

Developing Integrated Teaching Capacity Following STEM Educational Orientation for Pedagogical Chemistry Students

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Abstract The development of integrated teaching capacity following STEM educational orientation for students of Universities of Education in Vietnam is being concerned. Through surveying 104 Chemistry teachers in high school in Dak Nong province, 76 Chemistry teachers in Thua Thien- Hue province, 112 Chemistry teachers in Thai Nguyen province- the school years 2018-2019 and 2019-2020 with different awareness levels of integrated teaching, and survey on improvement needs for integrated teaching capacity under STEM educational orientation as well. The reality of the awareness and improvement needs in integrated teaching under STEM educational orientation of Chemistry teachers in high schools shows that the addition of the theoretical basis for integrated teaching, STEM education and application in the teaching process to form an integrated teaching capacity for students is very necessary. Based on the survey results and the basis of determining the structure of integrated teaching capacity, we have identified an integrated teaching capacity framework and proposed methods to develop integrated teaching capacity using STEM educational orientation for pedagogical chemistry students. We conducted pedagogical experiments on third-year and fourth-year students-the formal educational training program concentrated at the university of Education-Thai Nguyen University (215 students) and University of Education-Hue University (182 students) with 03 integrated teaching topics. Evaluating the progress of each student group about the designing capacity in integrated teaching topics and products for integrated teaching topics; evaluating the integrated teaching capacity of pedagogical students through the questionnaire. Experimental results after statistical processing show the effectiveness and feasibility of the proposed methods.

Keywords: *capacity, integrated teaching, integrated teaching capacity, STEM education, pedagogical students*

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1. Introduction

The quality of the teachers is an important factor in the success of a comprehensive renovation of Vietnamese education in the new period. In the context of globalization, it requires a new workforce with good adaptive capacity, creative thinking to meet the requirements of a competitive and developing economy. To meet that requirement, teachers should understand integrating science teaching, teach students how to collect and select; process information and apply the knowledge in real-life situations.

Integrated teaching is an indispensable trend in education today. From the XV to the XIX century, the natural sciences studied the natural world according to analytical thinking and each of the natural sciences studied a physical form, a moving form of matter in nature through the prism of each major by the independent way

[10]. But the natural world itself is not a complete entity, so the analytical thinking approach of each natural science industry will have certain limitations when solving problems in the movement of nature.

Integration has become a major trend in organizing knowledge as well as the number of integrated syllabus of natural subjects in some developed countries increases rapidly. A study of the program survey about 20 countries by the Vietnam Academy of Educational Sciences shows that 100% of those countries have developed programs in an integrated orientation, typically Korea, Singapore, Malaysia, Australia, France, England, USA, Canada [5,9].

The integrated approach in developing educational programs began to be highly appreciated in the United States and European countries from the 1960s of the XX. Nearly a decade later, this issue was concerned in Asia and Vietnam (in the 1970s and 1980s of the XX) [5].

In Southeast Asia, most countries have implemented integrated views. During the 1970s and 1980s of the XX,

UNESCO had workshops with reports on the implementation of integrated views of participating countries [9].

The application of integrated perspective into teaching is a common trend in countries in the region and around the world. Integrating with teaching has become a modern pedagogical movement in addition to the pedagogical movements under the target, solving problems and contracts and so on. According to UNESCO statistics, from 1960 to 1974, there were 208/392 subjects programs showing the integrated views at different levels, from interdisciplinary, combined to fully integrate with topics. In 1981, an international organization was established to provide information about the integrated programs (science subjects) to promote the application of an integrated perspective in the design of science programs all over the world.

A significant contribution to the formation of an integrated teaching theory system, in the first half of the 1990s under the direction of V.T Phormenko, educators of the Russian Federation researched an integrated program with the subject topic "Building the teaching process on an integrated basis" [23].

Integration is one of the new trends of teaching theory and is being interested in many countries around the world. Many countries with advanced teaching qualifications, such as France, China and the Philippines are also interested in integrated teaching. In the Philippines, a textbook called Fusion (consolidation) combines a lot of knowledge and skills to promote the synergy of disciplines in cognitive situations as well as in real situations [10].

In educational reform programs in some countries, an integrated perspective is specified as a compulsory requirement. Integration is one of the perspectives of building curriculum in many countries such as France, the USA and the UK. In the early 1990s of the XX, the introduction document of the program (Curriculum A comprehensive) of the United States devoted an entire section to talk about the integrated content in the educational program to adapt to social requirements, make the program meaningful [15].

In some Western countries, there also have serious studies on integrated teaching. Xavier Roegiers has compiled in the document "Integrated Pedagogy Department or developing capacity methods in schools ". In this book, the author has analyzed the basis of integrated teaching: the theory of learning processes, the theory of the teaching process (pedagogical movements), the methodology to build a curriculum based on an integrated perspective and the definition, objectives of an integrated pedagogy, the impact of this approach to the development of an educational program and the curriculum designing the model and also the student's results evaluation [25].

In Vietnam, integrated teaching is not a new method because it already exists at many levels. In elementary, there is usually inter-subject or internal integration, then gradually decreases from secondary school to high school (internal integration) [18].

STEM stands for Science, Technology, Engineering and Mathematics. STEM is a curriculum based on the idea of educating students in four specific disciplines - science, technology, engineering and mathematics - in an interdisciplinary and applied approach and learners can apply it into daily life. Instead of teaching four subjects as

separate and discrete subjects, STEM-oriented teaching combines them into a coherent learning model based on practical applications. STEM is known as a special education method that integrates elements of Science, Technology, Engineering and Mathematics. This integrated approach not only helps students understand the principles but also can bridge the gap between academic knowledge and practice to create products in daily life [4,6].

However, in practical teaching currently, due to being trained to teach a single subject, the integrated teaching capacity using STEM educational orientation of high school teachers is still limited, not only about the content of integrated teaching knowledge under STEM educational orientation but also about the organization of the teaching process [13,14,19].

2. Research Content

According to UNESCO defines integrated teaching "a way of presenting scientific definitions and principles that enable the expression of the fundamental unity of scientific thought, avoiding emphasizing too much or too soon about differences between different fields of science" (Conference on UNESCO program, Paris 1972) [25].

Integrated teaching is a teaching perspective. In the teaching process, there are participation and connection of knowledge of different professional fields or subjects to develop students' ability to solve complex and practical problems [2,7].

Integrated teaching: Action which links research, teaching, and learning subjects on the same field or several different fields in the same teaching plan. Integrated teaching is one process in which capacity components are integrated based on specific situations to build capacity for learners [3,15].

General education program with the orientation of developing the capacity to apply the knowledge and skills learned teachers need to pay attention to practice problem identifying, research planning, problem-solving, result evaluating and the solutions. Besides, using STEM in teaching is to develop the integrated knowledge and skill in Maths, Technology and Chemistry so they can apply those skills to research and solve actual situations. Methodological orientation is the formation and development of chemical capacity through the proposal of solutions to solve a problem of a learning project or a STEM model project [2,20].

Some targets of integrated teaching: (1) Integrated teaching is to develop the capacity of learners (2) Integrated teaching makes the learning process meaningful (3) Distinguishing the essential from the less important (4) Teaching how to use knowledge-based on every situation (5) Creating connection among definitions learned [16,23,24].

2.1. The Reality of Awareness of Chemistry Teachers in High School and Improvement Needs of Integrated Teaching Following STEM Education

According to the survey of 104 Chemistry teachers in high school in Dak Nong province, 76 Chemistry teachers

in Thua Thien - Hue province, 112 Chemistry teachers in Thai Nguyen province school year 2018 - 2019 and 2019 - 2020. The awareness levels of integrated teaching based on STEM educational orientation gradually increase from

1 to 4, the levels corresponding to each expression are as follows: Level 1. Unknown: 1 point; Level 2. Know: 2 points; Level 3. Understand: 3 points; Level 4. Application: 4 points.

Table 1. The survey of awareness levels result about the integrated teaching of Chemistry is taught in high school

No.	Understanding the issues at different levels	Mean value	Standard deviation	Reliability coefficient	Variance
1	Integrated teaching definition	2.51	0.706	0.516	0.499
2	Integrated teaching based on STEM educational orientation	2.37	0.602	0.494	0.363
3	Reasons to implement integrated teaching based on STEM educational orientation	2.15	0.748	0.506	0.559
4	Criteria to design some integrated teaching topics	1.93	0.698	0.527	0.487
5	The way to design some integrated teaching topics orientation	1.97	0.709	0.517	0.503
6	Ways/techniques to help design an integrated teaching topic	1.84	0.683	0.562	0.466
7	The way to evaluate students in integrated teaching	2.37	0.684	0.498	0.467
8	ICT applications in integrated teaching	2.63	0.666	0.519	0.444

Through Table 1, it shows that most of the teachers surveyed understand why it is necessary to implement integrated teaching based on STEM educational orientation, but not in a deep understanding about integrated teaching and how to design some integrated teaching topics in STEM educational orientation to form the corresponding capacity in students. Besides, the understanding of integrated teaching methods and the way to evaluate students in integrated teaching in high schools and ways/techniques to help design integrated teaching topics are still limited. The survey results show that teachers in high schools have certain knowledge about integrated teaching, although most teachers have not had much access to the theoretical basis of integrated teaching and application in the teaching process at high schools.

The survey result of improvement needs of integrated teaching based on STEM educational orientation.

Table 2. The survey of improvement needs results in the integrated teaching capacity of Chemistry teachers in high school

No.	Understanding the issues at different levels	Mean value	Standard deviation	Reliability coefficient	Variance
1	Integrated teaching based on STEM educational orientation	2.36	0.653	0.044	0.427
2	Reasons to implement integrated teaching based on STEM educational orientation	2.46	0.667	0.005	0.445
3	Criteria to design some integrated teaching topics	3.15	0.810	0.048	0.657
4	The way to choose and design some integrated teaching topics	3.34	0.761	0.005	0.579
5	Ways/techniques to help design an integrated teaching topic	3.40	0.699	0.123	0.489
6	The way to implement integrated teaching in high school	2.72	0.704	0.112	0.496
7	Modern teaching methods/techniques positively enhance students	2.29	0.712	0.060	0.507
8	ICT applications in integrated teaching	2.25	0.674	0.024	0.454
9	Ways of evaluating students in integrated teaching	2.81	0.842	0.023	0.709

From the results of integrated teaching needs survey based on STEM educational orientation, most teachers see the need to train integrated teaching issues, in which the criteria to design integrated teaching topics based on STEM educational orientation; The way to choose and design some integrated teaching topics based on STEM educational orientation to form the corresponding capacity of students; Methods of evaluating students in integrated teaching according to STEM educational orientation are interested in teachers.

According to the results of the survey on the situation and the training needs of teachers in integrated teaching, it shows that the addition of the theoretical foundation for integrated teaching and application in the teaching process

to create integrated teaching capacity for students at Universities of Education are essential to help students after graduating.

2.2. Integrated Teaching Capacity Framework following STEM Educational Orientation

Based on the survey result and foundation of the integrated teaching capacity structure, characteristics of the Chemistry program at the University of Education, we have defined the framework of integrated teaching capacity as follows:

Table 3. The integrated teaching capacity structure following STEM educational orientation of Pedagogical Chemistry students [15,16]

No.	CRITERIA	INDICATIONS
1	Some general issues of integrated teaching in STEM educational orientation	- Awareness of integrated teaching in STEM education orientation to develop learners' capacity - Understanding about general and specific capacity in every subject.
2	The capacity to design and organize integrated teaching activities	- Proposing names of some integrated teaching topics, designing some integrated teaching topics using STEM educational orientation. - Selecting appropriate and active teaching methods in STEM educational orientation - ICT applications in integrated teaching
3	Examining and evaluating capacity in integrated teaching	- Designing and using a set of tools to evaluate the students' capacity in integrated teaching in STEM educational orientation.

From the structure of integrated teaching capacity, we propose 4 levels with each expression as follow:

Level 1. No capacity: Students do not have any expressions in learning and group activities.

Level 2. Capacity at a low level: Students have expressions, but not often and not actively (applying stereotypes, little criticism and creativity of their own).

Level 3. Capacity at a moderate level: Students have expressions quite often and positively (with their judgment, criticism and creativity).

Level 4. Capacity at a high level: Regular and positive expressions (with own judgment, criticism and creativity). Products obtained have applicable value.

Criteria	Level 1	Level 2	Level 3	Level 4
1. Awareness of integrated teaching in STEM educational orientation aimed at developing learners' capacity	Not able to mention integrated teaching in STEM educational orientation aimed at developing learners' capacity	Able to mention some contents in integrated teaching in STEM educational orientation aimed at developing learners' capacity	Able to present integrated teaching in STEM educational orientation aimed at developing learners' capacity	Able to completely present and explain integrated teaching in STEM educational orientation aimed at developing learners' capacity
2. Awareness about general and specific capacity in every subject	Not able to mention general and specific capacity in every subject	Able to mention but not clear about general and specific capacity in every subject	Able to present, but not able to clarify the structure of general and specific capacity in every subject	Able to completely present and clarify the structure of general and specific capacity in every subject
3. Proposing some interdisciplinary, integrated teaching topics, designing some integrated teaching topics.	Listing some integrated teaching topics, but have not yet mentioned the principles of selecting integrated teaching topics and the process of designing integrated teaching topics.	Presenting but incomplete principles of selecting integrated teaching topics and processes for designing integrated teaching topics. Still confused about the design of some integrated teaching topics	Presenting the principle of selecting integrated teaching topics, the process of designing integrated teaching topics. Designing some integrated teaching, but incomplete topics.	Presenting the principle of selecting integrated topics, the process of designing integrated teaching topics. Designing completely some integrated teaching topics.
4. Applying positive teaching methods and techniques in integrated teaching	Not able to apply positive teaching methods and techniques in integrated teaching	Able to apply positive teaching methods and techniques in integrated teaching but low efficiency	Able to apply some positive teaching methods and techniques in integrated teaching	Able to apply positive teaching methods and techniques in integrated teaching and have high efficiency
5. ICT applications in integrated teaching	Not able to apply ICT in integrated teaching	Able to apply ICT in integrated teaching, but low efficiency	Able to apply ICT in integrated teaching	Able to apply ICT in integrated teaching with high efficiency
6. Examining and evaluating students in integrated teaching	Not able to design a set of assessment tools for students in integrated teaching	Able to design a set of assessment tools for students in integrated teaching, but using with low efficiency	Able to design and use a set of assessment tools for students in integrated teaching	Able to design and use a set of assessment tools for students in integrated teaching with high efficiency

2.3. Developing Integrated Teaching Capacity in STEM Educational Orientation for Pedagogical Chemistry Students

2.3.1. Instructing Students to Develop an Integrated Topic Process Equations

Determining specific learning goals

- Determining the desired learning outcomes of students after the end of the lesson or a topic. Those goals are often based on a set of standards in science education. The development of learning goals based on these standards helps the students' STEM preparation to be highly systematic, ensure inheritance from previous lessons, as well as helping students achieve new results better.

- Students apply a combination of interdisciplinary knowledge, such as Physics, Biology, Natural Geography, and Mathematics to select appropriate integrated content under a lesson or a topic. Lesson content based on real-life situations. From that students build content and choose appropriate teaching methods.

Requirements for effective implementation of the development of integrated teaching topics

- The topic of integrated teaching in STEM educational orientation focuses on practical issues

- The structure of integrated topics in STEM educational orientation has followed the technical design process: The engineering design process provides a

flexible process. Following this process, students should: Identify the problem; Research knowledge background; Propose many ideas for solutions; Choose the optimal solution; Develop and manufacture a model (prototype); Test and evaluate; Perfect the design.

- Teaching methods of integrated teaching topics need to lead learners into exploration and discovery activities, action-oriented, experiences and products: Learning activities are transferred and cooperated; The decisions about problem-solving solutions are made by the learners.

- The lesson organization format using STEM educational orientation attracts students to the constructive group activity. Working as a team in carrying out activities of STEM lessons is the basis for developing communication and cooperation capacity.

- The content of the applied STEM lesson comes from the content of natural sciences and mathematics that students have been studying.

- The process of developing an integrated topic based on STEM educational orientation takes into account the many correct answers and considers failure as a necessary part of learning.

2.3.2. Instructing Students to Plan Integrated Teaching Topics Tables

Lecturers give students the development process of integrating topics, organize activities according to the

active teaching techniques with teaching equipment and supporting materials following the teaching process designed in the topics.

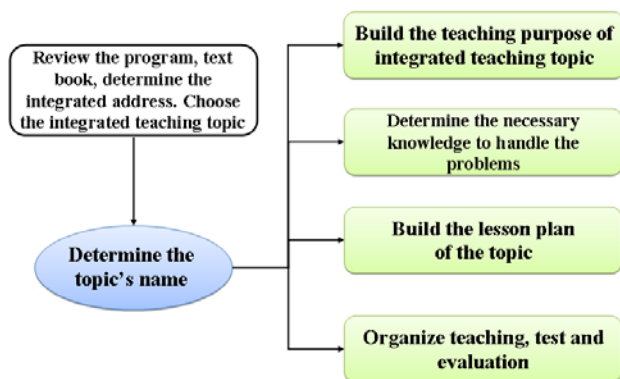


Figure 1. Integrated topic building process diagram

Applying the above steps, experimental teachers at the University of Education have guided groups of students to build integrated teaching topics. Giving comments, orientations for groups to self-supplement and adjust in the process of developing topics. Since then developing an integrated teaching capacity for students at the University of Education.

The topics have been developed and experimented with: (1) pH - the meaning of pH in life; (2) Glucose - The source of life; (3) Protein - the basis of life.

To develop integrated teaching capacity for pedagogical students, it has been conducted through 3 stages:

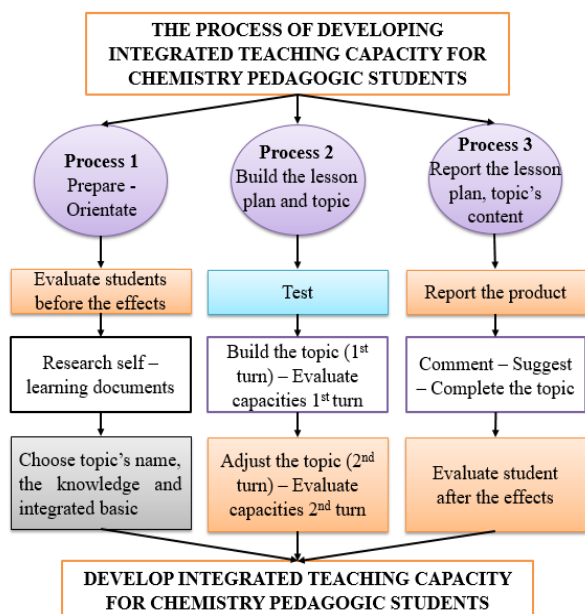


Figure 2. The process of developing integrated teaching capacity for chemistry pedagogical students

2.3.3. Topic: Glucose - The Source of Life

The reason to choose this topic

Glucose is a simple sugar and is also a typical monosaccharide, has wide applications in many fields, is easily digested and absorbed. Glucose has an important biological role in organisms and is close to human life.

Subjects on the teaching topic: Grade: 12

Teaching topic targets

Knowledge

- Demonstrating the open-chain molecular structure of glucose.

- Researching about preparation methods and applications of glucose

- Explaining the chemical properties of glucose based on the properties of the functional groups in the molecule
- Applying knowledge to explain problems in life.

Skills

- Explaining properties from observing experiments to comment on the properties of glucose

- Exploiting relationships, molecular structure and chemical properties

- Indicating the relationship between theory and practice:

- + Glucose is an essential nutrient for the body and life

- + Proposing a plan to test the sugar in the urine

- + Proposing plans for clean grape production and grape wine brands.

Capacities

General capacities: Self-study capacity, Problem - solving capacity, Cooperating capacity.

Specific capacities of the subject: The capacity of applying chemistry knowledge.

Teaching process

1. Topic implementation: Dividing the class into 4 groups with the assigned contents:

- * Group 1: The "Health and Family" category guides how making grape wine at home and the advantage of grape wine - a video on the grape wine production process

- * Group 2: Workshop "The role of glucose to improve the production efficiency of some industrial products of Pepsico Corporation, Quang Nam branch"

- * Group 3: Seminar "Finding new directions in the application of glucose in medicine at Hue University College of Medicine and Pharmacy"

- * Group 4: Medical News - Report on "Diabetes, causes and diabetes preventions".

2. Teaching activities

CONTENT 1: Physical properties and natural state

Activity 1 (based on perspective): Observation perspective, experience perspective

Observation perspective:

- + Observing the glass containing glucose (state, color, etc.)

- + Observing the images containing glucose (ripe grapes) in combination with documents, ask students to present their natural state.

Experience perspective: Testing the solubility of glucose. Conclude the solubility of glucose.

Through the perspective of observation and experience, filling in the information in the following learning card:

PHYSICAL PROPERTIES OF GLUCOSE	
State:.....	Melting point:
Color:.....	Solubility:.....
Smell:.....	

Activity 2: Look at some pictures of glucose in nature and show where the glucose is?

1. Why is glucose also known as grape sugar?

2. When honey is left for a long time, the bottom of the bottle often appears sugar. What is that layer of sugar?

3. How much is glucose in human blood?

Explain why some students faint when they are in fourth or fifth period? What do we need to do in that case?

CONTENT 2: MOLECULAR STRUCTURE

Activity 3: Experiments implementing on the molecular structure

Experiment 1: Reaction of glucose with $\text{Cu}(\text{OH})_2$

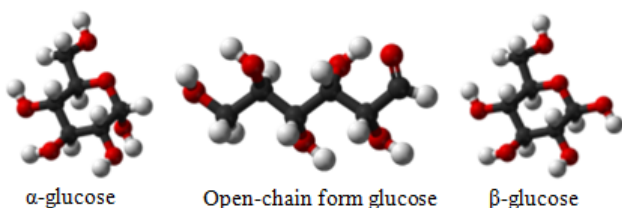
Experiment 2: Reaction of glucose with an excess of $\text{AgNO}_3/\text{NH}_3$

Group discussion and fill the missing information in the following worksheet:

WORKSHEET: "ANALYSIS" PERSPECTIVE			
No.	Experiments	Phenomenon	Conclusion
1	Reaction with $\text{Cu}(\text{OH})_2$ at room temperature
2	Slightly heat of the reaction of AgNO_3 in NH_3
3	Reaction with acetic anhydride	Create esters containing 5 acetate-based radical
4	Redox reaction of glucose by H_2	Create hexane

The formula of open-chain form structure of glucose molecule:.....

Activity 4: Understanding about cyclic form



Glucose exists mainly in the form of how many bonds? And how many forms are there? What are the differences among those forms?

CONTENT 3: CHEMICAL PROPERTIES

Activity 5: Group discussion about the chemical properties of glucose.

+ Group 1: Understanding properties of Polyhydric alcohols.

+ Group 2: Understanding the properties of aldehydes.

+ Group 3: Researching about the fermentation reaction

+ Group 4: Researching about specific properties of cyclic form.

DISCUSSION

1. Write the equation of the reaction of glucose with: H_2 , $\text{Cu}(\text{OH})_2$ heated, AgNO_3 in NH_3 , CH_3OH .
2. Present how to distinguish 4 solutions: Glucose; Glycerol; Acetic aldehyde; Ethyl alcohol by chemical method.
3. To cover a mirror by silver mirror reaction, 4.32 grams of Ag are required. Calculate the amount of glucose need for this reaction.

The groups write illustrated reactions on the sideboard to show that property. Other groups complement and refine the chemical properties of glucose

CONTENT 4: PREPARATION AND APPLICATIONS OF GLUCOSE

Activity 6: Understanding glucose preparation

- In industry, how is glucose prepared?
- In nature, how is glucose created?
- Why is the fruit sour and acrid before ripping and soft, sweet and fragrant when it is ripe?

Activity 7: Presentation using PowerPoint about applications of glucose

Dividing the class into 4 groups. The representative of each group presents assigned tasks in the previous period. The presentation time for each group is 5 minutes. Other groups supplement, comment to see the application of glucose.

Activity 8: Studying about famous wines in Ninh Thuan



Considering the potentiality of the growth of the grape in Ninh Thuan province. Proposing plans for clean grape production and brand of Ninh Thuan grapes?

Practice: Processing sirup from fruit

Preparation: 1 kg grapes, 1 – 1.5 kg sugar, washed and dried glass bottle/ jar

Implementing process:

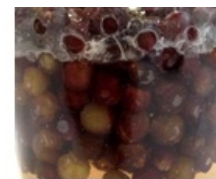
+ Step1: Fresh fruit, carefully selected, eliminate berries and worms. Rinse the fruit and drain

+ Step 2: Putting into the glass jar, 1 layer of fruit 1 layer of sugar. Close the jar tightly.

+ Step 3: After 2 days, put the entire mixture and heat it with a small fire. Boil and stir at the same time. When the grapes are ready, turn off the heat. Pour the whole mixture of grapes just boiled through a strainer, squeeze out the grape juice. Put the grape juice in a clean bottle and store it. Grape syrup, if properly preserved, can be stored for months to years.



Step 1



Step 2. Mixing grapes with sugar



Step 3



Enjoying

Activity 9: Practicing on the application of silver mirror reaction

Each group performed a silver mirror reaction on a flat-bottomed flask or cup

- Product obtained: Flask or cup "inlaid with silver" to make a "fancy" and a unique flower pot.



Product from ripe grapes



Silver mirror reaction



Glucose product



Flower and cup "inlaid with silver"

CONTENT 5: I AM A DOCTOR

Activity 10: Plan suggestion

One diabetic patient said: "Eating a lot of sugar will have diabetes so don't eat all sweets." In your opinion, is that idea correct? Try pretending to be a doctor and say whether the above opinion is right or wrong? Explain what diabetes is, what causes it, and how to prevent it.



APPLICATION QUESTIONS

Task 1. Binh's father came back from a business trip and brought a huge can of honey to give to relatives as gifts. Binh was very eager to help his father divide the honey into bottles. His father told him, "You have to remember to fill honey bottles with clean, dry, tight stoppers and put them in a dry place so that your honey will not degenerate". Binh did not understand why his father said that. Please help to explain to Binh.

Task 2: Poisoned by eating cassava, people often detoxify with sugar water. By chemical knowledge, please explain this case.

Task 3: Explain why when pickling, people often choose old or withered pickles and add a little sugar, compress in water.

Task 4: People prepare from corn-core one monosaccharide molecular formula $C_5H_{10}O_5$. It can add hydrogen (Ni catalyzed), have a redox reaction $AgNO_3$ in ammonia and bromine water, converts $Cu(OH)_2$ in water into a dark blue solution. Determine the structural formula of that monosaccharide and reaction equations.

Task 5: People with diabetes contain glucose in urine. List two possible chemical reactions to confirm the presence of glucose in the urine. Write chemical equations of reaction illustration. List two possible chemical reactions to confirm the presence of glucose in the urine. Write chemical equations of illustrated reaction.

3. Results and Discussion

The research object is the 3rd and 4th-year student – university program for the formal centralized pedagogical system. The research teacher has a concrete professional qualification, enthusiasm and high responsibility. We choose teachers and students to join research from 2 schools: the University of Education – Thai Nguyen University (215 students) and the University of Education – Hue University (182 students) in the school years 2018-2019 and 2019-2020.

3.1. Pedagogical Practice Preparation

Before pedagogical research, the discussion made with the teacher about aspects:

- Objectives; Processing method of integrated teaching.
- Providing theory about the integrated teaching for students and teachers and process the research based on the content of the teaching program of the universities.
- Infrastructure, necessary equipment, questionnaires ticket, exams, evaluation form, observation checklist.

3.2. Practical Content

Pedagogical practice evaluation. Pedagogical practice results are assessed qualitatively and quantitatively through a questionnaire before and after implementing integrated teaching; questionnaire evaluation of integrated teaching topics under STEM educational orientation, evaluation sheet of integrated teaching topics has been developed by students.

3.3. Evaluating Design Capacity and Integrated Practice Topic Outcome

During student doing integrated practice topic, the teacher observed directly (in the hall) or indirectly through integrated practice topic outcome, expressed about the integrated teaching ability of the student and score them

Based on the integrated practice topic outcome STEM-oriented education of groups to evaluate the ability and knowledge students gained after building-integrated teaching topic. From the criteria of content, form, design and outcome report presentation, the abilities of the student will be formed and developed.

Analysis of experimental results:

Evaluating results of the progress of the student group on the designing capacity of integrated teaching topics of University of Education- Hue University (182 students)

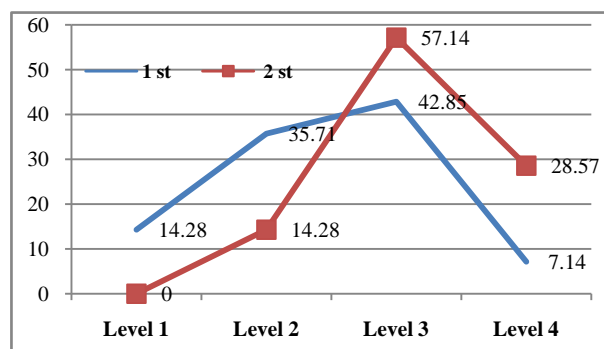


Figure 3. Diagram of progress on the work plan

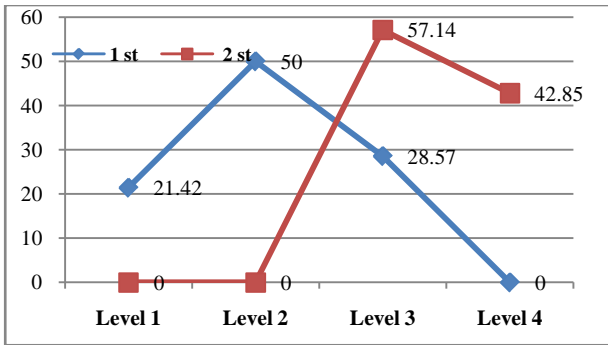


Figure 4. Diagram of progress on the proposal of integrated teaching topics

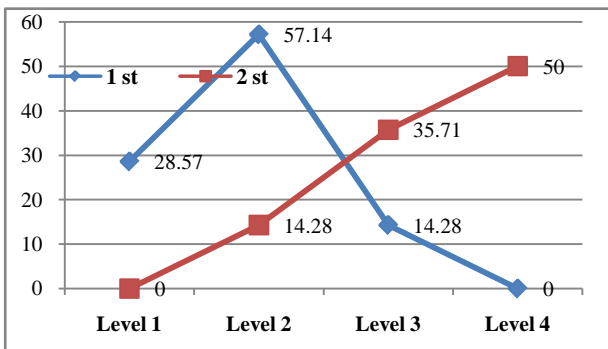


Figure 5. Diagram of progress on testing and evaluating the capacity of integrated teaching

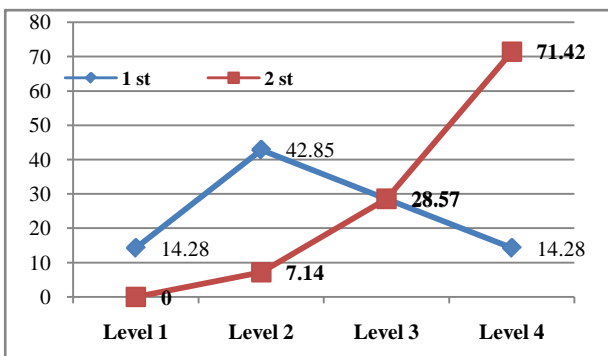


Figure 6. Diagram of progress on ICT application of integrated teaching

According to the diagram of the students' progress on the designing capacity of integrated teaching topics of University of Education- Hue University (Figure 3 - Figure 6) shows that each student evaluated in the process of training integrated teaching capacity for students increase during training time (shown in the ratio of levels 3 and 4, the second evaluation is higher than the first one).

Analysis of each skill shows that the progress in ICT application and the examining and evaluating capacity in integrated teaching is the fastest. This result is explained by pedagogical students' capacity to apply ICT. Teaching topics are commented on by teachers and learning materials, students adjust and apply in content development and evaluation.

Most of the integrated teaching topics reflect the work plan, the designing and organizing capacity of integrated teaching activities, the examining and evaluating capacity in integrated teaching, the creativity of students in presentation as well as problem-solving.

The results of the evaluation sheets and the observation tables of the groups implementing the integrated teaching topics of the experimental teachers show that the student groups cooperate well, have the spirit of learning and have the capacity to orient themselves of integrated teaching topics and always try to make sure the schedule is planned.

The survey results show that in the process of designing and organizing integrated teaching activities, students are very interested in those things. The design of integrated teaching topics helps students improve their cognitive and creative capacity, be more confident and diligent, be more responsible for their work, and help them formulate and develop self-directed capacity, testing and evaluating capacity as well as use ICT for communication and cooperation.

The results of evaluating the students' progress on integrated teaching topics of University of Education- Hue University

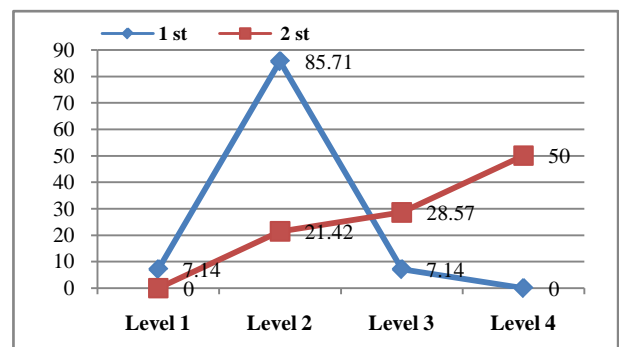


Figure 7. Progress in the content of integrated teaching topics

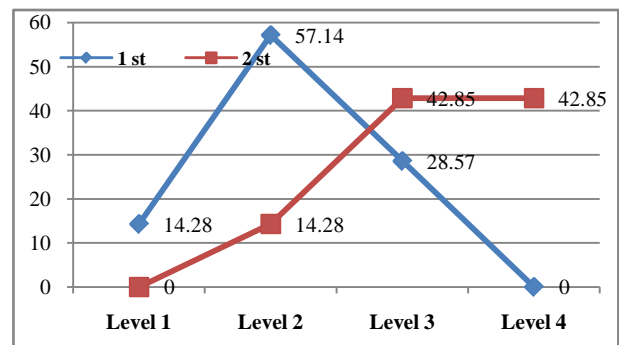


Figure 8. Progress in the form of integrated teaching topics

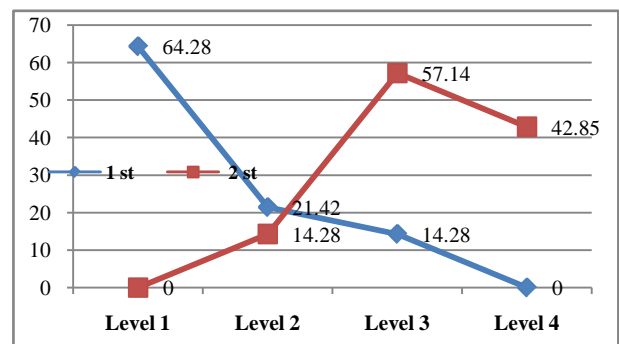


Figure 9. Progress of design, presentation of reports

Based on the results of the progress chart of the student on teaching topics, the results of capacity have increased during training.

Most integrated teaching topics meet the content, form, design and presentation of product reports. Based on the evaluation criteria, students can evaluate their progress in learning and also show teachers the learning results of students, adjust the teaching process and provide information about teaching accordingly. The way each group reports their products is consistent with the content of the integrated teaching topic, some of them are very professional and interesting. The questions are fully and accurately answered, and following the lesson content. References are collected in abundance, variety and largely taken from reliable sources.

Analysis of each skill showed that the progress in the content of integrated teaching topics increased rapidly after the first level at level 3 (28.57%) and level 4 (50.00%) compared to 7.14% level 3 at the first evaluation. This explains why it is not easy to select integrated content to put into the topic, after the comments and directions, the results of the second evaluation are much higher. The design and presentation of product reports are related to the form of the topic, the results of the second evaluation are nearly equivalent. From that, it can be affirmed that the application of the integrated topic process building through the module of general chemistry teaching methodology to train integrated teaching capacity for pedagogical students at Universities of Education which we propose is appropriate and effective.

3.4. Evaluation of the Integrated Teaching Capacity of Pedagogical Students through the Survey

Survey for students: Check before and after impact on a single group.

Before impact: Organize for students to survey integrated teaching capacity before approaching the theory and applying integrated teaching content - (before impact- BI)

After impact: After students access the theory and use integrated teaching content to build integrated teaching topics, students are surveyed the second time (after impact- AI).

Questionnaire of integrated teaching capacity (For chemical pedagogical students)

No.	Awareness level	(1)	(2)	(3)	(4)
1	Awareness of general capacity, the specific capacity of Science subject of high school students				
2	Awareness of theoretical issues about the integrated teaching				
3	Design ways of the specific topic of integrated teaching using STEM educational orientation				
4	Methods/techniques to help to design integrated teaching topics using STEM educational orientation				
5	IT application in integrated teaching				
6	Testing and evaluating students' methods in integrated teaching				

Table 4. The results of the measurements before and after the impact of Thai Nguyen University of Education (215 Students)

Question	Mean value		Standard deviation		Reliability coefficient		Variance	
	BI	AI	BI	AI	BI	AI	BI	AI
Q1	2.36	3.22	0.616	0.597	0.668	0.782	0.379	0.356
Q2	2.20	3.28	0.719	0.676	0.684	0.786	0.518	0.457
Q3	2.16	3.22	0.668	0.662	0.691	0.792	0.446	0.438
Q4	2.36	3.04	0.635	0.678	0.667	0.782	0.403	0.459
Q5	2.25	3.05	0.680	0.719	0.675	0.798	0.462	0.517
Q6	2.14	3.18	0.723	0.717	0.702	0.800	0.523	0.513

Experimental results analysis:

Table 5. The rate of students' awareness levels about the integrated teaching of Thai Nguyen University of Education

Question	Level 1		Level 2		Level 3		Level 4	
	BI (%)	AI (%)	BI (%)	AI (%)	BI (%)	AI (%)	BI (%)	AI (%)
1	6.6	1.2	51.4	5.8	41.3	63.3	0.8	29.7
2	16.2	0.8	49.0	10.4	33.2	49.0	1.5	39.8
3	15.4	1.5	52.9	8.5	31.7	56.0	0	34.0
4	7.7	3.9	49.0	9.3	42.5	65.6	0.8	21.2
5	13.1	2.3	48.6	16.6	37.8	55.2	0.4	25.9
6	19.7	3.1	47.1	8.9	32.8	54.8	0.4	33.2

Through the analysis of pedagogical experimental data of students at universities of education before and after the impact allows us to make some following remarks.:

a. Students' awareness of theoretical issues about the integrated teaching

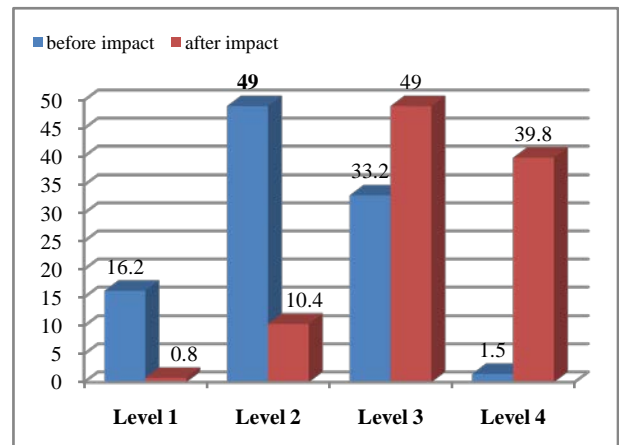


Figure 10. Awareness of theoretical issues about the integrated teaching

The data indicate that before the impact, most students do not understand well the concept and knowledge of integrated teaching. But after the impact when updating the integrated content was theoretical issues were better perceived (49%) for students even deeply understood (39.8%).

b. Awareness of student about design ways of specific topics of the integrated teaching under STEM educational orientation

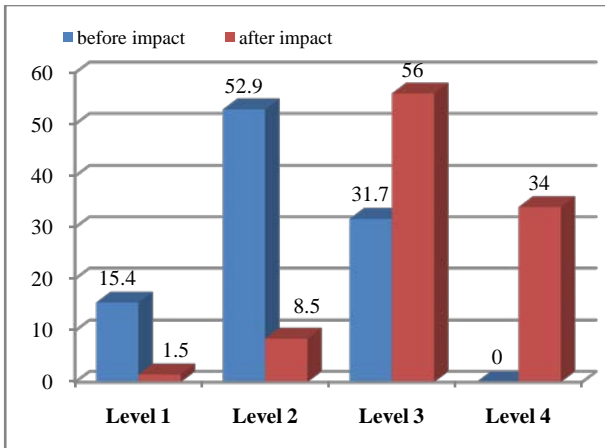


Figure 11. Design ways of the specific topic of integrated teaching

The result in Figure 11 showed: After building some integrated teaching topics under the guidance of the teacher, through the research from books, magazines. Many students do not understand or weak understand about how to design specific topic to gain the corresponding ability decreased significantly (not understood declined from 15.4% to 1.5%. weak understood from 52.9% to 8.5%). This result proved that designing specific integrated teaching topics has not been well understood and made to any student. To design a specific integrated teaching topic to gain corresponding ability need a process.

c. Student’s awareness of methods/techniques to help to design integrated teaching topics

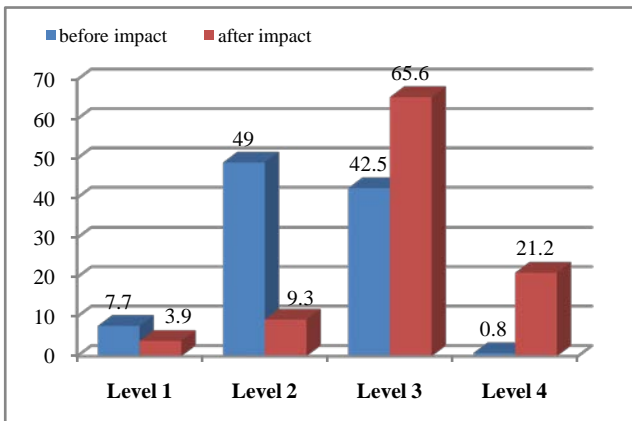


Figure 12. Methods/techniques to help to design integrated teaching topics

Based on the research results, the student applied better methods and techniques and able to design some specific integrated teaching, how to select topics, how to implement a topic as well as activity organized for student and few techniques like a table cloth, puzzle piece techniques 5W1H. This is proven by the difference in the percentage of students at the level of not understanding and understanding but not high.

d. Student’s awareness of Information and communication technology application (ICT) in integrated teaching

The student after impact who is knowledgeable about applying ICT in integrated teaching increases. Through the topics building, the student knew how to apply ICT to support integrated teaching effectively like Microsoft PowerPoint, iMind Map, Chem Office Ultra...

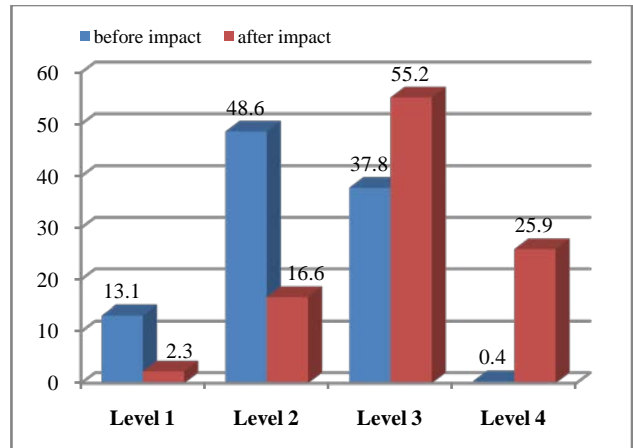


Figure 13. IT application in integrated teaching

e. Awareness of students on testing and evaluating students’ methods in integrated teaching

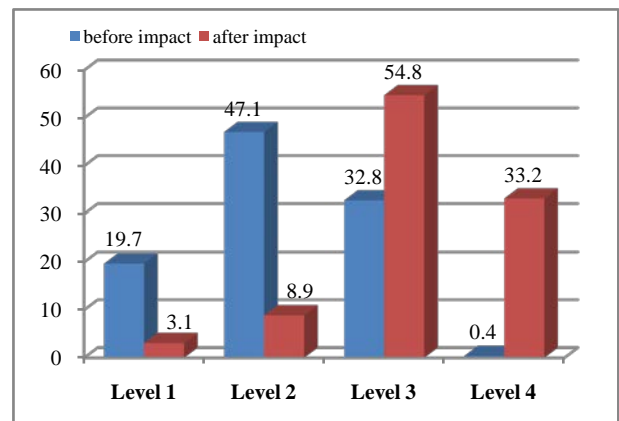


Figure 14. Testing and evaluating students’ methods in integrated teaching

Methods of evaluating students in integrated teaching are different from single-subject teaching, requiring teachers to evaluate comprehensively the capacity to link information and apply integrated knowledge to solve problems.

4. Conclusion

To successfully implement the renovation of Vietnam's high school education program after 2018 with the orientation of integrated fields under STEM education, the important step is to have teachers with the integrated teaching capacity towards STEM educational orientation. Currently, although the renovation of curricula and textbooks is being studied and implemented, the question is how to have teachers with the integrated teaching capacity in general or the integrated teaching capacity in the field of Natural Science in particular under STEM educational orientation, which is facing many bottlenecks and obstacles. Therefore, this issue needs to be researched so that not only teachers will have an integrated teaching capacity towards STEM education in the implementation of the new program, but also pedagogical schools should be a place to train students after graduation to meet the requirements of integrated teaching towards STEM education.

The qualitative and quantitative analysis results show that developing the integrated teaching capacity using STEM educational orientation for pedagogical students should have specific plans and methods.

The experimental research contents at some Universities of Education that we have carried out confirm the effectiveness of the process and methods to develop integrated teaching capacity towards STEM education for chemical pedagogical students which prove the correctness of the scientific and feasible hypothesis proposed.

Acknowledgments

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