Applied in Organic Chemistry: Pre-service Teachers Training through Situational Simulation Teaching Method

Wanmei Li[1]*, Yani Ouyang[1] & Jun Xu[1]

[1]College of Material Chemistry and Chemical Engineering, Hangzhou Normal University, Hangzhou- 311121, China

Correspondence: Wanmei Li, College of Material, Chemistry and Chemical Engineering, Key Laboratory of Organosilicon Chemistry and Material Technology, Ministry of Education, Key Laboratory of Organosilicon Material Technology, Hangzhou Normal University, Hangzhou 310036, China. E-mail: liwanmei@hznu.edu.cn

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Abstract

Situational simulation teaching method (SST mentioned below) is a mature teaching method that has been applied. It has been widely used in foreign language, law, management, clinical and other fields, and has been proved to have good teaching effect. The quality of teachers is the key to improve the international competitiveness of China's education system. With the growth of China's population and the reform and development of education, the training of pre-service teachers has become a public concern. According to the existing research, most of the pre-service teachers have good academic and moral qualities, but there are still deficiencies in teaching ability, management ability and communication ability. .In view of this phenomenon, this paper puts forward a scheme of training chemistry pre-service teachers by using SST method through the way of organic chemistry teaching reform. The results show that SST method can improve students' learning quality and cultivate students' comprehensive abilities (including pre-service teachers' professional skills).

Keywords: situational simulation teaching method, organic chemistry, pre-service student teachers, core literacy

1. The Introduction of SST

The SST method is a virtual and practical training method that helps students acquire knowledge and improve their abilities in highly simulated situations, by envisaging specific scenarios that bear a semblance to actual work or life situations related to pedagogy (Wu, Xu, & Qian, 2021). This process involves students taking on different roles in each scenario to complete a series of tasks, guided and evaluated by the teachers overseeing the process (Han, 2022). So far, SST has been widely used in the training of professionals associated with English (Abdyhalykova, 2016), Chinese (Chang, Chen, & Liao, 2020), Management (Chen, 2019) and Nursing (Pu & Yang, 2022; Gong, et al., 2022), but their application in the teaching of organic chemistry has rarely been reported. Therefore, this study explored the application of SST to an organic chemistry class. SST mode refers to the design of a practice scenario in which students play three different roles of teachers, students and parents, so as to cultivate students' speech skills, test students' professional skills and train students' communication skills (Xiao, et al., 2022). The three kinds of role play form a joint force to construct the SST teaching model. This mode helps lay a solid foundation for their future as teachers. The main subject of the SST is the student and it fully respects the students' subjective status and mobilizes their initiative in learning.

In addition, SST can also promote the cultivation of tertiary students' core literacy. The core quality of students includes cultural foundation, independent development and social participation. SST model requires students to study independently, analyze and solve problems independently, and give full play to the spirit of exploration and innovation. These requirements can enhance the cultural foundation of students and promote their independent development. Among them, the mode of scenario practice is also a disguised practice activity, which is the application of theory and practice, so it can also improve students' social participation. SST mode is a measure of killing three birds with one stone and a research with potential value.

Nowadays, tertiary students are an important source of pre-service teachers. A large number of pre-service teachers are trained by tertiary students. In fact, in the process of training tertiary students, we pay too much attention to the cultivation of professional knowledge, ideology and morality, and neglect the cultivation of professional skills (Wang, 2020; Jiang & Zhou, 2021). Therefore, in the process of teaching, it is imperative to improve the basic teaching skills

(including teaching, management and communication abilities still) of tertiary students. Organic chemistry is an important basic course for training chemistry teachers. Through the reform of teaching methods in organic chemistry, it has become a feasible way to improve the teachers' skills of tertiary students. Therefore, this paper proposes the introduction of an SST method in organic chemistry teaching to achieve a better development of core literacy and basic skills of tertiary students, and lay a solid foundation for their internship and subsequent entry into the teaching profession.

2. Specific Implementation of SST in Organic Chemistry Teaching

2.1 Objectives and Purposes of SST

Solid professional knowledge and effective basic skills of teachers are the necessary conditions for chemical tertiary students to enter the teaching profession. SST took tertiary students as the object. By designing practice scenarios and using the knowledge reserves of the university to simulate high school classes, it helped students to truly experience the daily work and responsibilities of teachers, gained working experience of teachers, and improved their professional ethics (Cai & Liu, 2022; Jin, 2019). In this process, the chemical professional knowledge of tertiary students would be consolidated, and the basic skills would be improved so as to achieve the goal of improving the core literacy of tertiary students and laying a solid foundation for the educational careers of tertiary students (Li, Ouyang, & Xu Jun, 2022).

2.2 Implementation of SST

SST was conducted based on the existing theoretical knowledge of chemistry. A typical duration of an organic chemistry class is 135 minutes (3×45 min). The main part of the class taught the basic knowledge of organic chemistry by the teacher. In the last half hour of the class, SST was adopted and taught by students to cultivate the teacher skills of tertiary students. Based on the basic knowledge of College Organic Chemistry, the SST created a high school class scene (Figure. 1).

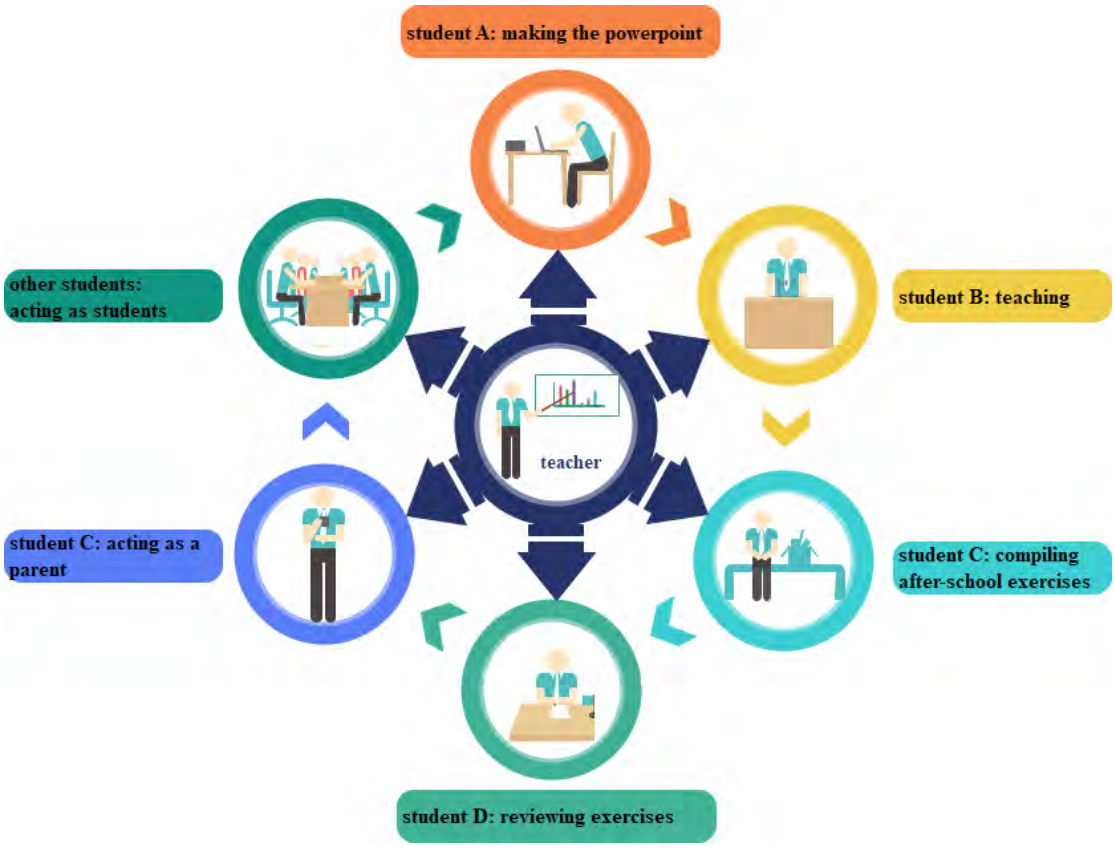

Figure 1. The model of SST method

There were 40 students in a class, and 8 groups were formed (5 members in a group), and one group was assigned to give lectures in each class. Five members in each group were responsible for different tasks, with one member creating the powerpoint (student A), one teaching (student B), one compiling after-school exercises (student C), one reviewing exercises (student D), one acting as a parent (student E), and other students in the class acting as students for scenario simulation. The first four students act as teachers and shared different work tasks as teachers, and the last student act as a parent. The SST proposed in this paper was that students played three different roles in real life: teacher, student and parent.

(1) Student A: This student is responsible for creating the powerpoint (PPT) presentation. PPT is one of the popular teaching tools for teachers in class and is one of the important teaching means of multimedia teaching. On the surface, the production of a PPT presentation may exercise the ability of tertiary students to create their own PPT, and have students appreciate the hard work teachers invest in creating effective PPTS. In essence, PPTS provides the opportunity to train tertiary students' ability to summarize (Kin, 2020), and mirror the quality of a teacher's teaching ability.

(2) Student B: This student was mainly responsible for the presentation and teaching of the PPT. As teaching is the most important part of the class, the student in charge of this task had the greatest pressure and difficulty. The purpose of allowing students to teach is to address the issue that many teachers lack effective teaching skills. Teaching cultivates tertiary students' lecture skills and the standardization of blackboard writing (Thomson, 2022). Tertiary students need to build up their skills through lectures in the areas of ~~as~~ knowledge refining, language, and emergency response ability, and lecture manners (Peiser, Pratt, & Putwain, 2022).

(3) Student C: The compilation exercises need to be determined according to the content of the presenter. The person who compiled these exercises needed to have enough understanding of the knowledge, the ability to screen and summarize the knowledge, and the ability to judge the difficulty of the knowledge. The difficulty of the compiled exercises should be moderate and in line with the law of students' cognitive development. The compilation of exercises belonged to the after-school task, and were distributed to the students online. After students finished, they would be returned to the person who reviewed the exercises.

(4) Student D: Students who were responsible for reviewing exercises needed to analyze the completion of exercises and summarize the key and difficult points in the class. In this way, teachers can grasp the difficult points and knowledge points that the students have not mastered. Marking exercises can not only cultivate tertiary students' ability to analyze learning situations and summarize knowledge, but also learn different problem-solving ideas from others' homework and expand their knowledge (Langberg, 2017).

(5) Student E: The role of parents is the object of learning feedback. By creating the role of parents, the project could cultivate the communication and adaptability of tertiary students. Effective teachers need the ability to communicate with others skillfully. How to communicate effectively with parents is a compulsory requirement for every teacher (Wendelin & Danielson, 2010). The education of every child needs the joint support of teachers and parents, and the success of every child is the result of the joint efforts of teachers and parents, so the skill of communicating with parents is equally important (Abel & Kiat, 2021).

(6) The other students: The remaining students were responsible for interacting with the trainee teacher in the class and were the subject of the learning analysis.

Each group was responsible for talking about a kind of chemical compound. Five people needed to prepare lessons before class, so that students could experience the teacher's lesson preparation process and learn how to prepare lessons. The whole scene simulation process was guided, assisted, evaluated, and summarized by the teacher (Figure. 2).

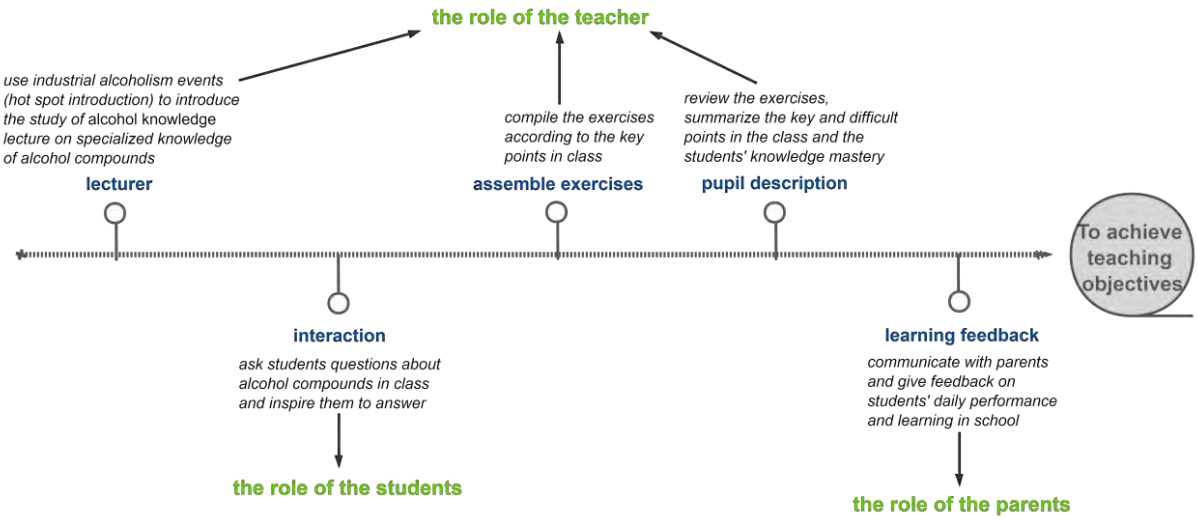

Figure 2. The model of scenario simulation process with "alcohol" as an example

Taking the chapter of alcohol as an example, the class may proceed like this: using real-time to import the new lesson, completing the learning of alcohol-related knowledge through interaction with students, formulating after-school exercises according to the teaching progress, then analyzing the completion degree of students' practice and summarizing the key and difficult points, and then reflecting the students' performance in school to their parents after school. The feedback led the teacher to adjust the course progress and the distribution of key and difficult points in order to achieve the requirements of teaching objectives.

2.3 Evaluation of SST

After the scenario simulation, teachers' evaluation and explanations were carried out and the accurate evaluation and guidance of teachers will directly affect the final teaching performance. Firstly, the teacher gave opinions and comments on the production of student A's PPT, and pointed out the advantages and disadvantages. The teacher gave guidance and evaluation on the expression and manners of student B in the teaching process, and then gave opinions and evaluation on the integrity and difficulty of exercises compiled by student C. According to the completion degree of students' practices and the feedback with their parents, teachers gave an appropriate evaluation. Teachers should comprehensively assess students' knowledge mastery, teaching process, homework completion, basic skills of normal students, teamwork ability and other aspects around teaching objectives, so as to guide students to realize their own advantages and disadvantages. In addition to the final examination results, scenario simulation should also account for the corresponding score proportion in the final evaluation of this course. Comprehensive evaluations can accurately locate and comprehensively assess students Unsure what you mean here - rephrase (Yao, 2022).

3. Results and Discussion

Because this teaching method took a long time to achieve its effect. Therefore, In order to prove the effectiveness of this teaching method, we compared the grades of students from 2017 to 2020, and also conducted a return investigation to the students who used this method.

3.1 Teaching Effects

The sample comprised the grades of tertiary students majoring in Chemistry for four consecutive semesters (2017-2020). The SST method was used for organic chemistry teaching in 2019−2020, while the traditional script-oriented teaching method was used in 2017−2018. The students' examination scores from 2017 to 2020 were calculated, and the results are shown in Figure 3.

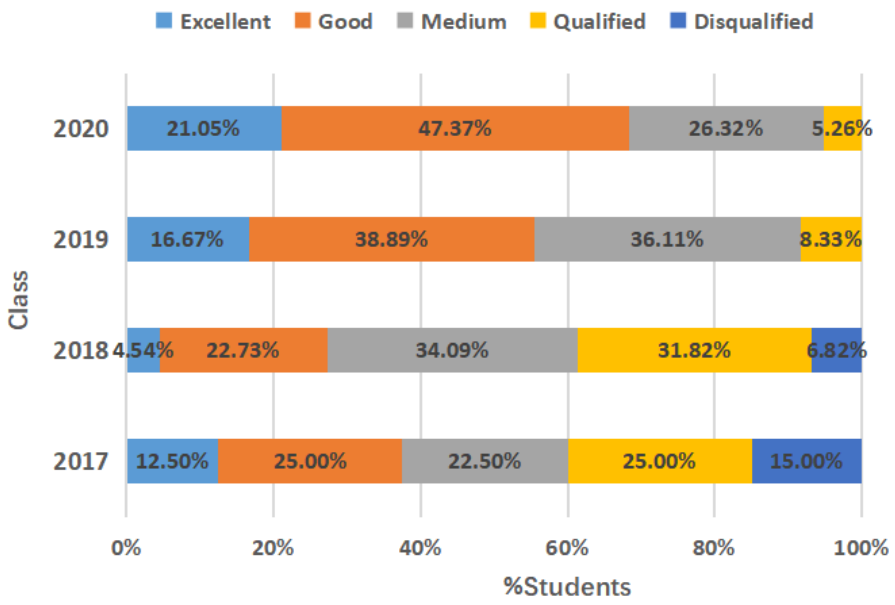

Figure 3. Assessment levels of the tertiary students in 2017–2020

The project analyzed the assessments levels of undergraduates in the chemistry class from 2017 to 2020. Assessments were divided into five levels: disqualified (below 60), qualified (60–69), medium (70–79), good (80–89), and excellent (90 and above) (Zheng, 2020). As Figure 3 shows, in 2017 and 2018 when no SST was used, the ratio of excellent students and good students were low. By comparison, the ratio of medium students and qualified students were high. Moreover, there were 15.00% of students and 6.82% of students who failed in 2017 and 2018 respectively. With the implementation of SST method from 2019 to 2020, the ratio of excellent and good students increased, the ratio of medium and qualified students decreased, and the number of disqualified students dropped to zero in 2019 and 2020. Thus, it can be seen that the SST can improve students' performance, greatly better the rate of excellence, and drastically reduce the rate of failure.

There are 40 graduates every year. The average score of students is obtained by dividing the total score of students by the number of students. The average scores of chemistry undergraduates from 2017 to 2020 were calculated, and the results are shown in Figure 4.

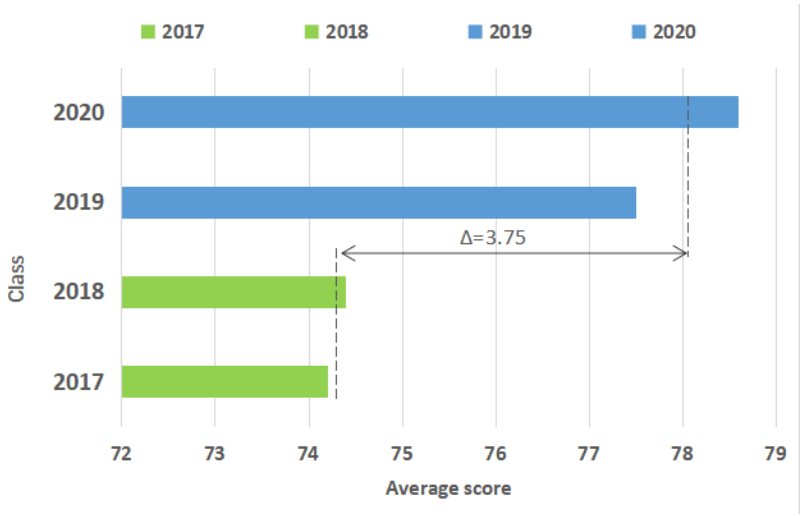

Figure 4. Average scores of tertiary students in 2017−2020

The average scores increased after the implementation of SST, which was convincing evidence of its teaching effect. The average scores for 2017 and 2018 were 74.3, and those for 2019 and 2020 were 78.05, up by 3.75 points, showing an obvious trend of improvement.

3.2 Interest Survey

After teaching tertiary students with SST method who majored in organic chemistry in 2019−2020, a questionnaire entitled "Improvement of organic chemistry learning quality in SST method" was distributed to them in an effort to obtain their opinions about the SST. There were 40 graduates every year, and all 80 participant questionnaires were returned. The questionnaire comprised five questions to evaluate the assistance of SST to the learning of organic chemistry and future careers of tertiary students and the training of tertiary university students' in acquisition of skills, their learning interest, and whether they will continue using the teaching method. Possible answers to all five questions ranged from *strongly disagree to strongly agree,* and the results are shown in Figure 5.

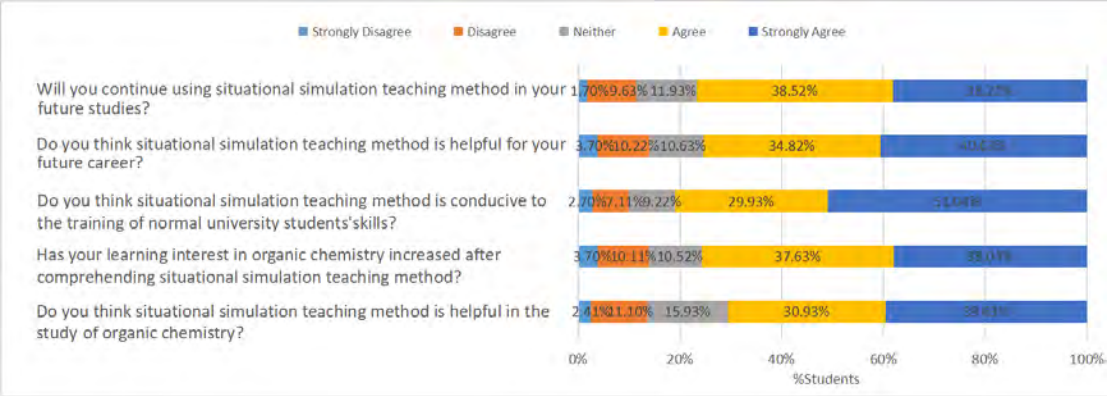

Figure 5. Questionnaire administered to undergraduates major in organic chemistry in 2019−2020

It can be seen that more than half of the students answered positively to the five questions, with less than 5% of the students answering negatively. Overall, 76.74% of the students indicated that they hoped for the continued implementation of SST. Moreover, 75.45% of the students indicated they agreed that the SST was helpful for their future careers and 80.97% indicated they agreed that the SST was conducive to the training of normal university students' skills. Further, 75.67% of the students indicated that they agreed that the SST can increase their learning interest and 70.56% indicated that they agreed that the SST was helpful in the study of organic chemistry. This provided favorable evidence for the contribution of SST in the cultivation of core literacy of normal university students.

3.3 Results of Quantitative Analysis

The implementation of SST method is not only effective in the achievement, but also helpful to the students' language expression ability, self-regulation ability, teaching ability and other incentive factors. Considering the possibility of Hawthorne effect, we added the study of other dependent variables.

Means and standard deviations for all dependent variables in 2017-2020 are displayed in Table 1 for the experimental and control groups separately.

Table 1. Means and standard deviations for the dependent variables

Dependent variables	Range	Control group（N=40）				Experimental group（N=40）			
		2017		2018		2019		2020	
		M_1	SD_1	M_2	SD_2	M_3	SD_3	M_4	SD_4
Achievement	1-100	74.2	9.362	74.4	9.223	77.5	7.408	78.6	7.117
Language expression	1-10	5.015	1.497	5.195	1.424	6.083	1.133	6.507	0.991
Deportment	1-10	6.299	0.978	6.595	1.038	7.329	0.679	7.651	0.625
Metacognitive self-regulation	1-10	5.099	1.463	5.074	1.379	5.274	1.325	5.409	1.239
Teaching ability	1-10	4.575	1.089	4.451	0.966	6.251	1.058	6.418	0.895

The mean scores of most basic skills were below the mid-point of 1-10 score range in control groups, above the mid-point of 1-10 score range in experimental groups (Cansel & Esen, 2020). Among them, the average score of language expression (an increase of 1.069 points) and teaching ability (an increase of 1.676 points) improved the most. The mean scores on the achievement indicated that students in the experimental group had significantly higher scores ($M_3 = 77.5$, $SD_3 = 7.408$; $M_4 = 78.6$, $SD_4 = 7.117$) than those in the control group ($M_1 = 74.2$, $SD_1 = 9.362$; $M_2 = 74.4$, $SD_2 = 9.223$). This study proved that SST method not only improved the achievement, but also was of great significance to the cultivation of various basic skills of normal students.

This study was conducted to test whether SST method created any significant difference in grades among control groups and experimental groups (Aysegul & Esen, 2017). The t-test is one of the most commonly used statistical methods in behavioral and social sciences, especially in teaching studies (Shrimathy, Parag, & Anand, 2019). After satisfying all the assumptions of t-test, t-test was run for the post-test scores. Table 2 depicts the t-test results.

Table 2. Results of t-test for the achievements

Effect		t_1	t_2	$t_\alpha(p=0.1)$	$t_\alpha(p=0.05)$
Treatment	T-test	1.7705	2.3964	1.686	2.024

Achievement improvement from pre-tests to post-tests was observed in Table 2, derived using paired sample t-test. However, no significant difference was observed while comparing the improvement scores of post-test in 2019 with pre-test in 2017 (t_1=1.7705, 0.1>p>0.05). The results of t-test indicated that there was a statistically significant mean difference between the experimental group in 2020 and control group in 2017 in terms of students' achievement (t_2=2.3964, p<0.05). These findings implied that the difference between the control and experimental groups arose from the application of SST method and had practical value.

3.4 Significance and Thinking

3.4.1 It is good for students to combine theory and practice and establish chemical thinking (Danuta & Patrycja, 2018)

The SST method creates a realistic working situation and applies theoretical knowledge learned in practice through lectures. As future teachers, both reserves of theoretical knowledge and practical skills of normal students are crucial. The study of theoretical knowledge and the cultivation of practical skills are two compulsory courses. Only the thorough combination of theory and practice can make tertiary students shine in their future teaching career. The advantage of combining theory and practice lies in avoiding dogmatism and empiricism, giving full play to students' subjective initiative, improving their mastery and application of theoretical knowledge, and enabling them to gradually develop chemical thinking in analyzing and solving problems and in terms of the core concepts of chemistry.

3.4.2 It is conducive to the cultivation of students' self-learning ability and basic skills of teachers (Leonie & Nicole, 2020; Yoder, Donna, & Sawicki, 2019)

Students are the main subjects of pedagogy, and the implementation of the SST improves on the traditional teaching method and allows students to participate in the class, mobilizing their enthusiasm to learn and turning passive learning into active learning. By preparing lessons and consulting materials by themselves, students can engage in effective, thoughtful, and independent learning, which helps them to have a deeper impression of the knowledge imparted to them and internalize it better. At the same time, lecturing is a necessary skill for normal students, and role-playing and task-assignment in SST can help students understand every aspect of the teaching process, which will enhance their future professional abilities.

3.4.3 It is conducive to promoting students' understanding of the teaching profession and the cultivation of professional ethics of teachers (Liu & Su, 2018).

By assuming and experiencing various roles in SST, students gain a holistic understanding and knowledge of the teaching profession, some psychological preparations, and practical experience that may appear in their future teaching careers. By playing the role of a teacher, students assume the teachers' perspective which helps them develop their professional ethics.

3.4.4 Beneficial to the improvement of teaching quality (Alfredo, et al., 2017)

By replacing traditional teaching with SST, students will be able to devote themselves to the class, and their performance will be related to their final assessment. Thus, they will be more attentive to the tasks in the class. Most importantly, SST is relevant to their future careers in terms of the criticality of knowledge and experience gained during this process. The implementation of SST will not only greatly promote the development of core literacy of tertiary students, but will also improve the overall quality of teaching and learning.

4. Conclusion

The results show that SST can not only improve students' academic performance, greatly improve the excellent rate, greatly reduce the failure rate, but also improve the average class score. According to the survey, more students agree and enjoy to use SST teaching method. The results of t-test indicated that there was a statistically significant mean difference between the experimental group and control group in terms of students' achievement. These findings implied that the application of SST method had practical value.

As an innovative teaching method, SST is different from the traditional teaching preparation as it stimulates students' interest in the class, mobilizes students' learning enthusiasm and subjective initiative, and makes up for the shortcomings of traditional teaching methods. At the same time, the ingenious combination of teachers' skills and teaching is conducive to the development and implementation of organic chemistry teaching. SST can promote the mastery and consolidation of knowledge, effectively train the basic skills of normal students, and promote the transformation of tertiary students into chemistry teachers. However, the SST method still has issues of limited class hours and heavy learning tasks, the application scope is very narrow, and it currently is not popular. Through reading the existing literature, it is found that the applicable disciplines of SST method are also very limited, and it is more suitable for the disciplines that are closely related to life or can be applied to the actual scenes of social life. At the sometimes, this innovative teaching method has high requirements for students. For students with poor grades, the burden of study is too big, and it is difficult to keep up with the progress of class. Therefore, the teaching method still needs to be further improved and explored.

Author information

Corresponding Author

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