Developing the Capability to Applying Knowledge for Non-Metallic Chemistry Module

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Abstract Currently, developing students' capability to apply knowledge is an essential task in teaching in high schools. Capability developing can be conducted by different means. One of the most effective methods is to use experiments associated with practice. In this article, the author referred the process of conducting experiments associated with practice, investigated the reality of developing capability to apply chemical knowledge for students through practical experiments in some high schools, built assessment tool, from which we designed and used the system of experiments associated with practice in the lectures of Non-Metallic Chemistry, conducted pedagogical experiments and evaluated the effectiveness of developing the capability to applying knowledge for students.

Keywords: capability to apply knowledge, developing the capability to apply knowledge, experiments associated with practice, non-metallic


1. Introduction

Chemistry is a science of both theory and an experiment. The feature of this subject is the use of experiments. In addition, Chemistry has close relationship with the sciences such as Physics, Biology, Earth science, etc. and real life. Therefore, in the course of teaching, it is necessary to use experiments associated with practice to develop the capability to apply chemical knowledge into real life, make lecture closer, give students the interest, enthusiasm in learning and awareness of the practicality of learning.

In the world, there have been some related research works such as Mohammad A. Chowdhury, “Incorporating a Soap Industry Case Study To Motivate and Engage Students in the Chemistry of Daily Life”: incorporating an industrial case study as an integral part of the chemistry curriculum, and discusses related issues with a proposed model of the soap industry to help improve secondary or undergraduate students’ engagement, motivation, and interest in chemistry [1]. Karpudewan, M., Hj Ismail, Z. and Mohamed, N. “The integration of green chemistry experiments with sustainable development concepts in pre-service teachers curriculum: Experiences from Malaysia”: This paper is to introduce green chemistry experiments as laboratory-based pedagogy and to evaluate effectiveness of green chemistry experiments in delivering sustainable development concepts and traditional environmental concepts [2]. On the issue of capacity development for the students, Avi Hofstein, Oshrit Navon, Mira Kipnis, Rachel Mamlok-Naaman, “Developing students’ ability to ask more and better questions resulting from inquiry-type chemistry laboratories”: This study focuses on the ability of high-school chemistry students, who learn chemistry through the inquiry approach, to ask meaningful and scientifically sound questions [3]. Basu M, Das P, Chowdhury G. “Introducing integrated teaching and comparison with traditional teaching in undergraduate medical curriculum” with the objective of evaluating the feasibility of Information Technology (IT); to compare IT with traditional teaching and to analyze student feedback and instructor feedback on IT awareness [4]. Rosa Betancourt-Pérez, Julio Rodríguez, and Lorell Muñoz-Hernández, “Homing in on the Capabilities That Are Most Predictive of Student Success in the First Semester of Organic Chemistry”: describing capabilities that expert organic chemists master and that novice students need to solve problems in organic chemistry. This paper presents the nine terminal objectives and the curriculum design that supports their development [5]. Qing Zhou, Quyuan Huang, Hong Tian, “Developing Students’ Critical Thinking Skills by Task-Based Learning in Chemistry Experiment Teaching”: investigate the effects of task-based learning (TBL) in chemistry experiment teaching on promoting high school students’ critical thinking skills in Xi’an, China; The California Critical Thinking Skills Test (CCTST) was used as a data collection tool [6].

In Vietnam, many research projects on developing the capacity to apply knowledge of authors such as Ha Thi My Linh “Establishing and using a system of
experimental exercises in teaching to develop the students’ ability of applying chemistry knowledge to practice” [7] and Pham Thi Kieu Duyen “Using practical exercises in chemistry teaching to develop students' ability to apply knowledge into practice” [8]: research on how to use practical exercises and experimental exercises in teaching to develop the capacity to apply knowledge into practice for students; Groups of authors Nguyen Thi Thanh, Hoang Thi Phuong, Tran Trung Ninh “Developing the ability to apply knowledge into practice for students through applying constructivist theory to teaching Chemistry”: proposing measures to develop this capacity for students through constructivist teaching using chemical exercises approaching PISA international student assessment program; Vo Thi Hong Vinh and Tran Trung Ninh “Developing capability of applying knowledge on practical for students at central preparatory school for ethnics through intergrated teaching” [10]: This paper presents an introduction to the development of the capacity to apply knowledge in practice to student at the preparatory school for ethnic students through integrated teaching with the theme “Limestone caves and the journey of carbonate sail - Famous sights of Viet Nam”, …. In addition, there is also research “Forming the ability to use experiments in our daily lives among chemistry pedagogy students” [11] of Phan Dong Chau Thuy presents a way to increase competency among chemistry pedagogy students at HCMC University of Pedagogy by using experiments that are related to daily life.

However, there has not been any research work about developing capability to apply knowledge for students through experiments associated with practice. Therefore, based on the research results of the authors and the orientation of general education program implementation, we proposed some measures to use practical experiments of Non-Metallic section in Chemistry teaching to develop capability to apply knowledge for students.

2. Content

2.1. Research Methods

Use a combination of analysis, synthesis and systematization methods in the study of relevant documents. Investigate the reality of using experiments associated with practice to develop the capability to apply knowledge for students at some high schools in Viet Nam; Conduct pedagogical experiment to evaluate the practical value of the research results. Use the methods statistical mathematic to process data, make valid comments and assessments and conclusions.

2.2. Research Facilities

Questionnaire, assessment test, tabulation and mathematical statistics formulas.

2.3. Research Subjects

- Chemical experiments associated with practice of Non-Metallic section in high schools.
- Some measures to use practical experiments of Non-Metallic section in Chemistry teaching to develop the capability to apply knowledge for students.

2.4. Research Results and Discussion

2.4.1. Capability to Apply Knowledge

a. Concept of capability to apply knowledge

According to [12], p 47]: “Students' ability to apply knowledge is the ability of students to mobilize themselves, use the knowledge and skills they have learned in class or learn through real-life experience to solve problems, out of diverse and complex situations of life effectively and with the potential to transform it. Manipulate knowledge capacity illustrates the quality and personality of people in the process of operation to satisfy the need to dominate knowledge”.

The concept of capability to apply chemical knowledge was identified by the Chemistry education program of the MOET as “the ability to apply the learned knowledge and skills to solve some problems in learning, scientific research and a number of specific situations in practice” [13]. It can be seen that this concept is built on the characteristic properties of the subject of Chemistry, which is the natural science that studies structure and chemical transformation.

In other words, the capability to apply knowledge of high school students is: “the ability to apply chemical language (chemical equations, formulas, symbols, signs, etc.) and the chemical principles and rules to address the essential needs of daily life with the preposition of improving and enhancing the quality of existing products” [9].

b. Structure of capability to apply knowledge [14]

The structure of capability to apply chemical knowledge of high school students is presented in Table 1.

<table>
<thead>
<tr>
<th>No.</th>
<th>Component capabilities</th>
<th>Demonstrations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Capability to systemize knowledge</td>
<td>1. Finding out and clarifying the problem</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Systemizing and classifying knowledge</td>
</tr>
<tr>
<td>2</td>
<td>Capability to analyze and synthesize chemical knowledge</td>
<td>3. General orientation of the need to apply chemical knowledge/skills to specific problems in learning and practice</td>
</tr>
<tr>
<td></td>
<td>applied to practical life</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Capability to recognize the application of chemical</td>
<td>4. Recognizing and understanding applications of chemical knowledge in different problems and fields in daily life</td>
</tr>
<tr>
<td></td>
<td>knowledge to problems in different fields</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Capability to detect problems in practical life and use</td>
<td>5. Detecting problems in practical life related to Chemistry</td>
</tr>
<tr>
<td></td>
<td>chemical knowledge to explain</td>
<td>6. Using chemical and interdisciplinary knowledge to explain natural phenomena and chemistry applications in life</td>
</tr>
<tr>
<td>5</td>
<td>Independent creativity to solve practical problem</td>
<td>7. Being proactive and creative in choosing methods of solving problem. Understanding and participating in discussions about chemical issues related to practical life</td>
</tr>
</tbody>
</table>
2.4.2. Chemical Experiments Associated with Practice (Practical Life)

a. Concept
Chemical experiment associated with practical life is a chemical experiment that uses tools and chemicals in human daily life and establishes the relationship between chemical science knowledge with real life [11]. Like traditional chemical experiments (using chemical tools in the laboratory and not linking knowledge of Chemistry with practice), chemical experiments associated with practice used in teaching to help students improve their interest in learning, create confidence in science, develop the ability to observe, inculcate knowledge of lessons, practice practical skills, etc. especially the experiments also enhance the practical significance of Chemistry in high schools, increase the capability to apply learned knowledge into practice, contribute to the development of problem solving and creativity capacity for students. [11]

b. The process of building chemical experiments associated with practice
Through the actual process of building chemical experiments associated with practice, we propose the process of building chemical experiments associated with practice as follows:

Step 1: Choose suitable lesson content to use while teaching experiment.

Step 2: Determine the goals, knowledge standards and skills of the selected lesson content.

Step 3: Select a chemical experiment suitable for the objectives, knowledge standards and skills of the selected lesson content.

Step 4: Look for materials and tools that are close to life in accordance with the selected content to replace chemicals and tools being used in the laboratory.

Step 5: Conduct experiments, verify phenomena and compare with traditional experiments being used.

Step 6: Adjust quality as well as implementation techniques, design appropriate forms of performance to improve efficiency.

Step 7: Prepare questions to exploit the experiment and suggest suitable solutions for the experiment.

2.4.3. The Reality of Using Experiments Associated with Practice to Develop the Capability to Apply Knowledge for High School Students

Through investigations and surveys of 36 teachers and 336 students at Buon Don High School and Hoang Viet Primary, Secondary and High School in Dak Lak province; Trung Vuong High School, Quoc Hoc High School, Hung Vuong High School in Binh Dinh Province.

Comments: Most of the teachers and students think that developing the capability to apply chemical knowledge in teaching is very necessary (62.50% of teachers; 61.02% of students). 62.5% of teachers commented that it is necessary to use chemical experiments in association with practice but only 50.00% of teachers have used experiments associated with practice (of which 6,25% very often, 18.75% often and 25% sometimes) because the design and use of experiments associated with practice meet certain difficulties. Students are quite interested (81.36%). Through the results of the above investigation, we found that it is necessary to use chemical experiments associated with practice in teaching to develop the capability to apply knowledge for students.

2.4.4. Propose Measures to Use the System of Experiments Associated with Practice of the Non-metallic Section in Teaching Chemistry to Develop the Capability to Apply Knowledge for High School Students

a. Use experiments associated with practice when studying new lesson
To develop the capability to apply knowledge of students, teachers can use experiments associated with practice based on research methods, problem-solving methods or verifying methods to develop thinking, provoking excitement, positive learning for students in the process of acquiring knowledge.

Example 1: When studying the physics of oxygen in the topic “Oxygen - Ozone”, teacher conducts the experiment “Finds oxygen in the air”

Place a burning candle in a dish full of colored water, cover the candle with a glass cup. After a short while, the candle will go out and colored water will fill the cup. Students observe and explain the phenomenon, compare the volume of rising water with the volume of the glass cup.

Answer: (Students apply chemical knowledge in the section of the physical properties and natural state of oxygen and knowledge of pressure changes in physics to explain)

The candle burning in the air proves that the air contains oxygen. After the candle is covered for a while, the oxygen will be gone, so the candle will turn off, the gas pressure in the cup decreases, so it spills almost 1/5 of the cup volume, which proves that oxygen accounts for 1/5 of the volume of air.

Through the above experiment, the teacher can form students with knowledge about oxygen which is the component that maintains the combustion in the air and accounts for 1/5 of the air volume. In addition, students also understand the knowledge that oxygen maintains the fire to apply in practical life such as when turning off the alcohol lamp, we just need to cover the alcohol lamp.
Develop students’ capability to systemize knowledge, select chemical and physical knowledge in explaining experimental phenomena.

Example 2: When teaching about carbon dioxide, in the warm-up activity to stimulate students’ interest in learning and knowledge acquiring, teacher conducts the experiment “Magic of candle light.”

Arrange the candles in a row and light them. Place vinegar in a glass, add a teaspoon of baking soda to the glass. Quickly bring the glass close to the candles. Students observe and answer the following questions:

Question 1: What is the gas released in the above experiment (gas X)?
Answer: (Students observe the experimental phenomenon and apply chemical knowledge about the non-burning properties of carbon dioxide to predict gas X)

The released gas is carbon dioxide with chemical formula CO2.

Question 2: What material source is gas X prepared from? Write chemical formula of the material and chemical equation to prepare X?
Answer: (Students rely on how to conduct experiments and apply knowledge of the chemical properties of carbonate salts to answer)

Ingredients: vinegar (CH3COOH) and baking soda (NaHCO3)
Equation: CH3COOH + NaHCO3 → CH3COONa + CO2 + H2O

Question 3: Based on the experimental phenomenon, what is the application of X?
Answer: (Students base on experimental phenomenon and apply knowledge of how carbon dioxide’s non-combustible properties are applied)

Through the above experiment, teacher can form students with knowledge about the non-combustibility of carbon dioxide, preparation and application.

Developing for students the capability to systematize knowledge, choose chemical knowledge about properties and preparation of carbon dioxide, capability to detect and understand the applications of carbon dioxide in fire protection.

When teachers use experiments associated with practice to teach new lessons, students need to focus on observing how to conduct and experimental phenomenon, discuss together to answer teacher’s questions. As a result, students will easily absorb and inculcate new knowledge while developing the capability to systemize knowledge, analyze and synthesize chemical knowledge to apply in real life and detect contents of chemical knowledge applied to problems in any field.

Table 2. Toolkit to evaluate students’ development of capability to apply chemical knowledge through experiments associated with practice

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Levels of evaluating capability to apply chemical knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Learning experiments and clarifying the nature, how to conduct experiments associated with practice</td>
<td>The nature has not been clarified and the chemicals, tools, and methods of conducting experiments are not linked to practice.</td>
</tr>
<tr>
<td>2. Systemizing and classifying relevant chemical knowledge when conducting and explaining experiments associated with practice</td>
<td>Relevant chemical knowledge to conduct and explain experiments associated with practice has not been classified and chosen.</td>
</tr>
<tr>
<td>3. Generally orienting the necessary chemical knowledge/skills to apply to conducting and explaining experiments associated with practice</td>
<td>The necessary chemical knowledge/skills to apply to conducting and explaining experiments associated with practice have not been oriented or incorrectly oriented.</td>
</tr>
<tr>
<td>4. Recognizing and understanding chemical knowledge/skills in experiments associated with practice are applied to which fields and issues in practical life</td>
<td>Chemical knowledge/skills in experiments applied to different fields have been recognized but not been understood.</td>
</tr>
<tr>
<td>5. Recognizing the practical issues related to chemistry</td>
<td>Chemical knowledge related to practical issues have been recognized but not figured out.</td>
</tr>
<tr>
<td>6. Using chemical and interdisciplinary knowledge to explain natural phenomena and chemistry applications in life</td>
<td>Chemical knowledge has been used to explain the phenomena and applications of chemistry in practical life but irrelevantly.</td>
</tr>
<tr>
<td>7. The initiative and creativity in choosing and proposing methods, means of conducting and applying experiments associated with practice.</td>
<td>The initiative and creativity in choosing, proposing and conducting experiments associated with practice have not been shown.</td>
</tr>
</tbody>
</table>
b. Use experiments associated with practice in practice and review lesson

The practice and review lessons are not only to reinforce the learned knowledge but also apply what learned to solve practical and learning problems. Practical chemistry experiments can be used to illustrate, inculcate and expand learned knowledge. Thus, students will easily recognize the relationship between knowledge in a particular section.

Example: When teaching the practice lesson: “Carbon and carbon compounds”, to help students understand more and memorize the mathematical module “CO2 reacts with alkaline solutions” and expand the application of CO2, teacher has students conduct the experiment “fresh lime solution reacts with 7up soft drink”

7up is a transparent carbonated soft drink with a cool lemon flavor. Pour slowly to excess 7up beverage into a glass of fresh lime solution. Students observe and answer the following questions:

Question 1: What happens when the 7up is slowly added to fresh lime solution?

Answer: When you put 7up in fresh lime solution, at first there was white cloudy, then the solution turned transparent again.

Question 2: From the above experiment, point out the chemical substance in 7up soft drink (substance A).

Answer: (Students observe the experiment and apply knowledge of the chemical properties of carbon dioxide reacting with alkaline solutions and the application of carbon dioxide to predict the substance in 7up soft drink to cause the experimental phenomenon)

7up soft drink contains CO2 gas

Question 3: Write chemical equations of the reaction. From the experimental phenomenon, give comment about the change of the amount of precipitate according to the amount of A gas into the fresh lime solution

Answer: (Students apply knowledge of the chemical properties of carbon dioxide reacting with alkaline solutions and chemical properties of carbonate salts to answer)

When pouring 7up soft drink into fresh lime solution, firstly the solution was cloudy because:

$$\text{CO}_2 + \text{Ca(OH)}_2 \rightarrow \text{CaCO}_3 \downarrow \text{white} + \text{H}_2\text{O}$$

When keeping adding 7up soft drink to excess:

$$\text{CO}_2 + \text{CaCO}_3 + \text{H}_2\text{O} \rightarrow \text{Ca(HCO}_3)_2$$

Through this experiment, teacher gives clues to analyze the phenomenon:

- What happened when lacking of CO2? What salt was produced?
- What happened when excessing of CO2? What salt was produced?

The above experiment help students develop and practice the capability to: systemize knowledge of reaction of CO2 and alkaline solutions, recognize and understand the application of CO2 in the production of carbonated beverage.

c. Use experiments associated with practice in practice lessons, extracurricular, learning projects

The theory testing experiments were suitable to organize in practice lessons. Teacher encourages students to choose experiments associated with practice to promote their ability to relate to reality, apply knowledge to detect and solve problems in practice.

Example 1: In the exercise "Properties of oxygen and sulfur", when performing experiments to verify the oxidation properties of oxygen monomer and the reduction properties of sulfur monomer instead of using modified oxygen cylinders that teacher prepared, teacher should encourage students to “Prepare oxygen from hydrogen peroxide” in combination with testing the properties of newly generated oxygen.

With simple experiments in the practice lessons, students can propose experimental improvements using
substances in daily life to replace the chemical substances in the laboratory while ensuring safety and success.

Through this experiment, students develop the capability to learn the experiment and clarify the nature, how to conduct the experiment associated with practice, which is shown in substances selection, the order of the conduction so that oxygen is generated without any loss and can test the properties immediately. General orientation of necessary chemical knowledge/ skills to be applied to conduct and explain the experiments associated with practice: apply knowledge of the composition of hydrogen peroxide containing hydrogen peroxide is oxygen rich and unstable for simple preparation; orienting the knowledge of oxygen-burning sustaining properties to manipulate oxygen-generated awareness, combining the application of knowledge of oxygen-oxidizing properties and reducing properties of sulfur monomers to conduct experiments. In addition, students can also detect practical problems related to learning and use chemical and interdisciplinary knowledge to: explain why hydrogen peroxide is used for wound bleaching in medical applications.

Example 2: With the project “Mini fire extinguisher” or “Water filter”, students apply chemical knowledge of the adsorption properties of carbon (activated carbon), the properties of not maintaining burning of carbon dioxide, the preparation of carbon dioxide, the chemical properties of carbonate salts in the topic “carbon and compounds” to make these objects from familiar materials in life. From that, not only develop students' ability to discover chemical knowledge contents applied in various fields such as health, fire prevention..., but also develop independent creativity in choosing the design and construction plan of water purifications, mini fire extinguishers from familiar items to ensure successful, effective and aesthetic implementation.

Example 3: Teacher can use the following practical situations to evaluate the capability to systematize knowledge, classify chemical knowledge appropriately to solve practical problems.

Due to carelessness, mother of A mistakenly confuses 3 packages of unlabeled powder that contain separate white flour: baking soda, rice flour and ground sugar. With chemical knowledge, A helped her to distinguish the above 3 powder packages as follows:

- First, A dissolves a small amount of powder from the above packages in turn into water. A saw that package number 1 and package 3 were completely dissolved, and package 2 did not dissolve.
- Next, A dissolves a small amount of powder from pack 1 and pack 3, respectively, into vinegar. A sees air bubbles from the powder of pack 3.

From the proceedings of A, answer the following questions:

Question 1: What is the chemical formula of baking soda? (Students apply the knowledge of application of carbonate salt)
A. NaCl.  
B. CaCO₃.  
C. Na₂SO₃.  
D. NaHCO₃.

**Question 2:** What is the gas released from the small amount of flour package 3? *(Students apply the knowledge about the properties of carbonate salt reacting with acid solution)*

A. CO₂.  
B. O₂.  
C. SO₂.  
D. NH₃.

**Question 3:** Which is the correct conclusion for the phenomenon that A conducted?

A. The white flour in package 1 is baking soda  
B. The white flour in package 2 is ground sugar  
C. The white flour in package 3 is baking soda  
D. The white flour in package 3 is rice flour

### 2.5. Results of Pedagogical Experiment

Pedagogical experiment was conducted in the school year 2019 - 2020 at Buon Don High School and Hoang Viet Primary, Secondary and High School in Dak Lak province in 4 classes with 122 students through the topics: “Oxygen” and “Flourine - Bromine - Iodine” (Grade 10); “Ammonia and ammonium salts” and “Carbon and carbon compounds - chemicals in fire and explosion prevention” (Grade 11). The teaching plan is designed using the methods of developing the capability to apply chemical knowledge through practical experimental system, combined with active teaching methods, using capacity test sheets, self-assessment sheets of developing students' capability to apply chemical knowledge. To evaluate the learning results of students through the test results processed by mathematical statistics methods (Table 3).

Analyzing the observation checklist: the students’ capability to apply knowledge after the impact is better than before the impact shown in the percentage of students meeting expectations and good achievement in each indicator criteria of students after the impact is always higher than before the impact and at a lower level of failure. Details as follows:

- Learning experiments and clarifying the nature, how to conduct experiments associated with practice: 22.13% of students have good performance and 12.30% of students are unqualified after impact while 9.84% and 38.52% respectively before impact
- Systemizing and classifying relevant chemical knowledge when conducting and explaining experiments associated with practice: 29.51% of students have good performance and 9.84% of students are unqualified after impact while 14.75% and 28.69% respectively before impact.
- Recognizing and understanding chemical knowledge/skills in experiments associated with practice are applied to which fields and issues in practical life: 24.59% of students have good performance and 9.02% of students are unqualified after impact while 11.48% and 26.22% respectively before impact.
- The initiative and creativity in choosing and proposing methods, means of conducting and applying experiments associated with practice: 18.04% of students have good performance and only 13.11% of students are unqualified after impact, which decreases a lot compared with 40.16% before impact.
- The results are similar when considering other criteria of students’ capability to apply knowledge from the data obtained (see in Table 3).

Thereby, it is confirmed that the methods of using experiments associated with practice of the Non-metallic section in High School Chemistry program that we proposed have developed the functional skills for students and have better learning quality.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>BEFORE IMPACT</th>
<th>AFTER IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Learning experiments and clarifying the nature, how to conduct experiments associated with practice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unqualified</td>
<td>47</td>
<td>38.52%</td>
</tr>
<tr>
<td>Meet expectations</td>
<td>63</td>
<td>51.64%</td>
</tr>
<tr>
<td>Good</td>
<td>12</td>
<td>9.84%</td>
</tr>
<tr>
<td>2. Systemizing and classifying relevant chemical knowledge when conducting and explaining experiments associated with practice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unqualified</td>
<td>35</td>
<td>28.69%</td>
</tr>
<tr>
<td>Meet expectations</td>
<td>69</td>
<td>56.56%</td>
</tr>
<tr>
<td>Good</td>
<td>18</td>
<td>14.75%</td>
</tr>
<tr>
<td>3. Generally orienting the necessary chemical knowledge/skills to apply to conducting and explaining experiments associated with practice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unqualified</td>
<td>40</td>
<td>32.78%</td>
</tr>
<tr>
<td>Meet expectations</td>
<td>69</td>
<td>56.56%</td>
</tr>
<tr>
<td>Good</td>
<td>13</td>
<td>10.66%</td>
</tr>
<tr>
<td>4. Recognizing and understanding chemical knowledge/skills in experiments associated with practice are applied to which fields and issues in practical life</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unqualified</td>
<td>32</td>
<td>32.22%</td>
</tr>
<tr>
<td>Meet expectations</td>
<td>76</td>
<td>62.30%</td>
</tr>
<tr>
<td>Good</td>
<td>14</td>
<td>11.48%</td>
</tr>
<tr>
<td>5. Recognizing the practical issues related to chemistry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unqualified</td>
<td>36</td>
<td>29.51%</td>
</tr>
<tr>
<td>Meet expectations</td>
<td>74</td>
<td>60.65%</td>
</tr>
<tr>
<td>Good</td>
<td>12</td>
<td>9.84%</td>
</tr>
<tr>
<td>6. Using chemical and interdisciplinary knowledge to explain natural phenomena and chemistry applications in life</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unqualified</td>
<td>30</td>
<td>24.59%</td>
</tr>
<tr>
<td>Meet expectations</td>
<td>77</td>
<td>63.11%</td>
</tr>
<tr>
<td>Good</td>
<td>15</td>
<td>12.30%</td>
</tr>
<tr>
<td>7. The initiative and creativity in choosing and proposing methods, means of conducting and applying experiments associated with practice.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unqualified</td>
<td>49</td>
<td>40.16%</td>
</tr>
<tr>
<td>Meet expectations</td>
<td>63</td>
<td>51.64%</td>
</tr>
<tr>
<td>Good</td>
<td>10</td>
<td>8.20%</td>
</tr>
</tbody>
</table>
3. Conclusion

Based on the theoretical basis of the capability to apply chemical knowledge and experiments associated with practice, we have built a number of experiments associated with practice of the Non-Metallic Chemistry section in high school, proposed some methods to use these experiments in teaching to develop capability to apply knowledge for students and conduct pedagogical experiment.

Experimental results on capability to apply chemical knowledge before the impact and after the impact have clearly changed showing that the proposed measures are feasible. Chemical experiments associated with practice not only create excitement, increase students’ positivity and creativity, but also help students see the close relationship between learned knowledge and practical life, contribute to improving quality of teaching Chemistry. This research result can be considered as a scientific proof of the use of chemical experiments associated with practice to develop the capability to apply knowledge for students and is a motivation for high school teachers to boldly apply the method into teaching chemistry in particular and teaching in general to meet the current educational trend.

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