chemical experimental teaching has not received comprehensive attention. Conflicts between class hours and teaching progress, inertia in repeated experiments, poor feelings in experimental operations, confusion in dealing with unexpected phenomena, lack of awareness of innovative design, and the ease with which video products are produced. Of course, there is also a lack of understanding of the value and significance of experimental teaching, insufficient emphasis on improving student abilities, excessive confidence in meticulous oral communication, and inability to extricate oneself from the exam oriented philosophy. Through chemical experiments, students can achieve hands-on, brain stimulating, and heart stirring effects in order to achieve the high-level training goals of enhancing their exploratory, divergent, and innovative thinking, which may be lacking in current experimental teaching.

The teaching content of high school chemistry in the new textbook of People's Education Press belongs to the selective compulsory module, mainly involving three parts: chemical reaction principles, material structure foundations, and organic chemistry. Compared to the understanding and learning of elemental compounds in the chemistry of the first year of high school, the teaching content of the second year of high school focuses more on abstract and slightly boring principles and regular knowledge. Combining the curriculum standards and

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textbooks, thinking about designing and promoting the infiltration of experimental chemistry is very meaningful for the classroom fun and exploration of high school sophomores.

2. Informed through survey interviews

2.1. Student questionnaire survey

A total of 550 high school sophomore students participated in the survey, involving 13 classes in three cities and five schools using the new chemistry textbook published by People's Education Press. The statistical data and related analysis are as follows:

Table 1: Questionnaire Survey Part I

	A	B	C	D
1. Do you think the chemistry experiment part is important in high school learning? A. Very important B. Important C. General D. Not important	70.1%	23.4%	4%	2.5%
2. Do you enjoy independently completing experimental operations? A. Very like B. A little like C. Don't like D. It doesn't matter	47.2%	35.1%	3.8%	14.7%
3. What is the experimental format in which you participate the most in the classroom? A. Hands on Practice B. Teacher Demonstration C. Video playback D. Oral introduction	13.4%	3.2%	70.8%	12.6%

The first part of the questionnaire survey （As shown in Table 1） mainly focuses on the status, current situation, and student participation willingness of chemical experimental teaching. The survey results show that students fully recognize the position of the chemistry experiment section in high school teaching, and 93.5% of students believe that the study of the chemistry experiment section is an indispensable part of high school chemistry learning. Meanwhile, 82.3% of students expressed their expectation of independently completing the experiment. Based on over a decade of experience in frontline teaching, the real feelings of participating in experiments and the reflections after experiments cannot be replaced by other methods. Real experimental teaching will always be stalled due to various so-called practical reasons, from group cooperation experiments to individual student demonstrations, to teacher live performances, and even more so, from conducting experiments to talking about experiments.

Table 2: Questionnaire Survey Part II

	A	B	C	D
4. Do you preview the relevant experimental content before the experiment? A. Frequent meeting B. Basic meeting C. Occasionally D. never	23.2%	28.1%	29.5%	19.2%
5. Will you carefully observe and truthfully record the experimental phenomena during the experiment? A. Frequent meeting B. Basic meeting C. Occasionally D. never	28.1%	37.8%	12.6%	21.5%

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6. During the experiment, if you encounter unexpected phenomena, would you discuss with the teacher or independently search for information in order to solve them? A. Frequent meeting B. Basic meeting C. Occasionally D. never	23.2%	24.9%	20.2%	31.7%
7. Will you look back at the phenomena in the experiment, integrate the conclusions, and accumulate them after the experiment? A. Frequent meeting B. Basic meeting C. Occasionally D. never	22%	29.4%	20.9%	27.7%

The second part of the questionnaire survey（As shown in Table 2） mainly focuses on the participation behavior of students in the three stages before, during and after the experiment. Effective preview before the experiment will enable students to have a certain understanding of the objectives, principles, and experimental operations involved in the experiment. At the same time, they will have a clearer focus on imaginative observation, detailed design, and condition control in the experiment, which will help to promote the rapid and effective progress of the experimental class to a certain extent. In the survey, it was found that half of the students would preview the content before the experiment, mainly driven by the task assignment of the teacher, especially in classes with experimental preview cards, where the frequency and validity of preview are better. Faced with the tracking of phenomena and the presentation of conclusions during the experimental process, most students still possess good academic literacy and a rigorous and pragmatic scientific spirit. They can calmly face various phenomena in the experiment, especially when encountering accidents, and can calmly face and think deeply. They can solve doubts and seek verification through communication with teachers and information retrieval.

Table 3: Questionnaire Survey Part III

	A	B	C	D
8. Have you ever independently completed experiments on neutralization titration or neutralization heat measurement during the learning process of "Principles of Chemical Reactions"? A. Only conducted neutralization heat measurement B. Only conducted neutralization titration experiment C. Both have been done. D. Neither has been done	3.8%	8.9%	15.7%	71.6%
9. How many of the 13 experiments related to hydrocarbons and their derivatives in the textbook "Fundamentals of Organic Chemistry" have the teacher demonstrated in classroom teaching? A. 0 B. 0-5 C. 6-10 D. More than 10	63.2%	20.9%	9.54%	6.36%
10. How many have you participated in the research and practice of the last 8 chapters in the textbook? A. 0 B. 1-3 C. 4-6 D. More than 6	80%	12.3%	3.96%	3.74%

Compared to the previous two parts of the survey, the third part（As shown in Table 3） more accurately aligns with the three selective compulsory textbooks for high school sophomores. The third part of the survey questionnaire used two classic data measurement experiments in "Principles of Chemical Reactions" and the integration of textbook experiments in

"Fundamentals of Organic Chemistry" as examples for statistics, and once again felt the lack of classroom experiments. Or due to the time-consuming nature of organic experiments and the complexity of mixed systems of products, by-products, and residues, as well as the need for temperature, pressure, and catalysts in most reactions, teachers often choose experiments that are sensitive to phenomena and have strong operability for demonstration in textbook experiments of organic chemistry teaching. Therefore, miniaturization or innovative improvement of experiments may become breakthrough points for quality enhancement.

2.2. Teacher dialogue interviews

At the same time as conducting a student questionnaire survey, we communicated with six frontline high school teachers through face-to-face dialogue, telephone voice communication, and online communication software on relevant issues in high school chemistry experimental teaching. The abstraction of course content, the tight arrangement of class hours, the pressure of academic examination, the lack of experimental configuration, the shortcomings of handheld technology, and the inability to innovate and improve are all the difficulties currently plaguing the reasonable and effective promotion of high school second year experimental teaching. In order to present significant experimental results, reduce possible errors and accidents during classroom demonstrations, and to some extent improve classroom timeliness, teachers have become accustomed to borrowing

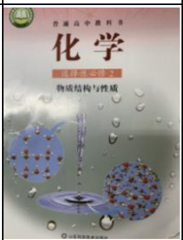
Helping to present the results of online videos, screen mirroring can also reduce local focus during live demonstrations and allow students in all corners of the classroom to share equally. During the communication, some teachers also talked about the idea of recording their own videos. Although there was no live demonstration, the camera showed their own original participation, and through the advancement and switching of the camera, students were able to pay more attention to the experiment in a more detailed and accurate manner. Compared to pure video reference playback or a better way. The most meticulous and authentic must be the closest distance, more sensitive, subtle, simpler, and safer. This is what the student-centered literacy experimental classroom expects the most: intelligent teaching, a combination of interest and interest, and only action.

3. Similarity, differentiation, and integration

3.1. Integration of textbooks, seeking differences from similarities

The module with the fewest experimental materials in the second year textbook of Material Structure Fundamentals Module has very few experimental operations in the 162000 character content of the textbook. In the process of learning material structure, the textbook introduces instruments such as mass spectrometry, nuclear magnetic resonance, infrared, ultraviolet, and crystal diffractometer that are beyond reach. The high-end instrument configuration is beyond reach and the operation is impossible, only staying at the level of understanding. There are only three experimental designs in the textbook, which are related to similar solubility, coordination compounds, and crystal cultivation. Comparing the three versions of Renjiao, Sujiao, and Lujiao, it was found that the distribution of experiments in each textbook was small and the topics were similar, and the preparation of complexes was highly favored. In contrast, the experimental part of the complexes in the Lu Jiao edition focuses more on application, using complex titration to qualitatively and quantitatively identify the presence and content of iron elements in ferrous succinate. At the same time, multiple feasible indicators are selected to improve the rigor of quantitative experiments, reflecting a scientific attitude of seeking truth and practicality. When teaching material structure, it is recommended to expand the understanding of ferrous and cuprous complexes beyond the textbook and supplement it with experimental exploration of simple and obvious phenomena. When teaching reaction principles, it is recommended to expand the perspective of titration principles after learning neutralization titration, and feel the powerful application of complexes from the perspectives of reaction category and endpoint identification.

Table 4. Distribution and Design of Experiments in Senior 2 Textbooks of People's Education Press, Jiangsu Education Press, and Shandong Education Press (Taking "Fundamentals of Material Structure" as an Example)

version	teaching material	Page number	Experimental content	Situational response materials
Human education		P59	Similar solubility	Extraction of iodine from iodine water using carbon tetrachloride Potassium iodide reaction dissolution
		P93	Cultivation of Alum Crystals	crystal growth
		P96~97	Preparation of typical complexes	Copper tetraammonium sulfate Iron thiocyanate Silver diammonium chloride
Su Jiao		P107	Preparation of simple complexes	Copper tetraammonium sulfate Copper tetramine chloride
		P1110	Preparation of silver ammonia solution	Silver mirror reaction
		P111	Experimental comparison of the reaction between a mixed solution of copper sulfate and iron sulfate with sodium hydroxide and ammonia solution	Competition for Coordination Ability
Lu Jiao		P29	The Harm and Removal of Formaldehyde	Using electronegativity analysis and prediction of material properties
		P63	Preparation and application of complexes	Tetra (water/ammonia/chlorine) copper ions
		P76	Inspection of iron elements in iron supplements	Application of characteristic complex formation color to test the iron element in ferrous succinate
		P78	Searching for better testing reagents	Phenanthrene, EDTA Na, etc
		P117	Institutional determination of artemisinin molecules	The application of crystals in molecular structure determination

According to As shown in Table 4，we found something worth thinking about. In different versions of textbooks, the same knowledge system with different architectural designs always has its advantages and disadvantages. If resources can be efficiently optimized, integrated, and integrated into applications, it will definitely improve the quality of classroom teaching. Either directly applied or designed as exploratory situational experiments, multiple encounters on the same topic, and the freshness of old knowledge and new materials can also make learning interesting.

The teaching content of Topic 1 and 2 of "Principles of Chemical Reactions" is about the thermal effect, chemical reaction rate, and chemical equilibrium in chemical reactions. As the first module of the sophomore elective course, only five experiments (as shown in the table) are involved in the 54 page teaching materials in the two chapters of the textbook, which undoubtedly makes it difficult to explain abstract knowledge and promote the course.

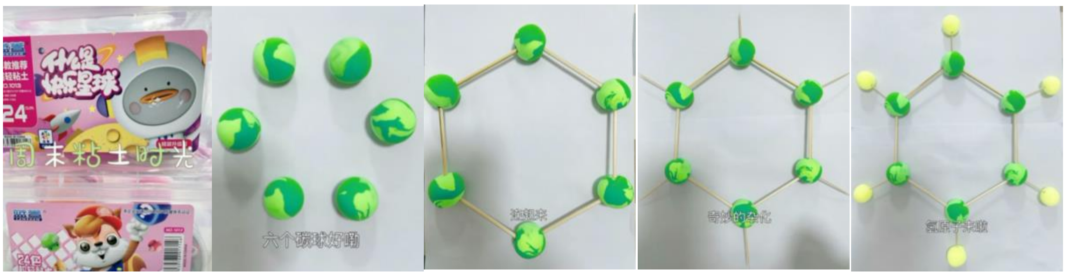
Although the basic knowledge of related content has been infiltrated into the study of the compulsory second year textbooks in the first year of high school, heat absorption and release similar to reactions can be integrated into open experiments involving several students in the chemistry textbooks of the first year of high school in addition to neutralization reactions. Real situations such as scale removal and braised fish in daily life help students construct a balanced concept and appreciate the value of subject services and life. In the teaching of the reaction principle section for many years, the concept that has been adhered to is the application of existing knowledge and concepts such as rate equilibrium in Chapter 3- Ion reactions in solutions. Ionization, hydrolysis, and dissolution are nothing more than three different equilibrium systems. Compared to the post adjustment of the electrochemical section in the Su Education Press textbook, the new textbook of the People's Education Press has more firmly established the close relationship between ion reactions in solutions and the chapters on thermodynamics and kinetics. From a changing perspective, I ask myself why the ion reactions that arise from the application of materials have not been used as the material for new lesson learning multiple times when traditional teaching content is being promoted. The balance is boundless, and the state arises from the heart. Textbook integration can integrate different versions of the same textbook into the same teaching point, as well as different versions of the textbook into the same teaching point. It can also integrate different chapters of the same textbook into the same teaching point, integrating, sharing, seeking change, and enlightening truth.

3.2. Module fusion, seeking similarities in differences

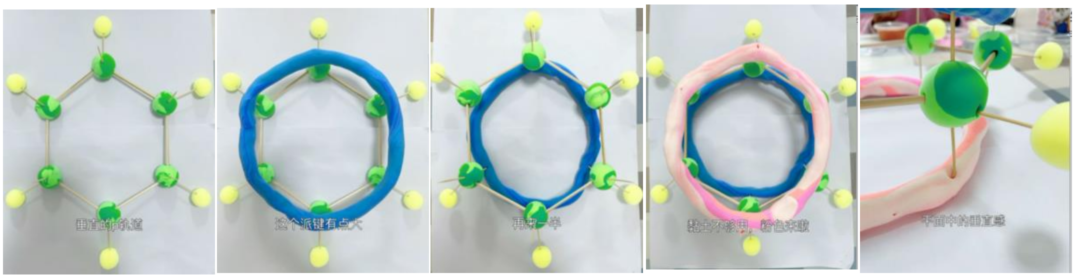
Structural chemistry approaches from a microscopic perspective, focusing on the modes of existence of particles, the forms of intermolecular forces between particles, the crystal forms and cell configurations formed by particles. These are the trilogy promoted in the textbook "Fundamentals of Material Structure". Structure determines properties, and properties reflect structures. While learning about the properties of benzene, I shared my weekend clay time and experienced the unique carbon carbon binding mode in the benzene ring structure. By analyzing the easily broken chemical bonds in the structure, I predicted the possible properties of benzene, which is also a good attempt. The process is shown in Fig. 1

Fig. 1 Building models of benzene

Weekend clay time → Six carbon balls are great → Connected to each other → Wonderful hybridization → Hydrogen atoms are here



Vertical p-orbitals → This π bond is a bit large → Try again → Not enough clay, come back pink → The sense of verticality on the plane



In the process of learning material structures, there is a lack of visual experimental presentation, and the classroom occasionally has food and no taste. The teacher's rational explanation did not bring students closer to understanding the micro world. Instead, it was more about accepting knowledge related laws and using reasonable experimental design to interpret abstract structural features through explicit experimental phenomena in order to solve the problem. The perception of emission spectra can be interpreted through flame tests, the comparison of electronegativity can be inferred through reasonable oxygen reduction reactions, the determination of crystal types can be determined through physical parameters, and the location of bond breaking and bonding can be tracked through isotopic methods. The understanding of energy changes, reaction rates, equilibrium limits, solutions, and electrochemical reactions in reaction principles is also based on the quantification of reaction experiments. Breaking through the boundaries of different sections, making small incisions and thinking big, is still very important in the second year of high school review and integration. If the experiment in the new lesson learning is for beginners to experience new knowledge, then the experiment in review and integration is for reviewing and reflecting on new ideas. The hydrolysis of ethyl acetate is the only property requirement of ester functional groups in high school organic chemistry, which was already understood in the first year of high school, so it is often overlooked in the teaching of new courses in the second year. Redesign experiments in the second year review class, or focus on and share findings from multiple modules.

3.3. Application integration, combining similarities and differences

The value concept of chemistry is to serve production and life, and the core pursuit of high school chemistry is to apply what is learned. Every synthesis attempt, condition optimization, product analysis, and design evaluation in the laboratory are aimed at achieving more cost-effective application value. In daily life, we often encounter urgent problems that need to be solved, such as the removal of various stains, the removal of ordinary oil stains, and the use of sodium carbonate as a general purpose in alkaline learning. In organic chemistry learning, we introduce the essence of bond breaking through alkaline hydrolysis of oils and fats and apply saponification experiments for identification. The removal of oil pollution requires the reaction characteristics of ester hydrolysis and the high solubility of sodium salts under alkaline

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conditions, with no change in the valence state of the substance before and after the reaction. More colored stains in daily life are removed using the oxidizing properties of bleaching agents. The role of bleaching was once favored by elemental chemistry, but the essence and enhancement of bleaching are exemplary applications of balance theory.

White hoodies dyed with pigments, urgent issues of clothing fading, comparison and optimization of supermarket reagents, and simulation attempts of bleaching effects. Using filter paper and red paper tape, meticulously cut a micro version of the sample garment, with red heart stitching and a lettered logo on the wide leg pants shown in Fig.2.

Fig. 2 Bleach selection with sample clothing customization

Before physical bleaching, give it a try and solve the problem with the most rigorous attitude. Place the top in a beaker, add bleach, and track and record the experimental phenomenon. Instantly not fading - exposed and slowly fading - left for a long time and completely fading (40 minutes+) - triggers thinking, $ClO^- \rightarrow HClO$ requires H^+assistance. The concentration of carbon dioxide in the air is only 390ppm. Try carbonated drinks (Fanta) by hand. Place the sampling pants in a beaker, immerse them in bleach, quickly add a small amount of Fanta, observe the experimental phenomenon. the color fades completely after 4 minutes(tracking experimental phenomena are shown in Fig.3). Then we propose a preset for white vinegar to assist in fading.

Fig. 3 Bleaching process tracking

Carefully read the precautions for using bleach-"Two Don'ts" - acidic toilet cleaners and oxygen-containing color bleach are major taboos.

Mix bleach and acidic toilet cleaner in a beaker and quickly invert the flower umbrella designed with funnel, starch potassium iodide test paper, pH test paper, and blue litmus test paper above the beaker. The yellow green gas above the beaker is accompanied by a pungent odor, causing the test paper to first change color and then fade (as shown in Fig.4). A small amount is still tolerable, a large amount is dangerous, leaving no blind spots for protection, and life situations are the most precious. Essentially the same, with different quick effects, the same goals and different philosophies, achieving value enhancement through goals, applying what is learned to a smart life, and thinking about continuing learning endlessly.

Fig. 4 The meeting of bleach and toilet cleaner

3.4. Contextual fusion, similarities and differences are unique to oneself

Creating realistic problem scenarios is an important strategy in chemistry teaching, and this is also true for chemistry experimental teaching in high school. The deployment of real-life scenarios can enhance the value of knowledge learning and experimental participation. Events from real life experiences can better promote students to move knowledge from understanding to understanding, and achieve application goals through model construction. The understanding of equilibrium establishment and movement in "Principles of Chemical Reactions" in the second year of high school is an essential knowledge for deep dialysis of the essence of reactions and reviewing the doubtful points of phenomena in the first year of high school. Breaking through is imperative. In the learning of ionization equilibrium, the micro contact of weak electrolytes in the first year of high school chemistry gave us a preliminary understanding of the existence and limitations of particles in solutions. In the second year of high school, we need to look back and explore new materials and situations.

Black goji berries are widely recognized as anti-aging tools, with effects such as removing spots and wrinkles, nourishing the kidneys and essence, and improving sleep. The usual way of using it is to soak it in water and drink it. When it dissolves in water, it will change color instantly. Due to different personal drinking habits, the temperature of the water may vary slightly, and even the source of the water may also vary. Therefore, the black goji berry soaking solution appears in different colors from different operators' perspectives, whether dark or light, blue or purple， as shown in Fig.5.

Fig. 5 Colors in different pH environments

The mystery of the phenomenon can only be traced back to its origin. Upon investigation, it can be concluded that anthocyanins belong to the category of polyphenolic pigments, which have weak acidity of phenolic hydroxyl groups and are in dynamic equilibrium. Molecular and ionic states each have their own characteristic colors, and the colors under different conditions are nothing more than color differences caused by different proportions of the two states. This highly aligns with organic acid-base indicators such as litmus and phenolphthalein. Different brands of purified water from Nongfu Spring, Wahaha, and Baishuishan were tested in sequence, and the color difference of the solution also sparked thinking about the acidity and alkalinity of purified water. Is it true that Nongfu Spring officially claims that it is a natural weakly alkaline water without adding any artificial minerals? When quantifying the pH of a small amount of Nongfu Spring and analyzing the reasons for its weak alkalinity, the possibility of salt hydrolysis was taken into consideration.

4. Clever ideas and elaborate designs, refined and refined

4.1. Experimental miniaturization, exploring the truth in micro

Under the background of the three new developments, the teaching of chemistry experiments must organically combine the theoretical teaching of subject knowledge with the practical teaching of experimental operations. This is not only a requirement for improving the literacy of chemistry subjects, but also a vivid demonstration of the student-centered classroom concept. Faced with the conflict between the desire for experiments in frontline education and the implementation of reality, more and more teachers are paying attention to the miniaturization design of experiments. Microscale experiments can actually be seen as a miniature version of traditional experiments, with small reagent usage, simple operation, and still sensitive phenomena. If there is waste or pollutant release during the reaction process, the impact will also be reduced to a low point, which does have obvious advantages. Facing the mini version of the experimental setup, students may have a stronger interest and more opportunities to participate. Not only can they collaborate closely in the experiment, but they can also minimize potential safety hazards during the reaction process.

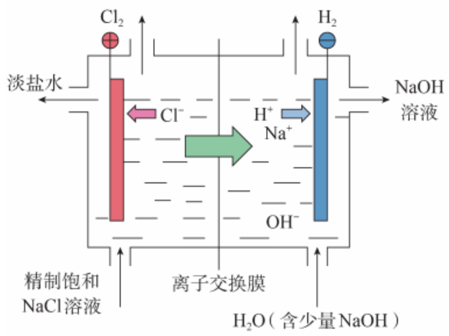
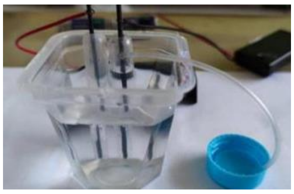


Fig. 6 Electrolysis of saturated salt water

Electrolysis of saturated salt water has appeared multiple times in high school chemistry teaching, from the initial introduction of the compulsory chlorine gas course to the preliminary exploration of the compulsory two electrolysis principles, and then to the selective compulsory one "two in, four out, and one membrane" in the chlor alkali industry (as shown in Fig.6), the experimental equipment has become increasingly complex and refined. One power supply, two electrodes, one liquid tank, two wires, dialysis essence, carefully thought and cleverly designed. The pencil lead is an easily accessible microelectrode, with a clever combination of droppers and straws, combined with bubble liquid collection and micro explosion experiments to prove the hydrogen gas in the product, everything is natural.

Case 1. Experimental Design of a Micro Device for Electrolyzing Saturated Salt Water

<table>
<tr><td rowspan="3">experiment content</td><td>experiment objective</td><td>Microminiaturization of electrolytic saturated salt water</td><td rowspan="2"></td></tr>
<tr><td>experiment Supplies</td><td>Items: Two wires, two 3-4cm pencil leads, 9V battery, one jelly box, two plastic droppers, one small straw, double-sided tape, cotton balls, matches
Reagents: saturated salt water, starch potassium iodide test paper, bubble solution, purple cabbage juice, sodium hydroxide solution</td></tr>
<tr><td>experiment principle</td><td colspan="2">2NaCl + H2O = 2NaOH + Cl2 + H2
The condition is to power on and control the concentration of salt water</td></tr>
<tr><td>Experimental process</td><td>experiment step</td><td colspan="2">① Insert the pencil lead into a plastic dropper as an electrode, and connect the small straw to the plastic hose
② Two plastic hoses are glued together with double-sided adhesive and placed in a jelly box. Pour saturated salt water into the jelly box, add a few drops of purple cabbage juice, and pour bubble liquid into the bottle cap
③ Connect the pencil lead to the battery with a wire and start the experiment
④ At the end of the experiment, disconnect the wires and block the opening of the anode plastic hose with a cotton ball soaked in sodium hydroxide solution to absorb chlorine gas
⑤ Recording experimental phenomena and integrating experimental conclusions</td></tr>
</table>

4.2. Digitalization of experiments and mathematical reasoning

Digital experiments refer to experiments conducted using sensors, data collectors, computers, and corresponding software [1], which are the application of modern technological means in middle school chemistry teaching. In 2018, the Ministry of Education released the "Education Informatization 2.0 Action Plan", which pointed out that "the ability to apply information technology to solve problems in teaching, learning, and life has become an essential basic quality." It advocates "leveraging technological advantages, transforming traditional models, and promoting the deep integration of new technologies and education.". [2] The first time digital experiments appeared in the People's Education Press textbook was when studying the decomposition of hypochlorous acid. Different sensors were used to quantitatively track and explain the pH of chlorine water, the concentration of chloride ions, and the volume fraction of chlorine gas from three dimensions (as shown in Fig.7). In the promotion of high school chemistry teaching, the thermodynamic and kinetic parts of the reaction principle module are mostly abstract and difficult to understand. If digital experiments can be used to assist teaching, it will make the experimental classroom teaching more targeted and persuasive.

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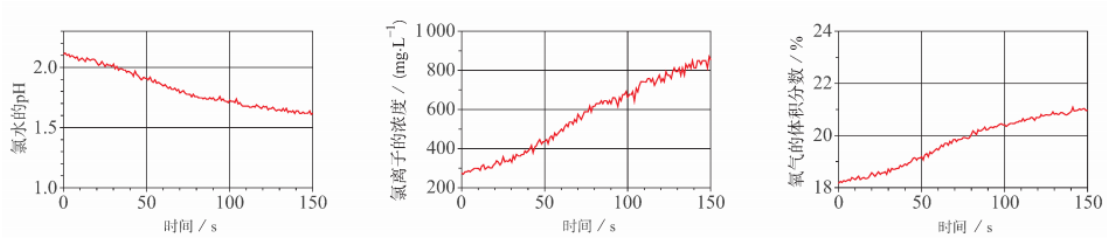

Fig. 7 Analysis of Factors Influencing the Reaction Rate between Sodium Thiosulfate and Acid in Precipitation Dissolution Equilibrium and Looking Back

Case 2.

In the textbook on the principles of chemical reactions published by the Jiangsu Education Press, precipitation dissolution equilibrium is a very special section. The three lines of precipitation generation, precipitation dissolution, and precipitation transformation are integrated, and the rich materials have created the integrity of the chapter on ion reactions in solutions. However, the study of this part has been selectively abandoned in the curriculum standards. The launch of the People's Education Press new textbooks is in line with the changes in the Zhejiang New College Entrance Examination, and precipitation dissolution equilibrium has emerged as a new point in the examination perspective. Different versions of textbooks without exception have chosen AgCl as the core research object in the new lesson teaching style.

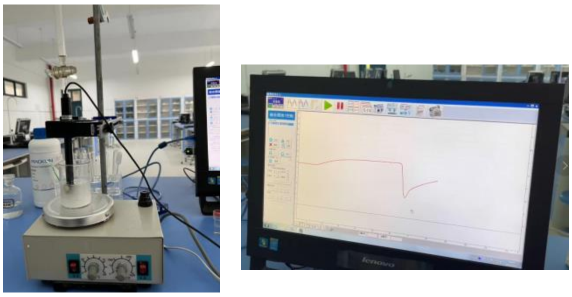

Fig. 8 Application of sensors in precipitation-dissolution equilibrium

When reviewing and looking back, I have chosen Mg (OH) 2, a common insoluble strong base. Mg (OH) 2 (s) → Mg2+(aq.)+2OH - (aq.), the solid is added to water, and the fully dissolved environmental value can be measured using a pH meter. However, this is only a small amount of evidence. Continuous monitoring with a pH sensor can record the continuous changes from time 0 to the equilibrium state, and mathematical analysis can also obtain a faster and slower trend, making the changes in the microscopic perspective vivid and evidence-based. As a dynamic equilibrium, changes in external conditions can cause disruption of the equilibrium. In traditional classroom teaching, we tend to use reasoning to explain, with the goal of establishing a new equilibrium by comparing the starting point, change point, and constant point, and predicting the change in equilibrium. Add dilute sulfuric acid to the Mg (OH) 2 suspension at a controlled rate and stir. Use a pH sensor to track and allow students to truly experience the process of pH suddenly decreasing and then slowly increasing until it remains unchanged in the system(as shown in Fig. 8). Upon closer examination of the numerical platform, it was found that the curves did not fully regress, and the changes in volume, temperature, and extensional thinking points met again.

4.3. Greenization of experiments, benefiting from greenery

Environmental and ecological security issues are increasingly prominent with the rapid development of the economy. The development of middle school chemistry experiments inevitably encounters problems such as energy consumption, environmental pollution, and low atomic utilization efficiency. Green development has become the theme of today's social development. As a responsible chemistry learner, one must make good use of their knowledge, be good at solving various problems encountered, and optimize synthesis routes. The property experiments in the second year of high school chemistry mainly focus on "Fundamentals of Organic Chemistry". Alcohol dehydration, esterification and amidation require concentrated sulfuric acid as a catalyst, while aromatic compounds and halogenated compounds have certain volatility and toxicity. Reasonable protection during the experiment and proper handling after the experiment need to be given special attention. In the experimental teaching of the properties of ethylene, after the rapid preparation of ethylene, a three-way valve connection device (as shown in the Fig.9) is used to minimize the demand for ethylene generation in large experimental devices. At the same time, residual gases are stored reasonably, achieving a shorter time and witnessing more obvious phenomena with fewer reagents, fully reflecting the concept of green chemistry. Regarding the 13 important experiments in organic textbooks, we have also attempted to optimize them from different perspectives.

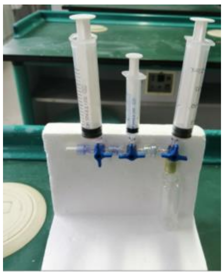

Fig. 9 Miniaturization device

In addition to organic chemistry, textbooks on reaction principles also contain content that can be further processed or slightly adjusted to better fit the concept of green chemistry. When the experimental operation feels that the reaction between ammonium chloride and barium hydroxide is an endothermic reaction, the textbook suggests mixing the two in an open beaker and stirring thoroughly with a glass rod. The cooling of the beaker wall can verify the conclusion of the endothermic reaction, but the pungent odor that comes from the face is really uncomfortable. If two substances are placed in a fresh-keeping bag and the bag mouth is tightly tied, rubbing the solid with both hands can feel a slight coolness, and the released ammonia is also stored reasonably. If adjusted from the root, fully consider the tasteless and pollution-free reaction characteristics when selecting reactions, or find more valuable methods to prepare real ice packs in life. Green wisdom, both practical and thoughtful.

4.4. Experimentation in daily life, finding fun in life

The chemistry curriculum standard clearly states: "We should feel and appreciate the positive role of chemistry in improving human life and promoting social development, and pay attention to social hot issues related to chemistry"[5] . The connection between course knowledge and practical life, and the use of course knowledge to solve practical problems, is a new challenge currently faced by high school chemistry teaching in the context of the Three New Policies. In the abstract and tedious teaching of high school chemistry, incorporating real-life materials can awaken students' thinking cells, enhance the classroom participation atmosphere, and enhance innovation awareness and social responsibility through experimental participation. The search for the entry point of life oriented experiments is a persistent task. When designing, attention should be paid to fun, scientific, and practical aspects. It is necessary to not only reasonably grasp the scale of using life oriented elements, but also avoid losing the theoretical characteristics of chemistry. The core concept of life oriented experiments is to use life experience to understand experiments, use life resources to innovate experiments, and use chemical experiments to solve life problems. Self heating pots and lithium batteries are common living resources, which can bring unexpected joy to teaching if used wisely.

Case 3. From Self Help Pot to Warm Baby(as shown in Fig.10)

The Five Episodes of Ziheguo--Return to the Gods→Busi salary increase→Brave and strategic→Exactly→ Sit and enjoy

Fig. 10 Self-heating pot simulation

This is the popular self-help pot on the market recently, which combines deliciousness and convenience, and can be heated without the need for ignition. The seemingly wonderful self heating process is all about the wisdom of energy conversion. The calcium oxide in the heating package quickly releases heat when it comes into contact with water, which is a simple combination; The iron powder, carbon powder, and electrolyte in the heating package form many small primary batteries. Through the interaction with oxygen and water vapor adsorbed on the carbon surface, iron is gradually oxidized to iron hydroxide, which is essentially consistent with the oxygen absorption corrosion of steel. Due to the spontaneous and exothermic nature of the reaction, the temperature of the self heating pot can rise and remain high for a period of time. During the experiment, it is possible to simulate the composition of the self heating element and simulate the experiment on a circular filter paper. Potassium ferrocyanide is used to test the generation of Fe2+, and the deflection of the sensitive ammeter pointer is used to confirm the formation of the primary battery. In the research and practice of "Principles of Chemical Reactions", the design and production of warm stickers are subject to independent experimentation, which is also the most realistic scenario application in daily life experiments.

Case 4. Playing with Lithium Batteries

In the research and development of batteries, lithium-ion batteries are the most widely studied and applied battery system. In recent years, lithium-air batteries and lithium sulfur batteries, as the new generation of lithium battery systems, have also received much attention [6], and exam points set around lithium batteries have also appeared frequently. In the teaching of chemistry in the second year of high school, experiments related to electrochemistry are all conducted using original ecological simulation. Whether it is the initial encounter of zinc copper primary batteries or the auxiliary improvement of salt bridge batteries (as shown in the figure), it is impossible to achieve the integration of the enlarged experimental system with daily life miniature batteries[7], let alone unfamiliar situations similar to lithium batteries. Although the phone is abandoned, the battery is still there. When opened and removed, the details become more beautiful. As long as it can make manual work and activate thinking, it belongs to the category of experimental chemistry. Just like when picking up a test tube for the first time, even if the tube is empty, even if only the key points of holding the tube are felt, it is also the accumulation of experimental ability. At the moment when the lithium battery in the mobile phone was fully unfolded(as shown in Fig. 11), we witnessed the double-sided metal electrodes, using the activity of the metal to prove lithium, and conducting in-depth analysis of the electrolyte through a small cell disassembled.

Fig. 11 Disassemble the lithium battery

Fuel cells and solar cells are widely used in daily life, and solar energy is a zero cost resource[8]. If it can be effectively converted into electricity to support various fields of industrial production, it is actually the preferred application. If there is a dual cut conversion of high-energy fuel cells with water as the source, the lack of solar energy in thunderstorms and sunny days can be avoided. The era of hybrid oil and electricity will eventually be passed, and zero cost resources such as solar energy and water are the trend. Therefore, every attempt is meaningful, and the splitting and sharing of lithium batteries only buys a seed in the hearts of students who are eager to explore. For the canal, where can it be so clear? For a source of fresh water to come.Life is like a pool of water in chemistry experimental teaching [9]. Pay attention to the hot topics of life, dig deep into textbook materials, value extracurricular time, flexibly apply and handle the connection points between chemistry and life. Every encounter and attempt is a pleasant feeling. Experiments are the most distinctive content of chemistry, and are an important way for students to understand the properties of substances and feel chemical changes[10]. As a key content of high school chemistry teaching, the implementation and promotion of chemistry experiments can deepen students' understanding of textbook knowledge, stimulate learning interest and deep level exploration and thinking, and is an important way to enhance core chemical literacy. The study of the chemistry module in the second year of high school is a continuation of the past and a starting point in high school teaching. It is not only a micro analysis of the macro materials in the first year of high school chemistry, but also a deep foundation for the review of the third year of high school. As a frontline teacher, it is necessary to make sufficient preparations, through thinking, trying, and integrating, to make the experimental teaching in the second year more flavorful and meaningful, to make abstract structural knowledge come to life, to make dry principle analysis move, and to make traditional organic exploration more beautiful. Walkers are fearless, those who think have no regrets, and those who act and think have a promising future!

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