High school chemistry teaching design based on project-based learning

—— Scientific understanding of iron supplement

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Abstract: ln order to deepen the reform of basic education teaching, change the teaching method and explore the penetration of project-based learning in basic education, in the teaching of "iron and its compounds" the evaluation gauge is set to provide the direction for students to improve the learning content and methods. The theme of "Scientific understanding of iron supplement" is to let students feel and understand in the real situation and the significance of knowledge, promote the deep understanding of the core knowledge of chemistry, establish the relationship network of the experience that chemistry comes from life and serve our life, gradually develop the core literacy and provide reference for comprehensively improving the quality of teaching.

Keywords: High school chemistry; Project-based learning; Iron and its compounds

At present, the field of education world-class transformation, which is due to the transition from the industrial age to the information age. As a result of the challenge of artificial intelligence, the demands of work on people are also increasing, namely, the ability to think critically and innovate. 《Opinions on Deepening the Reform of the Education System Mechanism》 also put forward that we should pay attention to cultivating students ability of independent thinking, teamwork and innovation, which put forward higher requirements of basic education. Students are required to not only acquire knowledge in school education, but also have the ability to use what they have earned to solve problems creatively, pay attention to basic and practical, and realize the promotion from low-order ability to higher order thinking. The literacy orientation is reflected in the classroom transformation. The chemistry classroom teaching requires students to comprehensively apply the subject knowledge and skills to the new uncertain situation, solve the real social life problems, and gradually move towards the subject creation of chemistry and enhance the understanding of chemistry. Project-based situations, teachers set challenging problems or tasks, organize students to autonomous cooperation, and display project results and works. To carry out project-based teaching in chemistry teaching in senior high school, the starting point is to change students' learning mode, and the goal is to cultivate higher-order thinking and develop students' core quality.

1. Project theme content analysis

The deep learning of chemistry is that under the guidance of teachers, students carry out experiment-oriented inquiry activities, and gradually develop the core quality of chemistry in the process of solving problems in real situations[1]. Project-based learning is based on real problems and situations, closely links learning with real life and practice, and focuses on cultivating students' ability to solve practical problems from the level of relevance structure, which is consistent with the concept of deep learning. The structuring and contextualization of curriculum content is mentioned in 《General Senior High School Curriculum Program(2017 Edition). Content structuring requires students to enrich cognitive structure and make connections diversified. Content contextualization requires students to solve problems in the real situation, so that the knowledge learned in school is no longer inert and can be transferred to the real problem situation which is the meaningful deep learning. This requires teachers not only to pay attention to the integration of knowledge within the subject, but also to design teaching in connection with real life, and pay attention to the forefront of the development of The Times. Teachers summarize the complicated curriculum content and sort out the ones with lasting transfer value within the discipline basic concepts, principles or methods, which can help students to accurately and deeply understand chemical knowledge, realize knowledge transfer, establish a more complete knowledge structure, and transform it into ideas and methods to solve real world problems.

As a new course, "Iron and its compounds" should focus on the mutual transformation and expansion of application between Fe^{2+} and Fe^{3+}, This lesson combines the requirements of《General Senior High School Curriculum Standards of Chemistry[2](2017 Edition, 2020 Revision)》("properties of Iron and its Compounds "for students to do experiments and carry out" "experiments on the properties of Iron and its compounds, preparation of ferrous hydroxide and other activities), teaching materials, students have the foundation, from the perspective of biology, to emphasize the physiological role of iron in maintaining human life activities; From the perspective of the chemistry, it emphasizes the composition, properties, transformation and uses of substances; From the perspective of materials science of good iron supplement packaging material sand technologies, etc and pay attention to the cross integration of multi-disciplines. Based on the internal connection between knowledge, the project theme that carries the core knowledge of chemistry and the thought and method of chemistry discipline is sought, and the project theme of "Scientific understanding of iron supplement" is established The project tasks are divided into several independent and progressive sub-projects: identifying iron in iron supplements, understanding the development history diagram of iron supplements[3], carrying out a series of scientific inquiry activities promoting deep learning in real sense, and promoting problem solving ability. Through the method of studying substances with classification thought was odium metal and its compounds is established; the study of nonmetallic chlorine and its compounds embodies the method of studying the properties of substances from the point of view of valence, iron is a variable valence element, which can help students to construct a transformation model from two perspectives of substance category and element valence (as shown in Figure I), strengthen the mutual transformation between different valence states of iron, further enrich the understanding of classification view, transformation view, ion reaction, redox reaction, and learn sodium and chlorine, sulfur, nitrogen and their compounds, as well as the structure of matter and the aw of elements Refine the big concept of "Understanding the nature and transformation of inorganic substances based on the substance class and the valence state of the element", so as to make the knowledge of inorganic compounds structured.

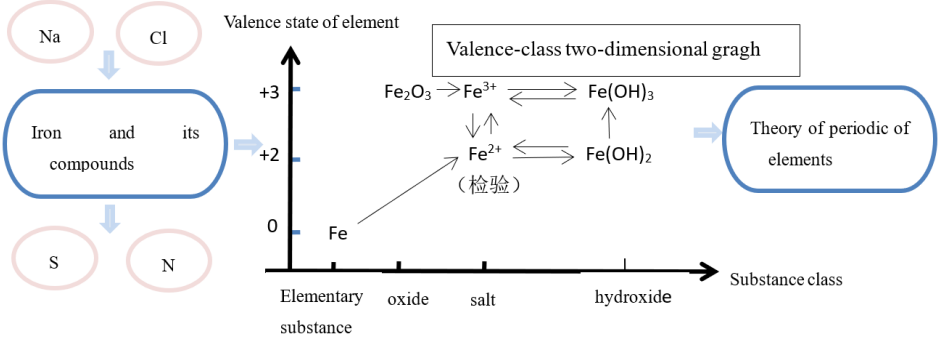


Figure I structuralframe diagram of "Iron and its compounds"[4]

2. Teaching objection of the project

In the teaching of "Scientific Understanding of Iron Supplement project, according to the corresponding content requirements and academic requirements in the curriculum standards, combined with relevant teaching resources and students' learning situation, the project teaching objectives are formulated:

(1) To understand the human body through understanding the role of iron in the human body. The principle of absorbing iron, understanding the great contribution of chemistry to the research of pharmacology, and feeling the application value of chemistry in human health.

(2) By exploring the reparation of $Fe(OH)_2$, experience the value of literature and form a rigorous and realistic attitude. To explore the reductibility of vitamin C and strengthen the awareness of evidence reasoning.

(3) By constructing a two-dimensional cognitive model, the transformation relationship between iron-containing substances is sorted out to form a knowledge structure. Through the use of materials around to test Fe, forming the consciousness of sustainable development of saving resources and protecting the environment.

(4) Through the analysis of iron supplement packaging materials and technology, water solubility, absorption effect, comprehensive application of multidisciplinary knowledge to solve the problem in the real situation, develop interdisciplinary thinking.

3. Evaluation of project results

In order to evaluate learning fairly, improve practical and effective feedback, and provide directions for improvement in student learning content and methods, detailed evaluation gauges have been developed (as shown in table I).

Table I "Scientific Understanding of Iron Supplement" evaluation gauge[5]

Project topic		Scientific understanding of iron supplements
Evaluation gauge of study achievement	Task1:Analysis iron is in the human body's role	C1: Understand the symptoms and manifestations of patients with iron deficiency anemia; (2 points) C2: knows that iron is an important component of hemoglobin; (2 points) C3: links biology to analyze iron's involvement in blood oxygen transport and REDOX metabolic processes. (4 points)
	Task 2: Identification Iron supplements	C1: Master the testing methods of $Fe^{2+}$and Fe^{3+}; (3 points) C2: According to the experimental phenomenon, the inner core and outer composition of ferrous sulfate supplement were analyzed; (3 points) C3: Conjecture on the composition of the grey-green precipitate and group discussion on designing feasible preparation Solution of Fe $(OH)_2$; (3 Points) C4: Explore and explain the reason why strong tea can not be drunk when taking oral iron supplement, but take Vitammin C together can promote iron absorption reasons; (3 Points) C5: Construct the conversion model between iron-containing substances from two perspectives of valence-class, and explain the reasons; (3 Points) C6: Put forward the use of materials around to complete the Fe2t inspection scheme. And verify the feasibility, form the awareness of sustainable development of saving resources and protecting the environment. (5 points)
	Task 3: Know iron supplement exhibition history	Level 1: Compare different iron supplements to understand the advantages and disadvantages; Using conservation thought, analysis can not over supplement iron, in more point structure level; (3 points) Level 2: Combine physiology, pharmacology and chemistry knowledge, analyze the pharmacological mechanism of ferrous sulfate and ferrous succinate, and reach the multi-point structure level; (5 points) Level 3: From the perspectives of physiology, pharmacology, chemistry, material science and technology,the selection of iron supplement packaging materials, water solubility and body absorption effect can be analyzed to achieve the level of correlation structure. (8 points)
	Task4: Recognize iron in food	C1: give examples of iron-rich foods, (3 points) C2: help make dietary recommendations for people with iron deficiency anemia. (3 points)

4. Project teaching implementation process

4.1 The role of iron in the human

【Question】According to a study in 2010, one-third of the world's population suffers from anemia, and iron deficiency anemia accounts for about half of them[6]. So what is the important role of iron in the human body?

【Group report】The source of iron in the human body, one is from food; Second, endogenous iron mainly comes from aging and damaged red blood cells. When the human body is iron deficient, the amount of hemoglobin synthesized by red blood cells is reduced, resulting in the small size of red blood cells and the decrease of oxygen carrying capacity, forming iron deficiency anemia. Iron is an important component of hemoglobin in red blood cells and participates in blood oxygen transport and redox metabolism in the body. So Fe^{2+} should be included in iron supplements.

Under the action of iron reductase Fe^{3+} is converted into Fe^{2+}, stored in the liver, bone marrow, called ferritin. When ferritin enters the serum, it forms serum ferritin. When used, Fe^{2+} is converted to Fe^{3+} by iron oxidase, and Fe^{3+} binds to transferrin in the plasma to form serum iron[7].

【Question】Are there any iron deficiency anemia patients around the students? What do you know about iron deficiency anemia?

【Group report】Consult the data, found that iron deficiency in the body is a gradual process from light to heavy, initial iron deficiency, storage iron consumption adjustment, serum ferritin concentration decreased; metaphase iron deficiency, serum ferritin concentration decreased, serum iron also decreased, red blood cell free protoporphyrin concentration increased; Severe iron deficiency, in addition to the

above indicators change, hemoglobin and hematocrit ratio decreased, human iron deficiency performance including fatigue, fatigue, palpitation, breathing difficulties, headache, pale skin and so on. The main patients of iron deficiency anemia are preschoolers (<5 years old), women of childbearing age and pregnant women.

【Data card】Iron deficiency anemia is attributed to the imbalance between the body's demand and supply of iron, resulting in a decrease in the hemoglobin content in red blood cells and a decrease in the number of red blood cells. When there is severe iron deficiency anemia, the patient needs to take iron supplements to treat, let's explore the secret of iron supplements.

4.2 Explore the secret of iron supplements.

4.2.1 Identification of iron in iron supplements

【Question】Show the iron supplement (ferrous sulfate tablet) What method can we use to identify the Fe^{2+} in the iron supplement?

Table 2 Test of Fe^{2+} and Fe^{3+}

	Fe^{2+}	Fe^{3+}
observational method	laurel-green	claybank
alkali addition	the white precipitate quickly turns gray-green and finally reddishbrown	Reddish brown precipitate
add KSCN	after adding KSCN solution, there is no obvious phenomenon, and then adding H_2O_2 solution, the solution turns blood red	after adding KSCN solution, the solution turned blood red
method of precipitation	add $K_3Fe(CN)_6$ solution, with blue precipitates generated	add $K_4Fe(CN)_6$ solution,with blue precipitates generated

【Group report】1. Ferrous sulfate tablets are dissolved in distilled water and drops of KSCN solution showed no obvious phenomenon. 2. Ferrous sulfate tablets are dissolved with hydrochloric acid, and the solution is added with KSCN solution, and the solution turn blood red.

【Analytical reasoning】The inner core of ferrous sulfate tablets contains $FeSO_4$, and Fe^{2+} is easy to be oxidized, so Fe_2O_3 is wrapped in its outer layer. Because Fe_2O_3 is an alkaline oxide, soluble in hydrochloric acid, easily dissolved by stomach acid, in the body it is reduced to Fe^{2+}, thereby improving the absorption rate of iron supplements.

【Student】The experiment found that the use of alkali method to identify Fe^{2+}, the white precipitate will quickly become grayish green, why?

【Discussion】White $Fe(OH)_2$ is easily oxidized, but $Fe(OH)_3$ is a reddish-brown precipitate. and the gray-green precipitate may be a mixture of $Fe(OH)_2$ and $Fe(OH)_3$.

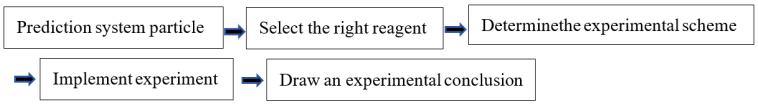
【Document literature】Using hand-held technology, the researchers found that the initial light gray-green precipitate was not a mixture of $Fe(OH)_2$ and $Fe(OH)_3$, but an $Fe(OH)_2$ colloid absorbed with Fe^{2+}[8].

【Group report】White $Fe(OH)_2$ easy to be oxidized, need to prevent the interference of oxygen, prepare the solution with distilled water after boiling and cooling, in addition, vegetable oil can be liquid sealed; reduce the concentration of Fe^{2+}, while increasing the concentration of lye, can prevent Fe^{2+} from being adsorbed.

【Question】That contains both Fe^{2+} and Fe^{3+} in the acidic solution of ferrous sulfate tablets. How do you test it?

【Group report】Take two identical parts of the above solution and drop KSCN solution into one. The solution immediately turns blood red, to prove that it contains Fe^{3+}. And a solution of KSCN was added to the other, no obvious phenomenon was observed, but acid $KMnO_4$ was added to the other, the solution turned blood red, proving the presence of Fe^{2+}.

【Summary】The idea of testing certain particles in real complex system



【Pharmacological effect】During oral iron, tea should be avoided as much as possible, especially strong tea, but with vitamin C, can promote iron absorption. Why?

【Experimental investigation 1】 1. Add tea to 25ml beaker about 1g, and then brew with boiling water, after a period of time to get strong tea. 2.Add 3 drops of $FeSO_4$ solution to 2ml of strong tea water, observe the phenomenon, and then add 2 drops of vitamin C solution, oscillate and observe the phenomenon.

【Phenomenon】Add 3 drops of $FeSO_4$ solution, observed that the tea turn blue black, and then add vitamin C solution, the tea return to the original color.

【Data card】Polyphenols in the tea react with Fe^{2+} to form tea polyphenol ferrous complex, the electrode potential between FeIII /FeII will be greatly reduced, the reductive property of FeII is enhanced, and it will soon be oxidized into blue-black precipitate of tea polyphenol iron, which can significantly inhibit the absorption of non-heme iron[9].

【Conclusion】1. Vitamin C is reductive. 2. Fe^{2+} in solution can be converted to Fe^{3+} by selecting suitable oxidant. And the appropriate reducing agent can convert Fe^{3+} to Fe^{2+} in the solution. Therefore, adding vitamin C to iron supplements can promote the absorption of iron, enhance the effect of iron supplementation and prevent the deterioration of iron supplements.

【Summary】 Conversion between Fe^{2+} and Fe^{3+}

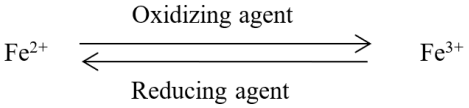


Figure 2 Conversion model between Fe^{2+} and Fe^{3+}

【Task】Please establish the Fe, Fe^{2+}, Fe^{3+} mutual conversion network diagram from the perspective of redox reaction.

【Results Show】Construct the conversion between iron-containing substances from the perspective of "valence - class"(Figure 3)

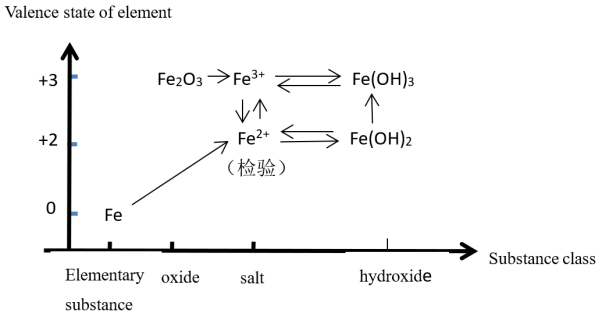


Figure 3 iron-containing substances from the perspective of "valence - class"

【Student】If we want to test Fe^{2+} at home, how do we choose reagents and instruments?

【Question】Students brainstorm, the experiment need: Fe^{2+} in the solution under test , alkaline solution, oxidizing agent, reducing agent, plant oil and the reaction container, etc. Think about how to use the materials around you to complete the experiment?

【Student 1】Fe^{2+} can be obtained by reacting iron nails with vinegar, or directly with iron supplements. The reaction container can be made of medical waste penicillin bottle or disposable syringe.

【Student 2】"84" disinfectant can be used as an oxidizing agent, and vitamin C can be used as a reducing agent.

【Student 3】 The sodium hydroxide used to unclog drains can be used as an alkaline solution.

【Group report】White precipitate can be observed, and then inhaled "84" disinfectant, white precipitate immediately changed to reddish-brown precipitate.

【Student】 The experiment found that the reaction rate of iron nails and vinegar is relatively slow. What method can be used to increase the reaction rate?

【Discussion】The carbon rod in the discarded No.1 battery or the discarded copper wire can be used to form a galvanic battery to speed up the reaction.

4.2.2 Understand the development history of iron supplement

【Question】If you are a drug researcher, what problems should be considered?

【Student】The selection of packaging materials for iron supplements should adopt good packaging technology and coating materials, not only to protect the iron and other nutrients in the supplements from loss, but also to facilitate swallowing; 2. Various groups of people should be considered when writing the instructions of the supplement, indicating the ingredients, indications and adverse reactions. 3. Water solubility and body absorption effect of iron supplement.

【Data card】Types of iron supplements

Types of iron supplement	Representative	Characteristic
First generation iron supplement (inorganic iron)	$FeSO_4$	cheap; low absorptivity; rusty taste; side effects on the gastrointestinal tract were significant
Second generation iron supplement(conventional organic iron)	Ferrous succinate; Ferrous fumarate; Ferrous gluconate	little irritation to the gastrointestinal tract; Long-term is easy to produce black tooth staining; rusty taste
Third generation iron supplement(new organic iron)	Ferric sodium edelate; Ferric hydroxide polymaltose compound	no rusty taste; high absorptivity; little irritation to the gastrointestinal tract;

【Question】How should we choose and take iron supplements?

【Student】When choosing the drug for iron deficiency anemia, the drug with high absorption rate should be preferred. It is important to pay attention to the large dose of supplementation. Filling iron is easy to lead to acute iron poisoning, when there is iron deficiency anemia, taking iron supplements can increase the amount of hemoglobin, and then gradually increase the amount of stored iron, so we must adhere to the principle of as mall amount, long-term, do not blindly use drugs, to follow the doctor's advice.

【Knowledge development】Ferrous succinate tablets are best taken after meals or meals to reduce its effect on stomach irritation, but also effectively improve its bioavailability, blood and serum iron levels should be checked regularly during treatment. After Fe^{2+} in ferrous sulfate is oxidized to Fe^{3+} by ceruloplasmin in the blood, it binds to plasma transferrin, and then enters the cell to bind protoporphyrin and globin to form Hb and promote Fe^{2+} absorption[10].

4.3 Understanding iron in food

Diet treatment is the basis of all kinds of anemia treatment, if the long-term partial diet, picky eating, may limit the intake of iron-rich food, resulting in long-term dietary iron can not meet the needs of the body. In plant foods, the main form of iron is non-heme iron(also known as plant iron), and the main form of iron in animal foods is heme iron. There are a lot of iron-rich foods in life, although the iron content of plant foods is higher[11], but the human body has a better absorption of iron in animal iron-containing foods. Such as animal viscera, meat, fish, eggs and other animal food iron is easy to be absorbed.

【Role Play】As a drug researcher: Please help people with iron deficiency anemia make diet recommendations.

【Group report】Consult the data and make the following dietary recommendations:

(1) Combine foods rich in vitamin C, such as citrus fruits. Strawberries, tomatoes, etc, can improve the absorption rate of non-heme iron.

(2) After eating foods rich in phytic acid, avoid taking iron supplements or other iron-fortified foods immediately, as phytic acid can affect iron absorption.

(3) Try to avoid foods rich in phytic acid after consuming foods high in calcium, as phytic acid combines with calcium to affect iron absorption.

5. Epilogue

This lesson takes "Scientific Understanding of iron supplements" as the project teaching theme. Teachers guide students to identify iron supplements, take iron supplements and a comprehensive understanding of iron supplements which is to experience the value of chemistry. In students' thinking to find available addition, if you are a pharmaceutical researcher be taken into account when studying iron supplements,

apply multidisciplinary knowledge to solve problems in real life. After class, the author interviewed situations, and feel that chemistry comes the students about the learning task of and the students all agreed that classroom learning in project tasks can better inspire initiative and curiosity for full exploration. And can be well connect complicated and redundant knowledge in series. It builds a bridge between real world and school education. Ren Xuebao said: "Teaching and research is the secret weapon of China's basic education, and an important support for ensuring the quality of basic education." The teaching-oriented classroom understand the functional value of the teaching needs to use the power of the curriculum content, consideration of problem, activity, selements and knowledge matching. To ensure that each driving question and core activity points to the development of students' ability cultivation[12].

Today, with the rapid development of information technology, project-based learning will be combined with big data, artificial intelligence and other technologies to accurately analyze students' earning and provide support for personalized teaching. However, the promotion of the concept of project-based curriculum needs the cooperation and support of education departments, schools, teachers and parents, so as to promote the education reform to pay more attention to the development of students' ability and literacy.

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