MINISTRY OF EDUCATION AND TRAINING
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DEVELOPING INDEPENDENT CREATIVITY COMPETENCY FOR STUDENTS OF TECHNICAL UNIVERSITIES THROUGH TEACHING ORGANIC CHEMISTRY

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SUMMARY OF EDUCATIONAL SCIENCE DOCTOR THESIS

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INTRODUCTION

1. Reasons to select the subject

Our country is now under the progress of international economic integration to improce the competitiveness of the economy. This requires higher education to strongly transform so as to enhance the training quality and supply the economy with adequately competent and qualified human resource in the operation of all economic fields. It also means that universities have to transform themselves step by step to become destinations that develop necessary abilities for learners, help them to act creatively yet independently, able to study, search and solve information on their own, become knowledgable workers that meet the demand of society, adapt to the ever-changing living environment and confidently join the global integration.

Political report of the Party at XI Congress has clearly stated: " The essential and comprehensive innovation of education and training... Program, content, teaching method, testing method innovation....enhance comprehensive education quality, especially attach importance to perception education,...,morality, lifestyle, creative ability, practice skill, industrial manner, social responsibiliy". Hereby, enhancing education and training quality in general; and higher educaton in particular, is an imperative issue and the most important solution for our education to keep pace with the world's science development and meet the requirements of international economic integration in the beginning of 21st century.

In Vietnam 's Education Law, the objective of higher education noted that : "The objective of higher education is to train learners into citizens who own political quality, morality, the awareness to serve people, the knowledge and professional ability that are equal to training level, the well-being to build and protect their nation..."

In the current times, when the perception of human reaches a higher level, the thinking ability is no longer holds its original meaning but also needs to become the ability to take action. It is because that people do not only think to grasp conceptions about the world, but also create in order to change it and make it a better place. The importance of creativity is still on the rise annually in every section of society as a response from the world life and the exciting business environment. The creativity is encouraged anywhere and anytime. Business brands seek for new product upgrade and highly creative marketing campaigns. Scientists seek for creative methods to carry out technical solutions. Meanwhile, communities and familes are in search of creative methods that create a higher living standard.

Application of positive teaching methods in Chemistry with the use of teaching equipments plays a significant role to develop the independence and creativeness of students.

Chemistry is a subject that belongs to natural science, playing an important role in implementing higher education objectives. Among those objectives are developing students's ability, helping students build up ability

to work independently and creatively as well as resolve issues of majors that they were trained for. The organic chemistry program in technical universities has many applicable contents for positive teaching method to effectively develop independence and creativity.

The actual testing result showed that the application of positive teaching method in organic chemistry still had limitation. Normally, teachers only used presentation skill as a main way. Students just only listen and take note. That was the reason why this approach has not brought on the activeness of students. A small number of teachers have applied positive teaching method but haven't aimed at developing independent creativity competency for students.

Therefore, the topic " Developing the indepedence in creativity for students in technical universities through teaching organic chemistry" holds a high necessity in terms of both theoretical and practical aspects, contributing to the enhancement of higher education quality.

2. Objective of research

Study several solutions that apply positive teaching method in organic chemistry to develop indepence of creativity for students, contributing to the enhancement of chemistry teaching quality in particular and of training quality in technical university in general.

3. Tasks of research

3.1. Study the theoretical and pratical basis of developing independent creativity competency for students of technical universities.

3.2. Recommend orientation, principles and various method to develop independent creativity competency for students of technical universities.

3.3. Carry out pedagogy experiments to assess the effeciency and feasibility of recommended methods.

4. Object and target of research

4.1. Research objects: Teaching progress of organic chemistry in technical universities

4.2. Research target: Methods that aim to develop independent creativity competency for students through organic chemistry teaching in techical universtiy , contributing to the enhancement of higher education quality.

5. Scientific hypothesis

The indepence of creativity in students of technical universitie can be developed if we can effectively apply several principal positive teaching methods like: contract based teaching method, project based teaching method, Spickler teaching method, in connection with other appropriate teaching methods with support from teaching equipment (computers, videos, chemical tool, cameras...) in teaching organic chemistry.

6. Method for research

6.1. Scope of research

Develop the independent creativity competency for student in chemistry and medical major of technical universities through teaching organic chemistry.

6.2. Method

- Theoretical research:

+ Relevant issues of independent creativity competency and developing independence in creativity.

+ Some positive teaching methods and using teaching equipment positively

-Practical research:

+ Inspect the reality of using positive teaching methods in teaching organic chemistry in technical universities (chemistry and medical majors)

+ Organic chemistry program in technical universities (chemistry and medical majors)

+ Pedagogy experiments on recommended solutions to develop independent creativity competency

- Mathematical statistic method to solve the results of Pedagogy experiments.

7. New contributions of thesis

Had contributions in terms of theoretical and practical aspects as follows:

- Systemized and clarified several theoretical issues which serve as basis to develop independent creativity competency: conceptions of ability, creativities, creative thinking, independence, independent creativity competency of students, signs for independence of creativity, and ways to check the competence of students, some positive teaching methods that helps like on-contract teaching method, on-project teaching method, Spickler teaching method, mind map technique, using teaching equipments positively.

- Inspected and clarified the reality of using positive teaching methods as well as developing independent creativity competency in a number of technical universities. Compared the content of organic chemistry in technical universities with that in high schools to identify the alikeness and difference in level of content among schools, clarified the attributes of students in technical universities

- Had new recommendations on developing independent creativity competency for student in technical universities: Identify some signs for independent creativity competency in students of technical universities, design the tool kit to assess ability of independent creativity for students in technical universities, propose orientation and principles to develop independent creativity competency for students in technical universities, propose 4 measures to develop independent creativity competency for students in technical universities through teaching organic chemistry :

Measure 1: Use contract based teaching method

Measure 2: Use project based teaching method

Measure 3: Use Spickler chemical practice method

Measure 4: Use mind map technique

- Select contents and design illustrative lesson plans for above measures. Results of Pedagogy experiments proved that application of measure to develop independent creativity competency for student in technical universities is feasible and effective.

8. Structure of thesis

Apart from introduction, conclusion, reference document and appendix, the content of thesis include 3 chapters:

Chapter 1: The theoretical basis and practical basis of developing independent creativity competency for student in technical universities (47 pages)

Chapter 2: Some measures to develop independent creativity competency for student in technical universities through teaching organic chemistry (74 pages)

Chương 3: Pedagogy experiments (35 pages)

CHAPTER 1
THEORETICAL AND PRACTICAL BASIS FOR DEVELOPMENT OF INDEPENDENT CREATIVITY COMPETENCY FOR STUDENTS OF TECHNICAL UNIVERSITIES

1.1. Conceptions of competency, professional competency, creativity, creative thinking, independence

1.1.1. Competency and professional competency

The conception of competency takes root from Latin word " competentia". Nowadays, this conception is understood in different ways.

Competency is a combination of knowledge, skills and attitudes which conform to a practical activity. Competencies are skills and techniques that obtained or already owned by an individual to resolve certain situations, as well as the readiness about social motivation …and the ability to apply problem-solving ways in a responsible and effective manner in flexible situations.

In this thesis, we agree on the viewpoint: ***" Competency is the ability to take effective and responsible actions, resolve tasks and issues that belong to professions, society or individual in different situations on a basis of comprehension, skills, techniques and experiences.***

Professional competency is the compatibility between human's psychological and biological characteristics and requirements of profession. The profession competency is not an innate quality. It takes shape and develops through learning and working activities. In the working progress, the competency continues completing. Learning and working unceasingly is the way to develop professional competency.

1.1.2. Creativity

There are various conceptions of creativity but it is visible to see that although they are stated from different angles, the common point shows that **"creativity is a progress of inventing ideas, solutions, new conceptions which are unique, useful and appropriate with the situation"**

1.1.3. Creative thinking

1.3.1.1. Conception of creative thinking

There are many conceptions of creative thinking from different angles but the common point of authors emphasized the role of independent thinking in proposing new conceptions and new effective solutions.

In this thesis, we hold a view that**: Creative thinking is the unconventional perception progress that offers new viewpoints, new methods for action which are highly effective in solving learning issues and practical issues in order to achieve targeted objective.**

1.3.1.2. Characteristics and signs of creative thinking

1.2. The competency of independent creativity of students

1.2.1. Conception

The creativity progress of human normally starts with a new idea, from the creative thinking of human. According to psychologists, the competency of independent creativity is displayed most clearly in the ability of creative thinking; it is the ultimate achievement among human's intellectual activities.

1.2.2. Attributes of people who own competency of independent creativity

1.2.3. Signs of independent creativity competency

Consolidation of researching result about signs of independent creativity competency of some authors:

Author Nguyen Thi Hong Gam has given out some sign of creativity competency of Pedagogy students through Teaching Theory and Inorganic chemistry at Pedagogy College:

- Propose new and simpler solutions for a familiar issue.
- Plan and follow plans to achieve results with certain works and tasks.
- Develop ideas from one issues, propose various solutions.
- Apply obtained skills and knowledge to propose solutions to settle issues in reality.
- Add up, redesign experimental model, teaching equipments into better ones.
- Make use of existing things in reality to make new things with good result conforming strictly with requirements.
- Find out, analyse, propose hypothesis and properly assess issues.
- Propose and implement unconventional approach.

Author Tran Thi Thu Hue proposed various signs of creativity competency of high school students through teaching inorganic chemistry:

- Find out problems, seek for solutions
- Plan and implement plan to achieve result
- Propose swift and effective solutions
- Propose one's own solution

- Be able to propose different solutions
- Be able to collect and process information, report the result of an issues that need studying
- Be able to improve old method
- Be able to predict result, check and conclude.
- Create new products, new ideas
- Be able to do self-evaluation and evaluate the result, other products and propose ways to complete.

1.2.4. Assess competency

1.2.4.1. Why to assess competency

1.2.4.2. Some form of competency assessment

Evaluating through observation, through learning profile or seminar, through product (research exercise), through examination, through process review and peer evaluation.

1.3. Some internal and foreign results of competency-related research

There has not been any systematic research about developing independent creativity competency for students through using positive teaching method and teaching equipments in organic chemistry in chemistry and medical majors of technical universities.

1.4. Some positive teaching methods that can be applied for organic chemistry teaching in technical universities.

1.4.1. Orientation for innovation of teaching method in higher education

Currently, innovation of teaching method is receiving much concern from Education field. Especially, in the trend of international integration, training human resource to meet the society's need is a burdensome task for education field in general and for all universities in particular.

The Resolution No.14/2005/NQ-CP of the Government issued on 02/11/2005" Toward the basic and comprehensive innovation ò Vietnam higher education in the period 2006-2010" has clarified: *"Implement innovation of teaching method basing on 3 criteria: equip way of learning, encourage the activeness of learners, use information technology and multimedia in teaching and learning Exploit open education data source and Internet data source. Select and use advanced programs and textbooks of other countries".*

In order to transform teaching method in higher education, we first have to make changes in program content, teaching method, learning method according to training objective in university. Renovate assessment according to the training objective of each subject. Besides, we need to organization research work for teacher to innovate teaching and learning method, improve management. Among those, it is truly important to foster the awareness and knowledge of teaching method in higher education.

1.4.2. Typical signs of positive methods

There are four typical signs that tell apart positive methods from passive ones:

- Teaching through organizing learning activities of students
- Teaching with importance attached to training self-study method
- Strengthen individual learning in connection with group learning
- Combine teacher's evaluation with self-evaluation of students

1.4.3. Some positive teaching methods/ techniques to apply in universities

1.4.3.1. Seminar method

1.4.3.2. Project Based Learning

1.4.3.3. Contract Based Learning

1.4.3.4. Spickler practical Teaching

1.4.3.5. Mind Map Techniques

1.5. Use teaching equipments to teach chemistry positively

1.5.1. Teaching methods are sources to supply knowledge

1.5.2. Use chemical experiments in positive teaching

1.6. Use chemical exercises under positive teaching approach.

1.7. The actual state of teaching Organic chemistry in some technical universities

1.7.1. Survey the actual state of applying positive teaching methods.

We build up the questionnaire and interviewed 32 teachers who lecture organic chemistry in technical universities: Hanoi Industry University, Viet Tri Industry University, HCMC Industry University, Vietnam Traditional Medicine Academy, Military Medical Academy, University of Vinh-Medical major. We also surveyed 758 students from technical universities.

Result of surveying the actual state of teaching and learning showed that:

Problems encountered by teachers when applying positive teaching methods: many teacher have not been fostered on positive teaching methods so applying via reading documents still holds limitation, has not brought into play the strong points of these methods. Currently, teachers only know how to apply for general innovation of teaching method. Meanwhile, the aspect of developing independent creativity competency is still not well-received.

Teachers still mainly count on presentation method and instruct student to read documents. This method makes student become passive and discourage the awareness to be initiative, positive and creative of students. For that reason, many students felt no interest in studying.

1.7.2. Organic chemistry program in technical universities

1.7.2.1. Content of Organic chemistry program in chemistry major of technical universities

1.7.2.2. Content of Organic chemistry program in medical major of technical universities

1.7.3. Attributes of students in technical universities

Students in technical universities all have quite good chemistry knowledge as chemistry including organic chemistry is one of the three subjects for the university entrance examination of Set A and Set B. Therefore, this is a

favorable condition to develop the independent creativity competency for students in teaching organic chemistry in technical universities.

After 12 years in secondary education, the thinking of technical students has been developed especially logical thinking, conceptual thinking, and higher level of independent working ability.

In technical universities, students have had clear objective and motivation for learning to become engineers or doctors, pharmacists. This is the progress to train profession so students have to innovate learning method to become high performing workers who own excellent professional competency to meet the demand of society.

CONCLUSION FOR CHAPTER 1

In chapter 1, we have studied the theoretical and practical basis of this thesis, including following main contents:

Systemized and clarified some theoretical issues related to development of independent creativity competency of students in technical universities: competency- professional competency, creativity, creative thinking, independence, independent creativity competency. Signs of independent creativity competency and ways of assessment. Some positive teaching methods that can be applied to develop independent creativity competency of students. Carry out studying the content of organic chemistry program in chemistry and medical major of technical universities.

- Surveyed the actual state of using positive teaching methods in teaching organic chemistry in technical universities.
- Studied the psychological- biological attribute, the ability to learn chemistry of students in technical universities. It is the theoretical and practical basis serving as scientific basis to propose measure of developing independent creativity competency for students in teaching organic chemistry in technical universities.

CHAPTER 2
SOME MEASURES TO DEVELOP INDEPENDENT CREATIVITY COMPETENCY FOR STUDENTS IN TECHNICAL UNIVERSITIES THROUGH TEACHING ORGANIC CHEMISTRY

2.1. Signs of independent competencies of students in technical universities

In order to develop and evaluate independent creativity competency, it is necessary to identify certain signs.

After studying the conception of independent creativity competency and with the start from actual state of teaching, we identified some signs of independent creativity competency. They are:

1- Be able to propose, select and use the resource, teaching equipments and time in an independent and effective manner, able to create new products.

2- Individual or student group propose their own solutions.

3- Be able to propose new ideas and approaches in learning activities

4- Be able to plan and implement assigned task in a scientific way.

5- Be able to propose various solutions to implement a task, sensible to select in accordance with factual conditions.

6- Be able to evaluate and self-evaluate the result of team working and individual working, be able to debate, refute and defend individual ideas or collective ideas.

7- Be able to propose question for researching an issue.

8- Be able to propose experiments to prove hypothesis, answer to the researching questions,….

9- Be able to predict, examine and conclude mentioned issues

Fact show that not every activity of independent creatitivity has all above signs, maybe just has some of those.

2.2. Design tool kit to evaluate the independent creativity competency of students in technical university through teaching organic chemistry

2.2.1. Requirements for the tool kit to evaluate competency

2.2.2. Design the detail evaluation tool kit

2.2.2.1. Design observation table

2.2.2.2. Design questionnaire

2.2.2.3. Design Product evaluation paper of student

2.2.2.4. Design organic chemistry questions and exercises to evaluate the independent creativity competency of students

Some types of exercise to evaluate the independent creativity competency of students:

Type 1: Propose different solution

Type 2: List out options and select possible option in a certain situation

Type 3: Propose group's choice of their own

Type 4: Calculate to identify molecular formula, write out possible structural formula and predict the basic property of every correspondent substance

Type 5: Propose implementation process and select the best option

Type 6: Design mind map

Type 7: Propose researching questions

Type 8: **Propose experiments to examine and make conclusion about the property of a certain organic compound**

2.3. Orientation and principle to propose measures of developing independent creativeness competency for students in technical universities through teaching organic chemistry

2.3.1. Orientation of developing independent creativeness competency

2.3.1.1. Create conditions for students to make plan and implement plan in accordance with individual and group conditions

2.3.1.2. Design diversified exercises/ tasks (required exercises/taks and optional exercises/ tasks, open exercises and closed exercises, exercises with or without support) to create conditions for students to do exercise or task in accordance with ability, speed and level

2.3.1.3. Create situation for students to propose different solutions to gain a better result

2.3.1.4. Create conditions that encourage students to make diversified products through self-made activities.

2.3.2. Pricipcles of proposing measures

Pricipcle1:. Meet the training objective of technical universities

Pricipcle2: Set a favorable environment for students to freely make creations, dare to think, dare to do and dare to propose.

Pricipcle 3: Make sure of suitability

Pricipcle 4: Make sure of feasibility

Pricipcle 5: Make sure of efficiency

2.3.3. Design lesson plans with a view of developing independent creativity competency

2.3.3.1. Select teaching content and method

Organic chemistry program in technical university is quite complicated, especially the experimental aspect, which requires rigorous conditions for experiment process and safety from toxification and combustion. Hereby, it is not easy to select suitable content for teaching methods.

The chosen teaching methods are: Contract based teaching method, Project Based teaching method, Spickler teaching method, Mind map method.

2.3.3.2. Process of designing lesson plan to develop independent creativity competency

Step1: Identify objective, select content

Step 2: Select the main teaching method

Step 3: Preparation of teachers and students

Step 4: Designing activities to develop independent creativity competency

Step 5: Evaluate independent creativity competency of students

2.4. Propose some measures of developing independent creativeness competency for students in technical universities through teaching organic chemistry

2.4.1. Measure 1: Using Contract Based teaching method

2.4.1.1. Objective

- Develop independent creativity competency for students through required and optional tasks, open and closed tasks, tasks with and without support.

2.4.1.2. Implementation Process

Step 1: Select content

Step 2: Design lesson plan with application of contract based teaching method

Step 3: Organize teaching with contract based teaching method

Step 4: Evaluate independent creativeness competency of students

2.4.1.3. Some illustrative lesson plans

LESSON PLAN 2: ANCOL-PHENOL-ETE

A. Objective

1. Knowledge

To understand:

Structure, reaction mechanism, preparation and application of ancol, phenol, ete. Terminology isomers of ancol, phenol, ete. Mechanism of uncoupling reactions. Basic property, practical application of ancol etylic, phenol, dimetyl ete in the ingredients of some medicines.

2. Skill

Be able to develop individiual ideas on ancol-phenol-ete. Be able to address, write structural formulas of isomers, write chemical equation, infer property from structrure... Contract based learning skill: Select and implement task. Team-working skill

3. Independent creativity competency

Independently select task, time, support level in accordance with speed, level and ability. Collect information from various sources and process information to draw out conclustion. Independently propose questions to implement 1 task/exercise. Independently propose experiment to demonstrate chemical property of a certain agent. Base on structural formula to infer basic property, propose examining experiment.

B. Preparation

1. Teaching equipments

2. Method

- The main method is contract based teaching method
- Coordinated methods: Cooperative method, problem-solving method, seminar, mind map technique, use equipments, chemical exercises.

C. Teaching and learning activities

Activity 1: Research and sign the contract (45 minutes)

Activities of teacher	Activities of students
- Teacher states the lesson's objective, the main learning method introduces contract content, emphasizes tasks and hand out contract to students	- Students research carefully the contract content to understand tasks in contract. -. Observe, follow and note the content of each task. - Contract includes 6 tasks, 3 of which are required (basic knowledge) and the 3 other ones are optional (extended and advanced knowledge)

	Students work in groups - Students discuss unclear things in contract - Select tasks and sign the contract.

Activities 2: Execute contract (6 days apart from class time)

Activities of teacher	Activities of students
- Teacher organizes contract execution for student outside the class: library, lab to complete the task in contract - Teacher needs to follow and instruct students timely when they encounter difficulties	- Student can implement tasks without order of time - Groups implement task according to plan - Group leaders divides task for students to execute independently, receive support from teacher when needed. - After completing individual task, students organize group activity to finish the group task.

Activity 3: Report the result of contract (60 minutes)

Activities of teacher	Activities of students
- 15 minutes before finishing tasks, teacher inform groups to swiftly finish the contract	- Groups consolidate products into a report - The group representative report the result with above products - Students give comments, discuss, refute and defend ideas.

Activity 4: Evaluate independent creativity competency (30 minute)

Activities of teacher	Activities of students
- Teacher comments on independent creativity competency of each group through the contract product	- Students carry out self-evaluation and mutual evaluation
- Give out organic chemistry test	- Take the test
- Teacher hand out questionnaire to students	- Students fill in the questionnaire

2.4.2. Measure 2: Use Project based teaching method

2.4.2.1. Objective

- Project based teaching method has helped students develop independent creativity competency, ability to find out and solve problems, mixed problems, stimulate further thinking when encountering different problems through developing ideas, making plans, executing plans, reporting result of project

2.4.2.2. Implementation Process

Step 1: Preparation

Step 2: Select the subject and make plan

Step 3: Execute the plan

Step 4: Report the result

Step 5: Evaluate independent creativity competency of students

2.4.2.3. Some illustrative lesson plans

LESSON PLAN 5: CARBOHYDRATE IN NATURE

A. Objective

1. Knowledge

To understand:

Project based teaching method. Categorize carbohydrate, the correspondent structural formula for every type. Physical, chemical property, production and application of carbohydrate.

2. Skill

Project based learning method: skill for collecting and processing information, skill for group discussion

3. Independent Creativity Competency

Be able to make and execute plan, implement assigned tasks in a scientific manner. Be able to use resources, learning equipments, time independently and effectively, create project's products. Individuals or student groups propose their own solution. Know how to make selection in accordance with factual conditions. Be able to evaluate and self-evaluate project result of individual or group. Be able to dispute, refute and defend ideas of individual or group.

B. Preparation

1. Teaching equipments

2. Method

- The main method is project based teaching method
- Coordinated methods: Method of realizing and solving problems, method of group cooperation, mind map technique, seminar, use equipment , chemical exercises.

C. Teaching and learning activities

Activity1: Planning project (45 minutes)

Activities of teacher	Activities of students
- Teacher selects common topic: carbohydrate - Teacher requires students to discuss and study about sub-topics. - Teacher can give suggestion so students can develop ideas. - Teacher requires groups to set up mind map to develop ideas about topic, make plan for implementation - Follow up and make comments on making detailed plan. Give suggestions about information searching for students. - Remark and complete. - Save the implementation plans of group.	- Sstudents select sub-topics. - Make groups, select the Group leader, secretary. - Sstudent propose their own ideas. - Discuss and make the final choice of sub-topics need researching, divide group for every topic: Topic 1: Study about monosaccarit in nature. Topic 2: Study about disaccarit in nature. Topic3: Study about polysaccarit in nature. - Groups discuss together, make mind map to develop ideas related to sub-topic. Topic1: Group 1 Topic2: Group 2 Topic3: Group 3 - Make plan to execute the project (content, time, how to take information, product). Group leader divides tasks for each member. - Groups report implementation plan and assign tasks of each group with different ways. - Complete in accordance with comments from teacher.

Activity 2: Execute project plan

(Execute within 6 days apart from class time)

Activities of teacher	Activities of students
- Teacher frequently stay informed of groups‘s update. - Give support for survey paper or questionnaire. - Maintain the high spirit of groups. Instruct selecting and analyzing data.	- Student groups implement the plan in accordance with task division. - Get in touch with teacher when in need of consultancy or support. - Heads of groups report the progress of implementation to teacher. - Groups consolidate result and prepare report.

Activity3: Report the result (60 minutes)

Activities of teacher	Activities of students
- Monitor and organize reporting session for students, 10 to 15 minutes for each group.	- Group representative report project result in different ways. Other groups listen, discuss and debate. - Students can propose questions about the topic studied. - Teacher can accordingly support by posing additional questions, finding out debatable issues and being an arbitrator when students discuss. - Secretary summarize comments

Activity4: Evaluate independent creativity competency of students (30 minutes)

Activities of teacher	Activities of students
- Teacher evaluates independent creativity competency of each group through project's product. - Give out the test. - Give out questionnaire. - Give out project self-evaluation paper.	- Students take the test. - Students complete questionnaire and project self-evaluation paper.

2.4.3. Measure 3: Use Spickler chemical practice teaching method

2.4.3.1. Objective

Develop independent creativity competency for students through proposing and selecting a way to carry out experiment

2.4.3.2. Implementation process

Step 1: Select content to practice

Step 2: Students propose and select experiments

Step 3: Students carry out experiments

Step 4: Demonstrate hypothesis and draw out conclusion

Step 5: Evaluate independent creativity competency of students

2.4.3.3. Some illustrative lesson plans

LESSON PLAN 7

PRACTICE EXTRACTING RUTILE FROM SHOPHORA JAPONICA

A. Objective

1. Knowledge

To understand:

Spickler chemical practice method, method of splitting and extracting organic compound.

2. Skill

Skill for finding and exploring. Have the skill to split, extract rutile from sophora japonica which ensures precision, safety of people and equipments. Have the skill to select tools, chemicals, to analyse and report result….

3. Independent Creativity Competency

Independently propose different experiments to extract rutile. Select experiments suitable for factual conditions to create products. Use suitable equipments, chemical tools to ensure the effect of experiments. Independently write report and explain by one's own way. Independently evaluate individual work and carry out mutual evaluation.

B. Preparation

1. Teaching equipments

2. Methods

- The main teaching method is Spickler chemical practice method
- Coordinated methods: Cooperative teaching method, method for realizing and solving problem, seminar, use equipments, chemical exercise, experiments.

C. Teaching and learning activities

Activity1: Student groups propose and select experiments (40 minutes)

Activities of teacher	Activities of students
- Nêu nhiệm vụ của buổi thực hành. State the objective of the practice session - Organize discussion section for students, propose possible solutions and select highly effective ways to extract rutile from sophora japonica Teacher consolidates proposals of students	Student groups take up the task and carry out discussion - Student groups discuss, propose methods to extract rutile from sophora japonica (students can consult books, textbooks, internet before practice session): Method 1: extract with hot water Method 2: extract with alkali fluid Method 3: extract with alcohol **Note:** Student groups have to propose methods that match the facility condition, to carry out and analyse figures. - Student groups select method to extract rutile for their own group. - Group representative give presentation for the proposal in front of the class

Activity2: Student groups carry out experiments (80 minutes)

Activities of teacher	Activities of students
- Teacher monitors and helps students when needed.	- Student groups independently design process and carry out experiments, collect figures, analyse figure, consolidate result.

	- **Note**: Students can propose different ways to analyse figures according to varied conditions of each university. Can use high performance liquid chromatography to analyse figures. If conditions do not allow, can use simple ways. For examples: look into the colour of water to affirm the concentration of rutile (high, medium, or low level). Yellow shows medium level of rutile concentration, dark yellow shows high level of rutile concentration.

Activity3: Verify the result (30 minutes)

Activities of teacher	Activities of students
- Monitor and help student when need - Prepare standard samples	- Student groups compare obtain result with the standard sample given by teacher. - Group representative report the researching result - Compare effeciency of propose methods (if conditions allow to do all experiments) - Write report to consolidate results.

Activity4: Evaluate independent creativity competency of students (30 minutes)

Activities of teacher	Activities of students
- Teacher comments, evaluates independent creativity competency through the experiment result of each groups - Give out organic chemistry test - Give out questionnaire for students. -Collect reports of research result	- Take the organic chemistry test. - Students fill in questionnaire.

2.4.4. Measure 4: Use mind map technique

2.4.4.1. Objective

Develop independent creativity competency for students through creating conditions for students to develop ideas, systemize knowledge in different ways.

2.4.4.2. Implementation process

Step 1: Make plan

Step 2: Organize teaching activities

Step 3: Organize inspection

Step 4: Evaluate independent creativity competency of students

2.4.4.3. Some illustrative lesson plans

LESSON PLAN 10: ALDEHYDE- KETON

A. Objective

1. Knowledge

Understand the teaching technique with mind map. Understand the concept, isomers, terminology, physical and chemical property, preparation and application of aldehyde-keton

2. Skills

Be able to apply learning skills:

Group discussion skill, Communication skill, Problem-solving skill, Note-taking skill.

3. Independent Creativity Competency

Create new product under mind map form with different models of content and shape. Independently propose different detailed ideas about mind map of individual and group. Explain result with mind ma in one's own way. Evaluate mind map of individual and group, evaluate results of other groups.

B. Preparation

1. Teaching equipments

2. Methods

- The main teaching method is mind map technique.
- Coordinated methods: Method for realizing and solving problems, cooperative learning method, seminar.

C. Teaching and learning activities

Activity 1: Student design mind map with learned knowledge (35 minutes)

Activities of teacher	Activities of students
- Teacher requires students to design mind map about aldehyde and keton with learned knowledge at high school	- Each student proposes different ideas to design mind map for the same key word: aldehyde or keton.
- Teacher divides class into 4 or 6 groups, requires groups to consolidate results of every students	- Student groups discuss and combine different ideas to build up a group mind map + Group 1, 2, 3: Complete mind map of aldehyde on A0 paper + Group 4, 5, 6: Complete mind map of keton on A0 paper
Note: require students' mind map to be diversified in term of colour, structure…	- Group representative paste it on the wall. - Each group has paper card to write formula, terminology, chemical property, preparation method of compounds next to the mind map of group - Note that groups can add information if

	paper cards do not contain enough information

Activity2: Student design mind map of new knowledge, with result reference of Activity 1 (35 minutes)

Activities of teacher	Activities of students
Assign tasks for student to execute Pay attention to characteristics of chemistry subject to build up mind map	- Students read content about aldehyde-keton in textbook - Students propose question to extend and improve knowledge about aldehyde, keton. - Students discuss in group and complete development of mind map

Activity3: Report result by mind map (35 minutes)

Activities of teacher	Activities of students
- Require each group to report within 8 to 10 minutes - Teacher monitors discussion of students	- Group representative report result by mind map with different ways. Other groups listen, discuss and debate. Teacher can accordingly support by raising additional question, finding out debatable issues, and being arbitrator when students discuss. - Group leader summaries ideas and add up to the mind map of the group

Activity4: Evaluate independent creativity competency (30 minutes)

Activities of teacher	Activities of students
- Teacher comments and evaluates independent creativity competency through mind map of each group. - Give out organic chemistry test. - Give out questionnaire for students.	- Students listen and complete - Students take the organic chemistry test - Complete the questionnaire

CONCLUSION FOR CHAPTER 2

On the basis of researching theoretical and practical related issues, there are new proposals on development of independent creativity competency:

+ Identify 9 signs of independent creativity competency of students in technical universities.

+ Design tool kitas (among those, there are 8 types of exerciese with 44 questions of organic chemistry) to evaluate independent creativity competency for students in technical universities.

+ Propose orientation, principles to develop independent creativity competency for students of technical universities.

+ Propose 4 measures to develop independent creativity competency of students of technical field through teaching organic chemistry. They are:

Design 11 illustrative lesson plans for 4 measures to develop independent creativity competency of students.

CHAPTER 3
PEDAGOGY EXPERIMENTS

3.1. Experiment Objectives

3.2. Experiment Missions

3.3. Experiment Methods

3.3.1. Experiment plan

3.3.1.1. Experiment locations

Technical universities in cities such as: Hanoi University of Industry, Vietnam Traditional Medicine Academy, Military Medical Academy, Vinh Medical University.

3.3.1.2. Selection of experimental lecturers

The experimental lecturers are selected on following standards:

Graduating from pedagogy schools, possessing high level of professional competencies and having worked in the sector for 6 years; being able to utilize ICT, being enthusiastic and responsible.

3.3.1.3. Selection of experimental subjects

Experiment class and control class are selected on following standards:

Assign equal number of students for both classes; in each class, select some students with equivalent enrollment results, same teachers, same progress and teaching content.

3.3.2. Experiment process

3.3.2.1. Pre-experiment instruction for lecturers

3.3.2.2. Experimental teaching

Thực nghiệm thăm dò, thực nghiệm vòng 1, thực nghiệm vòng 2

3.4. Experiment results

3.4.1. Processing and evaluation of results

3.4.1.1. Qualitative evaluation

Conducted based on general observation, class observations and collection of student and teacher’s feedbacks; and based on the product evaluation conducted by students for the Project and Mindmap.

3.4.1.2. Quantitative evaluation

- *Design the evaluation tool*
- *Collect the data*

- *Analyze the results:* process and analyze the experiment results by mathematical statistics, represent them by contingency table, frequency diagram, and particular parameters.

3.4.2. Pedagogic experiment results

3.4.2.1. Qualitative evaluation

Through class observations and feedbacks from the teachers, we realize:

- In the control class, teachers used presentation method, therefore students were inactive to absorb knowledge, then most of them did not show the sign of independent creativity competency. Most of the time, they listened, noted and did exercises which required them to demonstrate their understandings about the lessons.

- In the experiment class, teachers focused on development of independent creativity competency to teach, their main role was to advise and evaluate students. The students were given opportunities to participate in independent activities following their study contracts, to set up and execute their project plans, to develop their ideas for mindmap-based knowledge systematization, and to conduct experiments in different ways. Hence, students in experiment classes were more active and showed signs of independent creativity competency.

3.4.2.2. Quantitative evaluation

a. Class monitor results

We collected evaluation results through class monitor sheets for 7 experiment classes and 7 control classes, teachers observed and evaluated the development progress of student's independent creativity competency through those sheets (appendix 4). The experiment results are presented in following tables:

Processing experiment data and using excel software, to calculate mean values and standard deviation, show that:

- Mean values, shown in contract-based teaching, project-based teaching, Spickler-based teaching and mindmap-based teaching method, demonstate that students in experiment classes have better observation scores compared to those in common teaching method. That proves the methods above created a good environment for students to be active, creative and improved their independent creativity competency.

- The level of impact ES > 4.0 in the Hopkin scale shows that using those teaching methods in experiment classes had a complete impact on the development of independent creativity competency for students.

b. Teacher questionnaire results

- Through teacher questionnaires, teachers reckon that using the teaching methods above, which were combined with use of teaching equipment and some other supporting teaching methods, improved the

independent creativity competency for students. Specifically, we collected data from 5 experiment teachers from selected schools.

The results prove that the proposed 4 methods for development of independent creativity competency did improve student's independent creativity competency in experiment classes. Most of teacher's feedbacks are displayed in Good and Very good level.

c. Student questionnaire results

- Through student questionnaires, the results are: A lot of students self-evaluated the level of achievement of independent creativity competency through using 4 methods for development of independent creativity competency for teaching.

d. Product evaluation results

By distributing the product evaluation forms to students, the collected results are: the products are evaluated by students as good and acceptable, none as weak and unacceptable.

e. Test results

- Method 1: Using contract-based teaching method

+ Round 1 results, 2012

Table 3.8. Test scores for experiment and control classes (method 1, Round 1)

Class	No of students	Score X_i										$\bar{X}$
		0	1	2	3	4	5	6	7	8	9	10	
Ex class	360	0	0	11	28	48	83	99	58	18	11	4	5.54
Ctrl class	357	0	0	0	0	9	29	45	70	118	59	27	7.52

Table 3.12. Specific parameters for experiment and control classes (Method 1, Round 1)

Class	**X_i**	**S**	**V(%)**	**ES**	**t_d**
Ctrl class	5,54	1.60	28.88	1.24	23.48
Ex class	7,52	1.44	19.15		

With $d_f = 715$, probability $\alpha=0.05$, looking up to the table for $t_{\alpha, df} = 1.98$, so $t_d > t_{\alpha, df,}$ proves $\bar{x}_{TN}$ *and* $\bar{x}_{DC}$ being different is significant. From table 3.12, it can be said that results for experiment classes are better than those for control classes with the significance $\alpha=0,05$. The ES value is in the range which has huge impact, proving that the difference in the average test scores between

experiment and control classes is affected by methods for development of independent creativity competency, not at random.

- **Method 2: Project-based teaching method**

+ ***Experiment results in Round 1, 2012***

Table 3.13. Test scores for experiment and control classes (Method 2, Round 1)

Class	No of students	Score X_i											$\bar{X}$
		0	1	2	3	4	5	6	7	8	9	10	
Ctrl class	360	0	0	15	38	65	59	104	44	21	11	3	5.36
Ex class	357	0	0	0	0	11	29	40	98	92	53	34	7.47

Bảng 3.17. Particular parameters for experiment and control classes (Method 2, Round 1)

Class	**X_i**	**S**	**V(%)**	**ES**	**t_d**
Ctrl class	5.36	1.69	31.53	1.25	23.70
Ex class	7.47	1.48	19.81		

With $d_f = 715$, probability $\alpha=0.05$, looking up to the table for $t_{\alpha, df} = 1.98$, so $t_d > t_{\alpha, df,}$ proves $\bar{x}_{TN}$ *and* $\bar{x}_{DC}$ being different is significant. From table 3.17, it can be said that results for experiment classes are better than those for control classes with the significance $\alpha=0,05$. The ES value is in the range which has huge impact, proving that the difference in the average test scores between experiment and control classes is affected by methods for development of independent creativity competency, not at random

- **Method 3: Spickler chemistry teaching method**

+ ***Experiment results in Round 1, 2012***

Table 3.18. Test scores for experiment and control classes (Method 3, Round 1)

Class	No of students	Score X_i											$\bar{X}$
		0	1	2	3	4	5	6	7	8	9	10	
Ctrl class	146	0	0	8	15	19	30	34	21	13	6	0	5.45
Ex	147	0	0	0	0	0	7	14	39	46	25	16	7.79

class													

Table 3.22. Particular parameters for experiment and control classes (Method 3, Round 1)

Class	**X_i**	**S**	**V(%)**	**ES**	**$t_đ$**
Ctrl class	5.45	1.77	32.48	1.32	15.97
Ex class	7.79	1.28	16.43		

With $d_f = 291$, probability $\alpha=0.05$, looking up to the table for $t_{\alpha, df} = 1.98$, so $t_đ > t_{\alpha, df,}$ proves $\bar{x}_{TN}$ *and* $\bar{x}_{DC}$ being different is significant. From table 3.22, it can be said that results for experiment classes are better than those for control classes with the significance $\alpha=0,05$. The ES value is in the range which has huge impact, proving that the difference in the average test scores between experiment and control classes is affected by methods for development of independent creativity competency, not at random

- **Method 4: Mindmap-based teaching method**

  + ***Experiment results in Round 1, 2012***

Table 3.23. Test scores for experiment and control classes (Method 4, Round 1)

Class	No of students	Score X_i											$\bar{X}$
		0	1	2	3	4	5	6	7	8	9	10	
Ctrl class	240	0	0	11	22	38	56	60	36	10	5	2	5.32
Ex class	238	0	0	0	0	12	21	25	56	62	36	26	7.46

Table 3.27. Particular parameters for experiment classes and control classes (Method 4, Round 1)

Class	**X_i**	**S**	**V(%)**	**ES**	**$t_đ$**
Ctrl class	5.32	1.62	30.45	1.32	20.44
Ex class	7.46	1.60	21.45		

With $d_f = 475$, probability $\alpha=0.05$, looking up to the table for $t_{\alpha, df} = 1.98$, so $t_đ > t_{\alpha, df,}$ proves $\bar{x}_{TN}$ *and* $\bar{x}_{DC}$ being different is significant. From table 3.27, it can be said that results for experiment classes are better than those for control classes with the significance $\alpha=0,05$. The ES value is in the range which has huge impact, proving that the difference in the average test scores between experiment and control classes is affected by methods for development of independent creativity competency, not at random

The results from processed data in pedagogic experiment show that the performance for experiment students is better than that for control students, specifically:

- The rate of weak and average students (whose score is from 2 to 6) for an experiment class is lower than that for a corresponding one.
- The rate of good and excellent students (Tỉ lệ SV khá, giỏi (whose score is from 7 to 10) for an experiment class is higher than that for a corresponding one.
- The accumulation graph for experiment classes is always on the right and below that for control classes.
- The average score for experiment students is higher than that for control students.
- The variation lower than 30% shows that the fluctuation is reliable. The variation for experiment classes is lower than that for control classes showing that experiment students have equal performance.
- $t_đ > t_{\alpha, df,}$ proves $\bar{x}_{TN}$ *and* $\bar{x}_{DC}$ being different is significant with the significance $\alpha=0,05$. The ES value is in the range which has huge impact, proving that the difference in the average test scores between experiment and control classes is affected by methods for development of independent creativity competency, not at random.

CONCLUSION FOR CHAPTER 3

In this chapter, we have finished following parts:

1. Selecting 4 technical universities in Chemistry and Medical, with the participation of 5 experiment teachers.
2. Each proposed method is experimented and evaluated by quantitative and qualitative method. 11 lesson plans have been experimented.

Pedagogic experiment results have stressed the feasibility and effectiveness of 4 methods for development of independent creativity competency for students in technical universities.

GENERAL CONCLUSION AND RECOMMENDATIONS

A. General conclusion

The thesis managed to achieve the projected goal, task and new result as follows:

1. In term of theory

- Systemized, clarified some theoretical issues related to develop independent creativity competency of students in technical universities.
- Systemized some ideas of internal and foreign authors about competency, professional competency, creativity, creative thinking, independence, independent creativity competency, expressions of creativity competency and ways for assessment.
- Explain the nature, property, advantages and disadvantages of some positive teaching methods which can be applied to develop independent creativity competency of students in teaching organic chemistry.

2. In term of practice

- Carried out studying, analysing some practical issues related to developing independent creativity competency of students in technical universities through teaching organic chemistry
- Carried out studying organic chemistry programs in chemistry and medical major of technical universities to clearly see the same points and different points among them, as well as the variation of theory and practice level in comparison with organic chemistry content for high school.
- Inspected the factual situation of using positive teaching method in teaching organic chemistry in technical universities.
- Analysed psychological and physical property, ability to learn chemistry of students in technical universities.

3. On the theoretical and practical basis, there are new proposals on developing independent creativity competency of students in technical universities. They are :

+ Identified some signs of independent creativity competency of students in technical universities.

+ Proposed designing tool kit to evaluate independent creativity competency for students in technical universities: observation table, questionnaire, product evaluation paper, organic chemistry test (8 types of exercises with 44 questions about organic chemistry)

+ Proposed 4 points in orientation, 5 principles to develop independent creativity competency of students in technical universities.

+ Proposed 4 measure to develop independent creativity competency of students in technical universities through teaching organic chemistry. They are:

Measure 1: Use contract based teaching method

Measure 2: Use project based teaching method

Measure 3: Use Spickler chemistry practice teaching method

Measure 4: Use mind map technique

4. Designed 11 illustrative lesson plans for measures to develop independent creativity competency of students in technical universities

through teaching organic chemistry, include: 3 lesson plans for contract based teaching method, 3 lesson plans for project based teaching method, 3 lesson plans for Spickler method, 2 lesson plans for mind map technique.

Carried out pedagogy experiment in chemistry and medical major of 4 technical universities with participation of 5 teachers. The result of pedagogy experiment was evaluated with questionnaire for teacher and student, observation table, product evaluation paper, organic chemistry test. Data of experiments was processed with statistic method, showing average points of experimental ones are higher than control ones. The variation does have its meaning and influence size is of large range.

The qualitative and quantitative results proved the feasibility and effectiveness of measure for developing independent creativity competency of students in technical universities

B. Recommendations

Through the research and experiment process of the thesis, we have several following recommendations:

1. The research result of thesis continues being implemented and applied widely in technical university system of Vietnam.
2. The thesis continues being developed and extended to other fundamental subjects and specific subjects.

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