# DEVELOPING SELF-LEARNING ABILITY FOR STUDENTS THROUGH TEACHING "THE PERIODIC TABLE OF ELEMENTS" IN CHEMISTRY 10 APPLYING THE FLIPPED CLASSROOM MODEL

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**Abstract**. The formation and development of learners' abilities are becoming more prevalent and necessary. Self-learning ability (SLA) is one of the capabilities that people are interested in developing. Besides the specific skills of the subject, chemistry teachers also focus on developing SLA for students. Currently, various educational models have emerged to align with educational trends, including the flipped classroom model (FCM), which contributes to competency development, particularly in self-learning ability. In recent years, this model has gained popularity. Studying with FCM helps students have more time to learn, research, and master the knowledge. Moreover, students can learn independently. This study investigates the impact of the flipped classroom model on self-learning ability development through teaching "The Periodic Table of Elements" at a high school in Tay Ninh province. Surveys into the reality of the usage of FCM and the development of SLA at several high schools in Tay Ninh province show that most teachers care about the development of SLA for students. However, they assign tasks to students in the form of questions after the lessons. Most students only base on the knowledge that the teachers teach in class to answer the questions. This leads to SLA not being developed. The authors use a one-group pretest-posttest design in this study. The results of the pretest and post-test show that students have higher scores after participating in learning with FCM. Besides, the components of SLA are evaluated on becoming better after the intervention by using a scale of 5 levels combined with a checklist. Thus, applying FCM to develop SLA for students is necessary.

*Keywords*: self-learning ability, flipped classroom model, periodic table of elements, Grade 10 Chemistry, Tay Ninh province.

## 1. Introduction

With the development of the Fourth Industrial Revolution (Industry 4.0) to train human resources to contribute to the construction and development of the country, education focuses on forming and developing learners' capacity. SLA is a core competency that every learner needs to study and work [1]. Therefore, the formation and development of this ability is necessary. The authors of many domestic and foreign scientific articles mentioned SLA. In the world, some typical works mentioned are following: Samaras and colleagues have studied the close relationship between teaching and research; self-study and self-research help improve the quality

teaching for STEM lecturers [2]; The authors Sirisha and Souma studied the influence of SLA on academic achievement; thanks to self-study, students have better academic results, progress in knowledge and the ability to schedule time to perform learning tasks effectively [3]; Min Wu and colleagues studied the influence of self-study and self-adjustment on the academic achievement of Grade 10 students in chemistry. The results showed that most students could study their own and adjust their learning results at a high level [4]. In Vietnam, many researchers have been studied such as Vuong Cam Huong who has presented the SLA framework for high school students [5]. Nguyen Van Dai and Dao Thi Viet Anh have proposed the principles and processes for building a primary competency framework when teaching with the Blended learning model [6]. Ho Thi Loan and Nguyen Thi Hong Phuong have emphasized the role of primary education in learning and life. In addition, these authors also proposed a number of capacity development measures such as organizing group work and discussions during class, activating learning activities through situations, guiding students to read textbooks and references on their own, etc. [7]. Nguyen Minh Giam and colleagues have proposed a specific teaching process using an AI Chatbot to develop SLA. The support of an AI Chatbot can help students study anytime, anywhere, and according to their abilities [8].

"The object of study of Chemistry is substances and metamorphosis" [9]. Therefore, throughout the content circuit, much difficult and abstract knowledge requires learners to spend more time researching, learning, and inculcating knowledge, especially the knowledge of the periodic table of chemical elements. With 9 lessons, the knowledge content is in topic 2 in the 10th-grade Chemistry program. After completing the knowledge related to atomic structure, it is a premise to learn the topic of chemical associations. Therefore, if students do not have a solid foundation of knowledge in this content, it will be difficult for them to acquire knowledge in the next content. Therefore, teachers need to design appropriate teaching activities, promote positivity, and actively explore and grasp learners' knowledge.

The flipped classroom model (FCM) is a modern model that helps improve initiative and positivity, thereby forming and developing SLA. Many educators have been studying this model for more than a decade. In the world, there have been many researches about SLA: David Schultz and colleagues have studied the impact of the reverse classroom model on academic achievement; students are more interested in learning with the labor model than in learning with the traditional classroom model [10]. Michael K. Seery's research suggests that FCM creates a positive classroom, stimulating students' curiosity and interest in learning and acquiring knowledge [11]. Eunice Eyitayo Olakanmi researches the attitudes and achievements of students when using FCM to teach the content of Reaction speed; the acquisition of knowledge becomes more effective because students have time to prepare before coming to class, have many opportunities to interact and discuss with teachers and classmates [12]. In Vietnam, many studies have also affirmed the use of the FCM in teaching to contribute to the development of secondary education, typically scientific articles by the authors: Pham Thi Bich Dao et al. [13], Luong Quoc Thai [14], Nguyen Thi Diem Hang [15], Nguyen Hoang Trang and Bui Thi Thom [16], Pham Thi Binh and Do Xuan Hoa [17].

Based on the above theoretical and practical studies, it can be considered that the use of the FCM is an effective teaching method to achieve the knowledge objectives, and at the same time form and develop capacity. However, in Vietnam, especially in Tay Ninh province, there has been no research on using the flipped classroom model to teach "The Periodic Table of Elements" to grade 10 students to develop self-learning abilities. Based on this premise, selecting and researching the topic of "*Developing self-learning ability for students through teaching The Periodic Table of Elements Chemistry 10 using the flipped classroom model* " is highly necessary.

# 2. Content

## 2.1. Flipped classroom model

### 2.1.1. Concept of the flipped classroom model

According to Marks, FCM is a model with a sequence of learning activities that reverse from the traditional classrooms [18]. There, learners study new knowledge through E-learning lectures and references under the guidance of teachers. When participating in the real class, teachers and students will discuss, share, and solve existing problems [19]. Furthermore, FCM helps students study basic knowledge at home so teachers have more time to organize activities to practice and develop students' abilities [17]. Therefore, FCM emphasizes the role of learners; learners research on their own, and gain knowledge under guidance, through E-learning materials provided before participating in the real class. Teachers monitor and assess the progress of task completion, promptly make adjustments, and provide support when necessary.

### 2.1.2. The process of organizing teaching with the flipped classroom model

According to the research by Nguyen Hoang Trang and Bui Thi Thom [16] along with a study of relevant documents, the process of organizing teaching with the flipped classroom model consists of the following 2 main stages:

*Studying at home:* Teachers choose content, design lectures, and appropriate learning materials, and assign tasks. Students watch lectures and complete assigned tasks before coming to class.

*Studying in class:* Teachers ask students to exchange knowledge that they have studied at home and to discuss the problems that students do not understand and do not know. Afterward, teachers answer questions and conclude. Teachers and students evaluate and self-evaluate the effectiveness of self-study, find solutions, adjust, and overcome difficulties.

## 2.2. Ability and self-learning ability

### 2.2.1. Concept of ability and self-learning ability

According to the Vietnamese and Cambridge Dictionary, ability is the capacity to perform and complete a specific task. According to the General Education Program of the overall program, "ability is an individual attribute that is formed and developed through the available qualities and the process of learning, training, successfully performing a certain activity, achieving desired results under specific conditions" [1]. Thus, ability can be understood as the capacity of learners to perform a specific task through their knowledge and experience.

Self-learning ability is an important competency that needs to be developed in the new age. According to Luong Quoc Thai [14], self-learning ability is the capacity of learners to perform knowledge activities on their own to solve defined learning tasks. Thus, self-learning ability can be understood as the capacity of learners to gain new knowledge and skills through their existing knowledge and experience.

### 2.2.2. Structure of self-learning ability

Based on the general education program of 2018 [1] and a study by Nguyen Van Dai and Dao Thi Viet Anh about the design of a competency framework to include 4 competency components and 10 criteria, each of which has 3 levels [6], we recognize that SLA includes component competencies (CC) and manifestations (M) as shown in Table 1.

*Table 1. Competency components and manifestations of self-learning ability*

| Competency components | Manifestations |
|---|---|
| CC1. Identifying and creating a study plan | M1. Identifying study objectives.<br>M2. Creating and adjusting a study plan |
| CC2. Implementing a study plan | M3. Implementing learning with the provided E-learning<br>M4. Searching for relevant information and documents<br>M5. Communicating and connecting with teachers and friends.<br>M6. Recording and presenting learning results |
| CC3. Evaluating outcomes and adjusting learning | M7. Evaluating outcomes and adjusting learning |

**2.2.3. Developing a set of tools to assess self-learning ability**

*Assessment objectives:* To provide a timely and accurate manner, the requirements and levels of achievement corresponding to each component capacity of SLA, reflect the progress of students, which is the basis for adjusting teaching activities and improving the quality of education.

Through the study of relevant documents, we found that SLA can be assessed through the following tools:

*Scale:* used to assess throughout the process from studying at home to participating in studying in class. This is a tool used to measure the levels of achievement of each expression of each specific component competency of SLA. In this article, the research scale consists of 3 component competencies equivalent to 7 manifestations, each of which has 5 specific levels as follows: 1-Not participating; 2-Not yet achieved; 3-Pass; 4-Good; 5-Very good. Details of the scale are mentioned in the following link: scale.pdf.

*Checklist:* used for teachers and students to evaluate the criteria that students have fulfilled or not done. This helps teachers and students evaluate an overview of manifestations of SLA. The contents of the checklist are detailed in Table 2.

*Table 2. The checklist evaluates the students' self-learning ability using the flipped classroom model*

| No. | Criteria | Yes | No |
|---|---|---|---|
| 1 | Students identify specific, clear and detailed study objectives. | ☐ | ☐ |
| 2 | Students identify learning tasks and make effective learning plans. | ☐ | ☐ |
| 3 | Students participate in studying the E-learning. | ☐ | ☐ |
| 4 | Students complete at least 50% of the test in the E-learning. | ☐ | ☐ |
| 5 | Students complete 50% of the study sheet related to the lesson. | ☐ | ☐ |
| 6 | Students discuss the problems of the lesson with teachers and friends. | ☐ | ☐ |
| 7 | Students correctly answer 50% of the test when studying in class. | ☐ | ☐ |
| 8 | Students participate in learning activities actively. | ☐ | ☐ |
| 9 | Students record videos and take photos of the E-learning process. | ☐ | ☐ |
| 10 | Students discover the cause of the errors and propose solutions. | ☐ | ☐ |

*Using chemistry exercises:* This is used to assess the level of knowledge gained when students study with the flipped classroom model. The exercises in this article, mostly multiple-choice questions,

are integrated into E-learning. Besides, these exercises are used as a test after self-study at home through educational games such as Kahoot, quizizz, etc. The details of the exercises are updated on the following link: exercises.pdf.

*Learning products:* This can be seen as proof that students really participate in serious learning with the labor model and this is also one of the effective tools used to evaluate SLA. The learning products in the research are learning sheets, images, videos, and students' answers.

*Assessment time:* While the students participate in learning activities at home with E-learning, the teachers assign them to scale and checklist to define tasks. After studying in class, based on the scores of exams and learning products, both students and teachers evaluate the results. Chemistry exercises are integrated into E-learning to test students' ability to gain new knowledge. They are also used for the test (Exam.pdf) when the students take part in studying in class.

## 2.3. The reality of applying the flipped classroom model to teach chemistry at high schools in Tay Ninh province

Through a survey of 35 teachers (survey link: https://forms.office.com/r/mh6z1RqSR2) at a number of high schools in Tay Ninh province, the results are as follows: 82.9% of the teachers think that the formation and development of SLA for high school students is necessary. From 74.3% to 82.8% of the teachers identify the concept of SLA. This proves that the majority of high school teachers in Tay Ninh province have researched and are interested in forming and developing it for students. However, the formation and development of this capacity in high schools still face many difficulties such as large classes, passive students, and lack of attention. In addition, chemistry is a difficult subject that makes students easily depressed; many schools still lack supporting facilities.

On the other hand, through the study of scientific literature, we found that it is possible to use the flipped classroom model in teaching to develop self-learning capacity. However, from the survey results, 97% of the teachers have heard of this model, only 18% of them have applied it and 12% of them have applied it effectively. Thus, currently, the FCM has not been widely used by chemistry teachers in high schools to form and develop self-learning capacity for students.

Through a survey of 116 students (survey link: https://forms.office.com/r/j9b6F6tb3a) from a number of high schools in Tay Ninh province, 78.5% of the students believe that self-study before studying in class is necessary and as many as 81.9% of teachers in high schools assign learning tasks to students to study at home on regular and very regular bases. However, the majority (70.7%) of the tasks assigned by teachers are questions after each lesson, or through applications such as Azota, Google Meet, etc (about 58.7%). However, using azota is the most common (44.3%).

Thus, teachers are not interested in using the FCM in teaching chemistry in high schools to develop students' SLA; most of the studying tasks at home are assigned in the form of questions after the lesson or testing the knowledge learned online. Forming and developing this ability for high school students has not been taken seriously. Therefore, it is necessary to study the use of the flipped classroom model in teaching the periodic table of chemical elements to develop self-learning capacity for grade 10 students.

## 2.4. Design of the lesson plan

*Lesson plan structure of The Periodic Table of Elements*

*\* Objective*

| General capacity | Requirements | Encode |
|---|---|---|
| Self-learning | - Identifying and creating a study plan | CC1 |
| | - Implementing a study plan | CC2 |
| | - Evaluating outcomes and adjusting learning | CC3 |
| Communication and cooperation | Being confident, actively communicating, and discussing with teachers and friends. | GT-HT |
| **Chemical capacity** | **Requirements** | **Encode** |
| Expertise (E) | - Duplicating the history of the invention of the Periodic Law and The Periodic Table of Elements. | E1 |
| | - Describing the composition of The Periodic Table of Elements and state-related concepts (cells, periods, groups). | E2 |
| | - Duplicating the arrangement principle of The Periodic Table of Elements (based on electron configuration). | E3 |
| | - Classification of elements (based on electron profiles: elements s, p, d, f; based on chemical properties: metals, non-metals, rare gases). | E4 |
| **Qualitative** | **Requirements** | **Encode** |
| Responsibility | Responsible for performing learning tasks. | TrN |

*\* Equipment and educational resources*

*- Equipment:* Teachers: Projectors, computers, ipads, etc; Students: Phone/computer. etc.

*- Educational resources:* Chemistry textbook 10; Study sheets 01, 02 (PHT 01, PHT 02): study sheet.pdf.

- E-learning: https://olm.vn/chu-de/xu-huong-bien-doi-va-dinh-luat-tuan-hoan-2259421356/?i_c=115344269512.

*\* Lesson Organization Process*

*Stage 1: Studying at home (2 weeks).*

Activity: Learning with E-learning.

*- Objectives:* CC1, CC2, E1, E2, E3, E4, TrN.

*- Implementation:*

+ Teachers create classes and accounts for students on the *Olm.vn* website.

+ Students read textbooks, identify objective, make learning plans at home; watch E-learning published on the website: https://olm.vn/ (https://olm.vn/chu-de/xu-huong-bien-doi-va-dinh-luat-tuan-hoan-2259421356/?i_c=115344269512); complete PHT 01 (study sheet.pdf) and questions; record the learning process at home.

*- Assessment method:* Teachers use observation methods, based on learning results with E-learning, and record worksheets to assess CC1, CC2, E1, E2, E3, E4, and TrN.

*Stage 2: Studying in class.*

*Activity 1: Testing and concluding the knowledge (15 minutes).*

- *Objectives:* CC2, E1, E2, E3, E4, TrN, GT-HT.

- *Implementation:*

+ Students answer questions on Kahoot (link: https://create.kahoot.it/share/cau-tao-bang-tuan-hoan/ d5eab715-c23f-4efc-9016-c3e96b1a60f3).

+ Teachers check students' answers.

+ Students present unclear contents; the teacher answers questions and concludes the knowledge.

- *Assessment method:* Teachers use observation and Q&A methods, based on students' answers and questions to assess CC2, E1, E2, E3, E4, TrN, and GT-HT.

*Activity 2: Practice (20 minutes).*

- *Objectives:* Revision, CC2, TrN, GT-HT

- *Implementation:*

+ Students discuss in small groups (2 students/group) for 7 minutes, complete PHT 02.

+ Teachers randomly call some groups to report the results.

+ Teachers conclude.

- *Assessment method:* Teachers use observation and Q&A methods, based on students' answers to assess CC2, TrN, and GT-HT.

*Activity 3: Discussion (10 minutes).*

- *Objectives:* CC2, CC3, TN, GT-HT.

- *Implementation:*

+ Students discuss in small groups (2 students/group) for 5 minutes to share about experiences of studying with E-learning and offer direction.

+ Students assess themself and cross-evaluate the manifestations of self-learning ability through scale and checklist.

+ Teacher randomly calls some students to share and summarize.

- *Assessment method:* Teachers use observation and Q&A methods, based on students' answers to assess CC2, CC3, TN, GT-HT.

*Thus,* through observation, Q&A, products, and assessment tools (scales, checklists), teachers and students can evaluate the component competencies of SLA. Designing and implementing a teaching plan using a flipped classroom model can develop student's competence (specifically SLA).

## 2.5. Pedagogical experiments

### * Subjects

Sample: 34 students include in 10A1 (23 students) and 10I1 (11 students) of IGC Tay Ninh School, Tay Ninh City, Tay Ninh province.

Research design: One-group pretest-posttest design.

### * Results

From the data collected during the experiment, the following chart shows that before the intervention, the proportion of students reaching levels 1, 2, and 3 was higher than after the intervention. Otherwise, the proportion of students who reach level 5 is lower than after the intervention.
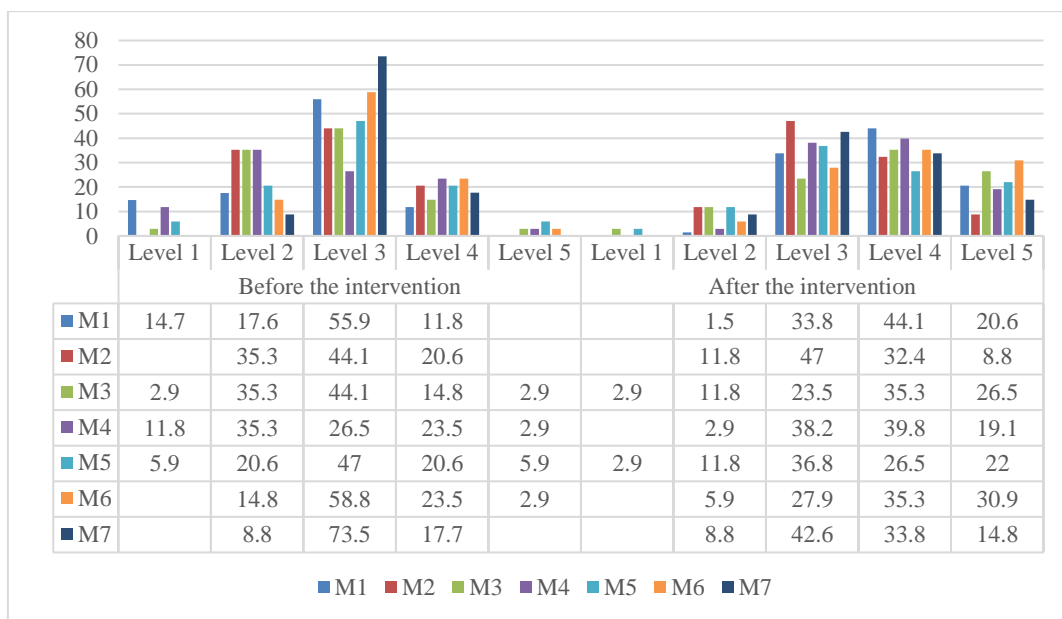
| | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Before the intervention | | | | | After the intervention | | | | |
| ■M1 | 14.7 | 17.6 | 55.9 | 11.8 | | | 1.5 | 33.8 | 44.1 | 20.6 |
| ■M2 | | 35.3 | 44.1 | 20.6 | | | 11.8 | 47 | 32.4 | 8.8 |
| ■M3 | 2.9 | 35.3 | 44.1 | 14.8 | 2.9 | 2.9 | 11.8 | 23.5 | 35.3 | 26.5 |
| ■M4 | 11.8 | 35.3 | 26.5 | 23.5 | 2.9 | | 2.9 | 38.2 | 39.8 | 19.1 |
| ■M5 | 5.9 | 20.6 | 47 | 20.6 | 5.9 | 2.9 | 11.8 | 36.8 | 26.5 | 22 |
| ■M6 | | 14.8 | 58.8 | 23.5 | 2.9 | | 5.9 | 27.9 | 35.3 | 30.9 |
| ■M7 | | 8.8 | 73.5 | 17.7 | | | 8.8 | 42.6 | 33.8 | 14.8 |

■M1 ■M2 ■M3 ■M4 ■M5 ■M6 ■M7

***Figure 1. Evaluation results before and after the intervention of an experimental group***

***Table 3. Statistics of test results before and after the intervention of an experimental group***

| Tests | GPA ($\overline{X}$) | Variance ($s_i^2$) | Standard deviation (SD) | Dependent t-test | Impact (ES) |
|---|---|---|---|---|---|
| Before the intervention | 5.69 | 0.926 | 0.858 | $5.81.10^{-5}$ | 1.11 |
| After the intervention | 6.64 | 0.908 | 0.824 | | |

In addition, the results of the two tests before and after the intervention show that students can acquire knowledge better. On the 10-point scale, the GPA of the test after the intervention is fairly good (6.64) and is higher than before the intervention (5.69). Besides, standard deviation measures the extent of scattering in a set of values, compared to the mean value of the set. In this study, the standard deviation is small (SD < 1). This shows that data are clustered tightly around the mean. Furthermore, the dependent t-test value is also small (t-test value < 0.05). This indicates that the results are significant. On the other hand, the impact ES of value is large (1.11), and the results show that the intervention has effects on students. Therefore, based on these results, using the flipped classroom model to teach the topic of a Periodic Table of Elements completely affects the achievement and develops the students' self-study ability.

## 3. Conclusions

The results of surveys at several high schools in Tay Ninh province show that the development of SLA is important and necessary. Besides, most of the teachers have researched FCM. A few teachers have applied it but using is still limited. The reason for the reality is that as classes are crowded, applying this model takes a lot of time.

The authors designed and implemented a lesson plan about the topic of "The Periodic Table of Elements". The results of the exam after the intervention show that most of the students can

acquire knowledge better after learning with FCM. Moreover, assessment tools are designed, and the students' self-learning ability is evaluated.

In summary, nowadays, the development of the self-learning ability for students is highly necessary. It not only helps students become better but also contributes to developing high-quality human resources for the country. Moreover, to adapt to the trend of modern education, teachers need to enhance knowledge and change teaching methods. The flipped classroom model is a positive teaching model that teachers can consider and choose to develop students' abilities.

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