The Measures to Develop the Competence of Knowledge Manipulation in Real Life for Pupils through the System of Real Exercises with Metal Chemistry of Grade 12

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Abstract The competence of knowledge manipulation to the life realities is a core competence needed to be established and developed for pupils in Chemistry. Various measures can be used in order to develop the competence of knowledge manipulation for pupils. This article offers the theoretical basis and four measures about the use of chemical knowledge through exercises in the classroom. Used in teaching as used when assigning homework to prepare new lessons; studying new texts; practicing and revision; experiments, practices to develop the competence of knowledge manipulation in many life realities such as health, medicine, environment, agriculture, food, industry,... for high school pupils of 12th grade through the system of metal chemistry exercises.

Keywords: competence of knowledge manipulation, develop the competence of knowledge manipulation, exercises of practical exercises, exercises of competence development

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1. Introduction

Chemistry exercises play a very important role in the pupil's cognitive process, not only as a measure of cognitive ability, strengthen the pupil's knowledge but also as a tool of training pupils with different skills [1]. There have been a number of masterpieces offering the teaching issue in the direction of developing the competence of knowledge manipulation for pupils such as [2,3,4], ... However, the use of chemical exercises have not been much studied by many authors to develop the competence of knowledge manipulation in many fields such as health, the environment, agriculture, food,... the reality of daily around the pupil's life. This article proposes some measures to develop the competence of knowledge manipulation of various fields to the real life of high school pupils through the system of practical exercises of 12th grade metal chemistry.

2. Content

2.1. Research Method

Using the combination of methods such as analysis, synthesis and systematization in studying the relevant documents. Investigating the real situation of using the exercise, the problem of development of the pupil's competence of knowledge manipulation and take pedagogical experiment to test the practical value of the researched results. Using the methods of mathematical statistical to process data with accurate comments, authentic assessment.

2.2. Research Facilities

Questionnaires, system of practice exercises, assessments, spreadsheets, formulas of mathematical statistics.

2.3. Research Subjects

- The chemistry exercises in metal chemistry to develop the pupil's competence of knowledge manipulation.
- Measure to develop the the pupil's competence of knowledge manipulation.

2.4. Results of Research and Discussion

2.4.1. Competence of Knowledge Manipulation of High School Pupils

a. Conception about competence of knowledge manipulation

“The pupil's competence of knowledge manipulation is the learner ability to mobilize, use the knowledge, skills which have been learned in the classroom, or being learned from the real-life experience to solve problems occured in the life’s diverse and complex situations with
an effective and capable way which is able to transform it. The competence of knowledge manipulation shows the people's qualitative and personality during the operation process so as to satisfy the demand of knowledge acquisition" [2].

Some knowledge, principle or theory in spite of being good at what level that have not been applied yet is useless; Application or manipulation can be understood in the same sense as when general principles are applied to solve new problems, new mathematical exercise in new situations.

b. Structure for competence of knowledge manipulation [5]

The competence of knowledge manipulation of high school pupils through chemistry consists of five following main components:
- Competence to systematize knowledge.
- Competence to analyze the synthesis of chemical knowledge manipulated to real life
- Competence to detect the contents of chemical knowledge applied in the problems of different fields.
- Competence to detect problems in practice and use chemical knowledge to explain.
- Innovative independent competence in dealing with practical issues.

c. Expressions of the competence to manipulate knowledge through chemical exercises [5]

The competence to manipulate knowledge through chemical exercises can be shown with the following manifestations:
- Possible to systematize, classify, and deeply understand the characteristics, contents and attributes of chemical knowledge through chemical exercises.
- Discovering and understanding the chemical applications in food, agriculture, industry, medicine, health, science, manufacturing, natural and environmental phenomena through chemical exercises.
- Actively and creatively choosing the methods, modality of problem settlement through chemical exercises.
- Finding the relationships and explaining the phenomena in nature and the applications of chemistry in life based on chemical knowledge and other interdisciplinary knowledge.
- Having the competence to understand and discuss chemical issues related to real life and initially engage in research to solve those problems.

2.4.2. Measures of Competence Development that Manipulates the Knowledge Into Pupils' Lives through the System of Practical Exercises in Metal Chemistry of 12th Grade

2.4.2.1. Measure 1: Using when assigning homework to prepare new lessons

The traditional teaching-learning method has shown that the transfer of one-way knowledge in the manner "reading-writing" in which considered teacher as center has revealed many insufficient gaps in pupils' cognition. There, pupils passively acquire the knowledge by the teacher's available arrangement.

Exercises of practical chemistry are well suited for teachers to use in teaching with positive direction today. Instead of passively passing on knowledge, teachers can assign homework related to daily life. Pupils can occupy new knowledge with their own motivation, self-awareness, positivity, independence; Develop the competence of intellectual activity, creative thinking, learning the life around, deeper memorize knowledge when learning new lessons.

Example 1: Before teaching "Metal erosion" (Chemistry 12 - Advanced), the teacher assigns the pupils to complete the following homework:

There are items made of iron coated with tin (iron) iron or iron coated with zinc (tole). If there are deep scratches on the surface reached the iron layer inside, tell us:
- What happens when the item is placed in moist air?
- In your opinion, why do people use tole to roof without using iron?

This exercise can orient the pupils to manipulate the knowledge of metal corrosion to explain the problems of everyday life. Since then pupils have always found solutions to protect the metal in life and production.

Example 2: Before teaching "Some important compounds of aluminum" (Chemistry 12 - Advanced). Teachers can assign the following chemical lesson:

When making bread from wheat flour without leavening, the bread is not spongy, but if added to the flour with a little aluminum alum - potassium (K₂SO₄·Al₂(SO₄)₃·24H₂O} and soda (Na₂CO₃·10H₂O), the bread is blistering, spongy after baking.

![Figure 1. The bread is mixed with aluminum - potassium and soda](image)

a) Please explain that phenomenon
b) What is the ratio of alum and soda for reasonableness?
c) Can we replace alum with a sufficient amount of hydrochloric acid solution on the powder mixture above? Why?

Training pupils in the use of the chemical natures of alum - potassium, soda to solve the problem of wonder there are puffs and sponges which are encountered in practice by pupils. The above exercise is intended to develop the competence to manipulate the chemical knowledge to explain applications in the food industry today.

Example 3: Teacher assigns pupils homework with chemistry exercises to prepare for the new lesson "Some Important Substances of Alkaline Metals" (Chemistry 12 - Advanced):

Lesson 1. To make acid deoxidization for the soil, farmers often use lime to fertilize the field. The method to make lime as follows: put the clays of burned lime in the shade for a few days, burned lime will slowly turn into fine powder.

![Figure 2. The clays of burned lime](image)
Lesson 2. The curtain of magnificent stone has been formed with many stalactites inside the caves of the limestone mountains and many positions have been created with stalagmite forest, other ones have been formed with stalks of great stone pillars (connected together by stalactites and stalagmites) give your eyesight with the nice look. By your understanding, you should explain the formation of stalactites and stalagmites.

These exercises aim to engage pupils to manipulate knowledge of calcium compounds so as to explain the above issues and bring joy to parents when their children by using the knowledge learned in school to coherently explain the problems in the practice of agricultural production as well as the phenomena occurring in nature.

With such chemical exercises is the best way to prepare for further study or to enter into their life of daily labor in agriculture and considered as a precondition for pupils to become scientists in the not far future.

2.4.2.2. Method 2: To be used in teaching and research new lesson

In teaching new knowledge, teachers can integrate the practical life-style exercises in the form of questions that raise the problem or problematic situation so as to make lesson becomes lively and attractive. These assigned chemistry exercises will be addressed and verified after pupils have received new knowledge.

However, teachers should choose exercises of practical chemistry when using that integration to be close to the pupil's life experiences which will be more effective. Simultaneously, it's also needs to have timely and diversified level so as to ensure the pupils are quickly attracted and excited about the chemistry exercise given out.

Example 1: When teaching the chemical properties of the lesson "Aluminum" (Chemistry 12 - Advanced), teachers can give the following chemical exercise:

Aluminum cookware should only be used for cooking rice, water without using to make sour soup or to keep sour soup too long in an aluminum pot. By your understanding please explain why?

Pupils understand the nature of aluminum when reacting with oxygen forming a layer of aluminum oxide (Al₂O₃). This aluminum oxide layer adheres firmly to the aluminum surface making the aluminum surface dim. This oxide layer is very scared of acid and alkali. Since then, teacher can orient for pupils to explain so the aluminum appliances are only suitable for cooking rice, boiling water and is not suitable for containing acidic or alkaline substances. This exercise helps students to create new knowledge through practical exercises and simultaneously adds some of their life-saving tips in life about health and food safety.

Example 2: When teaching new lesson "Some important compounds of alkali metal" (Chemistry 12 - Advanced). Teacher can give the following exercise:

Why do people use NaHCO₃ salt to prepare the medicine of stomach pain?

Resolving that question, pupils need to learn more about medical knowledge: In the stomach contains solution of HCl acid. People with stomach pain who have a high concentration of HCl acid causes the stomach to be eroded. Pupils must use the chemical nature of NaHCO₃ because NaHCO₃ reduces the amount of HCl content contained in the stomach by chemical reaction so as to explain the reaction mechanism of the drug:

$$NaHCO₃ + HClNaCl + CO₂ + H₂O$$

Such practical exercises aim to stimulate the thinking ability and apply knowledge not only in everyday life, industry, agriculture, food ... but also in higher knowledge fields such as health, medicine.

Example 3: When teaching new lesson "Some compounds of iron" (Chemistry 12 - Advanced). Teachers can give the following exercise:

In groundwater, iron usually exists in the form of iron ions (II) hidrocarbonate and iron (II) sulfate. The high content of iron in the water causes the water with fishy smelling and yellow when longlylayed to adversely affect human health and life. Please explain how to remove iron from drinking water?

Such problems affect the pupil's curiosity with their surrounding environment, thereby stimulating the love of science to find the answer for that problem with main purpose of helping pupils apply knowledge learned about iron compounds to solve problems arising in daily life related to the environment, health in the most reasonable way.
2.4.2.3. Measure 3: Using in the form of exercise and revision

During rehearsals, revision; chemistry exercises are the most effective way for pupils to review and reinforce their learned knowledge. Apart from the previous quantitative and qualitative lessons, teachers can integrate with additional, factual information to enrich the practice system with main purpose of facilitating pupils to connect theory to reality so as to deepen knowledge and develop the synthetic competence as well as apply knowledge to daily life.

Example 1: After teaching the "Alloys of Iron" (Chemistry 12 - Advanced). At the end of end-hours revision sessions, the following practical exercises can be used to help pupils review their learning:

Needing how many tons of magnesite ore contains 80% of iron from the oxide to be able to handle 800 tons of cast iron with iron content of 95%. Knowing in production, the loss iron is 1%.

In order to solve this exercise, pupils apply the knowledge of elemental conservation principle, the efficiency of a reaction. That exercises can train pupils with skill to solve chemical problems related to efficiency.

Example 2: In Exercise "the properties of aluminum and the compound of aluminum" (Chemistry 12-Advanced). Through the practice hours, teachers should systemize the knowledge need to grasp pupil's thinking plan, solve textbook exercises, and teachers need to add some practical exercises to develop pupil's competence of knowledge manipulation as follows:

Exercise 1. In the electrochemical range, aluminum stands in front of iron means that aluminum is easier to be responsive to oxygen than iron. But in reality, why iron is rusted and aluminum is not rusted?

Exercise 2. When caluminum objects are dirty what following thing should we use for scouring?

A. Soft brush.
B. Sand.
C. Metal brush.
D. Ash (contains potassium bicarbonate)

Choose the right solution and explain.

Lesson 3. Write formula of alum chemistry and explain:

a) Why can alum work in water?

b) When the pH of water is less than 7, people often use alum along with burned lime to make water. Then the process of doing in water is quick, thorough, but save alum. Explain that.

Lesson 4. Fire extinguisher of foam spraying has the following structure:

- Tube of open glass containing aluminum sulphate solution
- Solution vessel with high content sodium bicarbonate.

Normally, the fire extinguisher is upright stood, not to be lied down. In case of fire, the tank must be upside down.

Figure 6. Fire extinguisher

a) Why must keep the fire extinguisher upright? Why must we turn upside down the fire extinguisher when extinguishing the fire? Write the reaction equation (if any).

b) What is the principle of fire extinguisher?

Pupils use the chemical knowledge of aluminum compounds in combination with other compounds to explain all the exercises. Give students a panoramic view of the chemistry applied in reality of everyday life to fields such as rescue and production, essence substances,...

2.4.2.4. Measure 4: Use in the form of experiments, practice

Chemistry is a subject of experimental science. Beside the transmission of theoretical knowledge, the teacher also needs to enhance the use of exercises with practical content to reinforce and train competence for pupils. By presenting contingent practical situations that conflict with previously learned theories will enable pupils to develop their observational skills, practice, and verifiable knowledge from the textbook so as to affiliate pupils to explore the real deal to resolve that conflict.

Example 1: When teaching "Exercise 4: Metal erosion, Anti-corrosion of metal" (Chemistry 12 - Advanced), teachers can integrate experimental content into exercise:

The following picture is drawn by a pupil to describe electrochemical corrosion experiments when two Cu and Zn sheets (connected by a conductor) are plugged into a solution of dilute H2SO4:

Exercise 1. In the electrochemical range, aluminum stands in front of iron means that aluminum is easier to be responsive to oxygen than iron. But in reality, why iron is rusted and aluminum is not rusted?

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- Tube of open glass containing aluminum sulphate solution
- Solution vessel with high content sodium bicarbonate.

Normally, the fire extinguisher is upright stood, not to be lied down. In case of fire, the tank must be upside down.
a) Please explain the way to install the above test equipment?

b) At the end of the experiment, why we must disconnect the air duct before turning off the alcohol lamp?

These exercises are aimed at training the practical skills for pupils. Simultaneously, pupils need to apply their physical knowledge in the field of pressure, electricity in order to solve the above problems, apart from chemical knowledge,… to make the exercises become lively and catch up with the trend of today new education is integrated teaching with main purpose of help pupils develop the ability to mobilize knowledge, skills, and so on in various disciplines to effectively solve problems in learning and in life.

2.5. Pedagogical Experiment

Pedagogical experiment was conducted in 2016-2017 school year at Tran Quoc Tuan High School and Vo Nguyen Giap High School in Quang Ngai province. The lesson plan design utilizes measures to develop competence of knowledge manipulation through the exercise system with methods of active teaching, using the checklist, self-development assessment so as to develop the competence of knowledge manipulation for pupils. Examining the assessment of the learning outcomes through the checklist assessed by teachers and self-assess pupils with the test results processed by mathematical statistics.

Table 1 shows that: Grade point average plus of the pupil’s experimental class is higher than that of the control class; V (in the range of 10 - 30%, the results are credible) of the experimental class is always smaller than that of the control class, which indicates that the scattering scores of the pupil’s control class are wider than the experimental one. The quality of experimental class is always better than the control class; the experimental class in both cases have value p <0.05, so the difference in scores between the two experimental and control groups is significant. The magnitude of impact of both cases ranges from 0.68 to 0.72, so the impact of the experiment is small (Impact brings moderate influence).

| Test No | Class      | Number of pupils | X    | S   | S²  | V (%) | Calibrated value p | Influence level ES |
|---------|------------|------------------|------|-----|-----|-------|--------------------|--------------------|
| No 1    | Experimental | 83               | 7.38 | 2.49 | 1.58 | 21.41 | 0.001443           | 0.72               |
|         | Control    | 82               | 6.23 | 2.54 | 1.59 | 25.52 |                     |                    |
| No 2    | Experimental | 83               | 7.27 | 2.50 | 1.58 | 21.73 | 0.003709           | 0.68               |

Table 2. The results table assesses the pupil's competence of knowledge manipulation

| Serial number | Indicator criterion                                                                 | Level assessment |
|---------------|-------------------------------------------------------------------------------------|------------------|
|               |                                                                                     | Experimental     | Control                      |
|               |                                                                                     | 1    | 2    | 3    | 4    | 1    | 2    | 3    | 4    |
| 1             | Having ability to systematize, classify, and understand the characteristics, contents, attributes of chemical knowledge through chemical exercises. | 6    | 22   | 39   | 16   | 15   | 36   | 25   | 6    |
|               |                                                                                     | 7.23%         | 26.51%           | 46.99%       | 19.28%       | 18.29%       | 43.90%       | 30.49%       | 7.32%       |
| 2             | Discovering and deeply understanding the chemistry applications in food, agriculture, industry, medicine, health, science, manufacturing, natural and environmental phenomena through chemical exercises. | 6    | 25   | 37   | 15   | 16   | 35   | 26   | 5    |
|               |                                                                                     | 7.23%         | 30.12%           | 44.58%       | 18.07%       | 19.51%       | 42.68%       | 31.71%       | 6.10%       |
| 3             | Actively and creatively selecting the method, mode to solve problems through chemical exercises. | 5    | 24   | 39   | 15   | 15   | 34   | 27   | 6    |
|               |                                                                                     | 6.02%         | 28.92%           | 46.99%       | 18.07%       | 18.29%       | 41.46%       | 32.93%       | 7.32%       |
| 4             | Finding the relationship and explanation of phenomena in nature and the chemistry applications in life based on chemical knowledge and other interdisciplinary knowledge. | 6    | 27   | 36   | 14   | 17   | 32   | 26   | 7    |
|               |                                                                                     | 7.23%         | 32.53%           | 43.37%       | 16.87%       | 20.73%       | 39.02%       | 31.71%       | 8.54%       |
| 5             | Being capable to understand and discuss the chemical issues related to real life and initially engage into research to solve those problems. | 6    | 27   | 36   | 14   | 18   | 34   | 24   | 6    |
|               |                                                                                     | 7.23%         | 32.53%           | 43.37%       | 16.87%       | 21.95%       | 41.46%       | 29.27%       | 7.32%       |

Level 1: Unsatisfactory (0 - 4 points); Level 2: Pass (5 - 6 points); Level 3: Good (7 - 8 points); Level 4: Very good (9 - 10 points).
Through the checklist (Table 2): each criterion demonstrates the competence of knowledge manipulation, the score of experimental class is always higher than the control class (evidencing that most of the criteria are in the experimental class evaluated at level 3 and level 4), that means the pupil's competence of knowledge manipulation in the experimental class develops more than the control class.

Thereby it can affirm the pupils are learning in a new method combined with measures to develop the competence of knowledge manipulation proposed by us having learning quality and applying knowledge into the life reality better.

3. Conclusion

In this article, we briefly offer the theoretical basis of knowledge manipulation competence and simultaneously present some measures to develop the competence of knowledge manipulation in daily life, agriculture, industry, health, pharmacy,... for pupils through the system of real exercises in 12th grade chemistry. The experimental results show the feasibility of using these measures in developing the competence of knowledge manipulation for pupils so as to help teachers maximize the effect of chemical exercises as implementing the teaching goals, maximize the potential of inherent individual in each learner, meet the tendency of current education which is necessary for pupils to enter life in the future.

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