
ANALYSIS THE 21ST CENTURY SKILLS OF STUDENTS IN CHEMICAL EQUILIBRIUM LEARNING WITH FLIPPED CLASSROOM-COLLABORATIVE PROBLEM SOLVING MODEL

Prita Atria Karyadi¹, Maria Paristiowati^{1*} and Afrizal¹

¹*Chemistry Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta, Jl. Rawamangun Muka, RT.11 / RW.14, Rawamangun, Kec. Pulo Gadung, Kota Jakarta Timur, Special Capital Region of Jakarta 13220, Indonesia*

**E-mail: maria.paristiowati@unj.ac.id*

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ABSTRACT

This study aimed to analyze the 21st century skills of students in learning chemical equilibrium with the Flipped Classroom-Collaborative Problem Solving model. Flipped Classroom is a learning model that students learn first outside the classroom through video, then carry out active activities in class such as discussions, presentations, making posters, and doing practicum. Collaborative problem solving is done when students discuss in solving problems for each learning activity. The research method used descriptive qualitative method. Data collection techniques were: observation, interviews, questionnaires, and reflective journals. Data analysis consisted of several stages, namely data collection, data reduction, data presentation, and verification or conclusions. Based on data analysis, this learning model made students active in learning and also made the students learn independently outside the classroom using mobile learning and searching some sources of references. In addition, students were actively involved in problem solving discussions, presentations, making projects, and practicums that were designed by students themselves. Thus it can be concluded that the Flipped Classroom-Collaborative Problem Solving learning model can train and grow students critical thinking skills, creativity and innovation skills, communication skills, and collaborative skills in learning chemical equilibrium.

Keywords: 21st century skills, flipped classroom, collaborative problem solving

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1. INTRODUCTION

Education in Indonesia refers to the 2013 curriculum which has targets with criteria that are expected for a good employee in the world of work. Several criteria are expected to appear in the world of work, including; having the ability to solve problems (Problem Solving Skills), having the ability to work in teams (Ability to work in a team), having good skills (Communication skills), and having creativity (Creativity) (Koc et al., 2018). These abilities are challenges of the 21st century that students must carry out in the process of learning. The

current learning process also leads to 21st century learning that has the main principle that learning must be student-centered, collaborative, contextual, and integrated with the community (Zubaidah, 2016).

The Partnership for 21st Century Skills (P21), identified the competencies needed in the 21st century, namely "The 4Cs"- communication, collaboration, critical thinking, and creativity (Zubaidah, 2016). Students can convey ideas quickly and clearly (Communication), students can also work together to achieve the same goal (Collaboration), have the ability to solve problems (Critical thinking), and have the

ability to think out of the box (Creativity) (Roekel, 2010). These four skills are the objectives of the learning process. Therefore, teachers must prepare all forms of learning to grow and develop the four skills.

In addition, the 21st century has entered the era of the industrial revolution 4.0. In general, the definition of an industrial revolution is when major technological advances are accompanied by significant socio-economic and cultural changes. The terminology of the Industrial Revolution 4.0 was first recognized in Germany in 2011. Industry 4.0 was marked by strong integration between the digital world and industrial production. The industrial revolution 4.0 is a digital era when all machines are connected through the internet system or cyber system (Hart et al., 2019).

The world of education is now starting to prepare a generation that is able to survive in competition in the industrial era 4.0 (Hart et al., 2019). The current generation is millennial generation that lived between 1982 and 2005. The uniqueness of the millennial generation is one of them being dependent on technology. Millennials do not consider cellphones, gadgets and other technologies as tools, but have become part of their lives. They also know the development of an increasingly advanced era and enter an era where all things depend on technology (Phillips & Trainor, 2014). According to millennial expert Prensky (2010) shows that it is not students' abilities that change, but their tolerance and needs. With this millennial generation technology makes learning in the classroom using such technology, such as gadgets or laptops, so that classroom learning can keep up with the times demanded by the needs of these millennials (Hemant et al., 2018).

The learning process begins to develop to facilitate students so that students are able to adjust to the challenges of the times. Responding to this, an educator must have new creativity and innovation, so that in the learning process students can build and practice their ability to compete in the world of work. One of the ways teachers can deal with this 21st challenge is to develop a learning

process that can foster and practice critical thinking skills, communication skills, collaborative skills and students' creativity by using an innovative learning model and in accordance with the challenges of the era industrial revolution 4.0.

A suitable learning model is Flipped Classroom. The Flipped Classroom model is the latest developing pedagogy and its effectiveness has been proven empirically (Rahman et al., 2015). The basic idea of the Flipped Classroom model is to provide teaching before entering class through videos provided by teachers online, so that class time becomes more effective with other active activities (Lo & Hew, 2017). According to several studies, Flipped Classroom has many face-to-face interactions, collaborations, and discussions with peers that allow students to have a deeper understanding of their knowledge (Hwang & Chen, 2019). Flipped Classroom makes students have more responsibilities, especially when studying at home (Avery et al., 2018). Class time is used effectively and has more time to discuss students' doubts and solve many problems (Kittur, 2016). Learning with Flipped Classroom also makes students have higher motivation than ordinary learning (Asiksoy & Özdamli, 2016). Flipped Classroom also has a positive impact on students' learning activities such as achievement, motivation, involvement, and interaction (Zainuddin & Halili, 2016). Flipped Classroom trains students to have higher cognitive abilities and discussion in class gives students the opportunity to digest and reflect on learning (Zheng et al., 2014). Learning experiences of students using Flipped Classroom, student achievement, motivation to learn, attitudes of students when learning, and the ability to solve problems significantly increase using the Flipped Classroom model (Lin, 2019). Learners argue that with Flipped Classroom, he has a readiness to learn, and with collaborative learning in class can increase their success in learning (Yu & Zhu, 2019). Conceptual understanding of students increases by learning to use Flipped Classroom (Putri et al., 2019).

Maria and Javdan (2016) stated that the Flipped Classroom model accompanied by active learning strategies can improve the performance and attitudes of students (Entezari & Javdan, 2016). Flipped Classroom accompanied by Collaborative Learning brings up three soft skills such as; communication skills, collaboration skills, and ICT literacy, then the learning model makes it easy for students to understand subject matter inside and outside the classroom, study subject matter, help learners who are passive, and can be used as a guide in doing assignments and preparing tests, Inquiry learning with the Flipped Classroom model has a positive impact on chemistry learning outcomes on the reaction rate material (Paristiowati et al., 2017). The Flipped Classroom learning model with Project Base Learning can also be used in chemistry learning to improve student learning outcomes if it is supported by high learning independence (Paristiowati et al., 2018), and the Flipped Classroom learning model accompanied by Cooperative Learning shows an increase in achievement academic (Foldnes, 2016). In this study used an active learning strategy, Collaborative Problem Solving. This learning strategy is a construct of two components, namely problem solving and social collaboration. Problem solving hones the cognitive component of students so that students are able to solve problems and find solutions to those problems, while social collaboration has a role to interact with other participants. The combination of these two components determines interdependent soft skills to find solutions and solve problems (Herborn et al., 2018). Collaborative Problem Solving has interactive and interdependent groups to solve problems (Swiecki et al., 2019). According to Rau research (2017), the combination of Collaborative Problem Solving and Flipped Classroom causes students to have higher learning outcomes compared to students with traditional learning (Rau et al., 2017).

Chemistry is a lesson that discusses the macroscopic, submicroscopic, and symbolic dimensions of a material (Chang, 2010). In this research, the material used is Chemical Equilibrium. Chemical equilibrium has

material characteristics, including analyzing the factors that influence the shift in the direction of equilibrium and solving problems related to the quantitative relationship between reagents and reaction products (class XI chemical syllabus). Based on interviews with teachers, students found out difficulties in analyzing the factors that affect the shift in equilibrium and calculations on chemical equilibrium. This understanding of chemical equilibrium material was supported by Mobile Learning media to make students more active in the learning process. So, it is expected that the Flipped Classroom-Collaborative Problem Solving model with Mobile Learning media can help students to understand the chemical equilibrium material and also foster develop the 21st century skills possessed by students.

2. RESEARCH METHOD

This study aimed to determine the 21st century skills of students who emerge in learning chemical equilibrium with the Flipped Classroom-Collaborative Problem Solving model.

2.1 Research Methods

The research method in this study was a qualitative descriptive method, because researchers would like to describe the facts found from chemical equilibrium learning using the Flipped Classroom-Collaborative Problem Solving model.

2.2 Research Participants

This research was conducted at one of the state high schools in South Tangerang by taking 36 students of class XI MIPA as samples.

2.3 Research Instruments

This research instrument was adopted and developed from the 21st Century Skills Assessment Partnership 21 (P21).

Table 1. Indicators of 21st Century Skill Instruments

No.	4C's skills	Indicator
1.	Critical Thinking Ability	Analyze and question thinking, reasoning, and critical thinking with accuracy
		Identify the number of reasonable solutions to problems, answers to questions, or approaches to meet challenges.
		Presenting logical conclusions about how to solve problems, meet challenges, answer questions, etc. illustrate understanding; simply cite evidence for conclusions drawn.
		Comparing and classifying information accurately; almost always identifies characteristics that make meaningful comparisons.
		Define the problem, investigation, or challenge clearly; keep looking for clarity and understanding.
2.	Ability to be Creative and Innovate	In certain situations a creative person will see a number of problems while others see little or nothing.
		Someone who generates ideas in large numbers is more likely to have specific ideas.
		Creative people have ideas that are not public but are acceptable.
		Creative people can easily switch from old thinking habits to new ways of thinking.
		Number of ideas added; shows one's ability to develop and elaborate ideas.
3.	Communication Skills	Pay attention to what is said, ask the other party to explain exactly what he means, and ask for ambiguous ideas to be repeated.
		Send verbal messages constructively
		Write clearly and precisely
		Expressing your feelings, preferences, needs, and opinions directly by not threatening also punishing others.
		Strengthen or replace oral communication through the use of the body; language, movement or sound.
4.	Collaborative Skills	In collaboration, group members must communicate effectively, which includes communicating with words (e.g., writing, speaking) and without words (e.g., eye contact).
		In collaborating, someone checks whether other group members have clear and relevant solutions to the problem at hand.

The instruments to gain data were observation, interviews, questionnaires, and reflective journals. The quality standard was trustworthiness with credibility criteria through prolonged engagement, persistent observation, progressive subjectivity and member checking (Sugiyono, 2016).

2.4 Research Procedure

This study used Flipped Classroom model which students learned first outside the classroom using mobile learning by Collaborative Problem Solving strategy. The

syntax of Collaborative Problem Solving were as follows:

2.4.1 Engagement

In the first stage, the teacher distributed groups based on different abilities, social and culture.

2.4.2 Exploration

In the second stage, the teacher presented contextual problems. At this stage, students worked together with their groups to solve the problems given and provide solutions to those problems.

2.4.3 Transformation (Collaborative Discussion)

In the third stage, students in each group shared opinion or ideas in discussions to solve the problem.

2.4.4 Solution (Checking Group Discussion Results)

In the fourth stage, students were asked to check the answers of the problems that had been solved.

2.4.5 Presentation (Presentation of Group Discussion Results)

In the fifth stage, the group presented the results of the discussion regarding contextual issues. If the group made a presentation, the other group should observe and respond to the results of the group discussion that was presented.

2.4.6 Reflection (Feedback and Rating)

In the sixth stage, the teacher guided students to accomplish the material. Learners were not just discussion in groups to solve problems. But, students were asked to make a poster with the theme "Chemical Equilibrium in Everyday Life" and present the poster's results with the Two Stay Two Stray method. Students also did practical work with tools and materials designed by them by adapting from mobile learning that provided.

2.5 Data Analysis

Data analysis was carried out consisted of several stages, namely data collection, data reduction, data presentation, and verification

or conclusions. Data obtained from observations, interviews, questionnaires, and reflective journals. Data were gained then reduced from data that were not related to research, then the data was categorized into several categories namely, critical thinking skills, creativity and innovation skills, communication skills, and collaborative skills. From the questionnaire data, 21st century skills are said to be good if they have an average of > 3.00, observation data, interviews, and reflective journals will explain 21st century skills of students who are trained and grow during learning with the Flipped Classroom-Collaborative Problem Solving model. Students themselves by adapting from the mobile learning provided.

3. RESULT AND DISCUSSION

Based on the results of data processing from questionnaires, interviews, observations, and reflective journals. The 21st Century skills of students, can be seen as follows:

3.1 Critical Thinking Ability

According to data taken from the questionnaire, the picture shows that students have the ability to think critically with an average number of 3.46. Figure 1 shows the students' critical thinking skills.

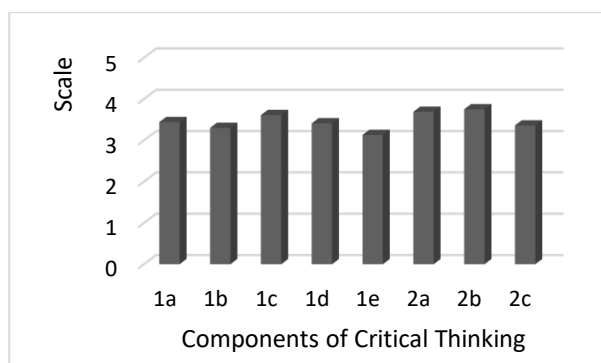


Figure 1. Students' Critical Thinking Ability

Information:

1a: able to gather information and draw conclusions correctly

1b: able to evaluate problems and provide the best solution

1c: able to summarize / make my own interpretation based on what I read or did

1d: able to analyze differences in arguments or solutions to a problem

1e: able to solve complex problems / answer questions that don't only have one answer

2a: Students have tried to build critical thinking skills

2b: Many students have developed critical thinking skills

2c: Students could effectively reflect their critical thinking skills

From the picture showed that students were able to collect information and draw conclusions correctly, students were able to evaluate problems and provide the best solution, students were able to summarize / or make their own interpretation based on what is read or done, students were able to analyze differences in arguments or the solution of a problem, students were able to solve complex problems or answer questions that do not have only one answer. Thus, it can be concluded that students have good critical thinking skills.

Student learning activities using Flipped Classroom-Collaborative Problem Solving, including working on LKPD individually and in groups. In individual LKPD, students worked on questions with C1-C2 cognitive level and group LKPD with C3-C6 cognitive level. Forms of questions in groups were very varied, namely in the form of puzzles, matching sentences, arranging random letters, cause-effect questions, and problem solving-based problems. Students considered that when discussing working on LKPD, their critical thinking skills are trained, students can develop something, and raise questions that improve critical thinking skills. The following are data from students' interview statements:

"We do problem solving when we discuss in groups and answer LKPD questions. From the LKPD, I can develop something and ask questions that can train my critical thinking skills" [PD3]

"Because I have to solve the problems in LKPD itself and there are tasks that make me have to analyze, so it makes me think more critically" [PD6]

"Very interesting, because the given LKPD makes students think critically so students are accustomed to think critically" [PD13]

Learning with Flipped Classroom-Collaborative Problem Solving improves students' critical thinking skills, because Flipped Classroom requires students to learn autonomous outside the classroom, moreover students have the potential to explore learning resources such as videos, powepoints, e-books, and scientific articles (Kurnianto & Haryani, 2020). Then, by conducting Collaborative Problem Solving in class, students have the ability to discuss in solving problems and find solutions, so students are accustomed to exchange ideas and opinions that make students' critical thinking skills better.

3.2 The ability to be creative and innovative

According to data taken from the questionnaire, the picture showed that students have the ability to be creative and innovate with an average number of 3.35. Figure 2 showed the creativity and innovating skills of students.

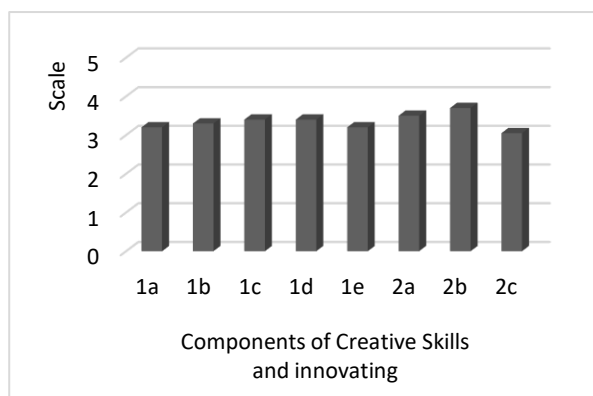


Figure 2. Creativity and Innovation Skills of Students

Information:

1a: able to create their own creative ideas through observations or experiences that students experience.

1b: able to convey creative ideas and receive input to develop these ideas.

1c: able to evaluate ideas from various inputs and find the best solution.

1d: able to be creative in realizing and applying creative ideas, and to be useful and accepted in groups.

1e: able to ask important questions in gathering information.

2a: try to build creativity and innovation skills

2b: Many students from different backgrounds have developed their creativity and innovation

2c: can effectively use creative and innovative skills

From Figure 2 it can be said that students were able to create creative ideas, evaluate ideas, implement ideas, asking important questions, and try to build creative skills effectively and innovatively. Thus, it can be concluded that students have the ability to be creative and innovate well.



Figure 3. Student Poster Results

In learning Flipped Classroom-Collaborative Problem Solving, students were asked to make A3-sized posters with the theme "Chemical Equilibrium in Everyday Life". Students created posters with a variety of images, with attractive colors, as well as appropriate content. Figure 3 is an example of a poster made by students.

In addition to make posters, students also have creativity and innovation in practicum. In this practicum, students designed their own tools and materials because the tools and materials used were quite simple and harmless, students replaced chemical cups with plastic cups, stirring rods with straws, spatulas with plastic spoons, and also designed materials that were simple as basic solutions obtained from soap, and acid

solutions obtained from vinegar. Figure 4 was a practicum done by students in class.



Figure 4. Students Doing Practicum that was Designed by Students

In their experience, students felt that with Flipped Classroom-Collaborative Problem Solving, students' creative thinking abilities emerge.

"I have to think when making posters, so the composition is good and the results are good. When practicum we also have to find our own material that makes us have to be creative "[PD1]

Learners also stated that the ability to be innovative is improved because the ability of students is used when learning takes place.

"This learning makes me more able to innovate, I prefer to improve things rather than making something new" [PD2]

"This learning is quite interesting, because I like to design, I have to think in terms of equilibrium, images that represent chemical equilibrium, so I have to think so that my ideas can be understood by people" [PD5]

Students also stated that with this learning, the ability to be creative and innovative is formed, because they are encouraged in this learning.

"When making posters, I was not able to use the application because of this learning model, it made me learn on YouTube myself [PD6]

Learning with Flipped Classroom-Collaborative Problem Solving makes them develop their ability to be creative and innovate because with Flipped Classroom learning students are able to define and analyze problems, produce original ideas, explore various choices, including various complex points of view, produce arguments that are complex strong, and communicates complex arguments by focusing on main ideas (Rodríguez et al., 2019), while with Collaborative Problem Solving students can collaboratively discuss to produce specific ideas and ideas.

3.3 Communication Skills

According to data taken from the questionnaire, the picture shows that students have communication skills with an average number of 3.54. Figure 5 showed the communication skills of students.

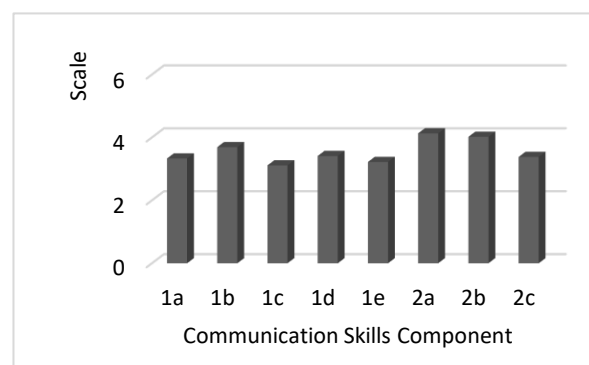


Figure 5. Communication Skills of Students

Information:

1a: Students were able to express ideas clearly verbally and in writing

1b: Students were able to communicate effectively with a variety of people and diverse groups in an effort to achieve their goals verbally or in writing

1c: Students were able to convey group ideas in different ways

1d: Students were able to plan and decide how the presentation will be done by the group

1e: Students were able to answer questions raised by other students

2a: Students tried to build my communication skills

2b: Many students from different backgrounds have developed their communication skills

2c: Students could effectively use communication skills

The picture showed that students were able to convey ideas clearly verbally and in writing, communicate effectively with a variety of people and diverse groups, able to convey group ideas in different ways, able to plan and decide how the presentation will be done by the group, able to answer questions proposed by other students, and students can effectively use communication skills. Thus, it can be concluded that students have good communication skills.

In learning Flipped Classroom-Collaborative Problem Solving, students conducted group discussions to discuss group LKPD. In the discussion group students trained their communication skills with their group friends, students exchanged ideas and opinions then conveyed their ideas or ideas in oral and written form. Learners felt that with the group discussion students could learn to convey words well, students were trained to convey what is in their minds. Like the interview statement to the following students:

"Because I was compelled to have many things to say, so I had to think about how to deliver it" [PD5]

"Because we need other people's responses so we communicate well" [PD8]

In addition, in making posters, students also conveyed their communication in written form. Learners learned about the way to convey their thinking through writing on the posters to make others understood. Like the interview statement for the following students:

"With the poster assignment, I have to think related to chemical equilibrium, how the image that represents chemical equilibrium, so I have to think so that my ideas can be understood by other group members" [PD5]

Learners also practiced their communication in public when presenting the results of the discussion. At that time the students felt that the communication that he made must be correct, so that it could be understood by many people who listened. Like the interview statement to the following students:

"When the presentation is taking place and when discussing in a group, I have to deliver it correctly if not later the other group members don't understand what I mean" [PD1]

Learning with Flipped Classroom-Collaborative Problem Solving can develop students' communication skills because with Flipped Classroom, students become more active and they interested in learning to use learning media and are easily motivated to talk in the class. Learners were responsible for learning more deeply about the content being studied. Two components "in the classroom" and "outside the classroom" encourage learning activities that are centered on students and foster attitudes and behaviors that are more positive. Flipped Classroom helps to improve students' verbal communication skills, because the Flipped Classroom model brings a pleasant atmosphere in the classroom (Tazijan et al., 2016). Whereas with Collaborative Problem Solving, students are given the opportunity to talk to each other both verbally and in writing which enables students to have good communication skills.

3.4 Collaborative Skills

According to data taken from the questionnaire, the picture shows that students have collaborative skills with an average number of 3.75. Figure 6 showed the students' collaborative skills.

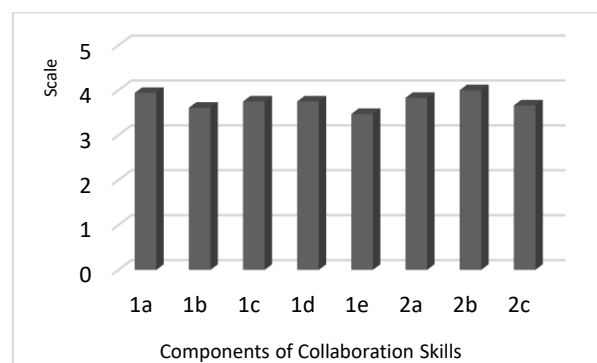


Figure 6. Students Collaboration Skills

Information:

1a: Students were able to work together and be responsible in a variety of groups

1b: Students were able to manage the division of tasks in project planning to achieve goals

1c: Students were able to make products together with contributions from other students in the group

1d: Students were able to work as a team to combine responses related to tasks or products

1e: Students were able to motivate others in achieving their goals

2a: Students have tried to build collaborative skills

2b: Many other students from different backgrounds have developed collaborative skills

2c: The teacher had effectively encouraged students to collaborate

The picture shows that students were able to work together and be responsible in groups. Students were able to make products together with contributions from other students in the group. Students were able to work as a team to combine responses related to tasks or products and students were able to motivate others in achieving their goals. Thus, it can be concluded that students have good collaborative abilities.

Learning with Flipped Classroom-Collaborative Problem Solving, students conducted group discussions consisting of 4 people each group. Students discussed, expressed opinions, argued, shared ideas, provided motivation to their friends, and provided explanations. In this group, students worked together to answer the group LKPD questions, students discussed and shared their tasks, some were asked to find answers from the internet and books, then discussing the results of these investigations.

Students not only collaborated during group discussions to answer questions, but also collaborate when practicums were held. Students shared the task with their friends to bring various kinds of tools and materials for the practicum, in the practicum the participants worked together to complete the practicum properly, there were those who try to hold a plastic glass so it did not fall, there was a duty to shake up the plastic glass so that the solution merges, some took material, cut material, and worked together.

Then, when doing the Two Stay Two Stray method the students worked together to share the information to be given, the students divided the tasks and complete each other. When making posters, students also worked together to share the tasks of each member, some were asked to find out content, the others did designing and printing posters. These tasks were well done. This can be seen from the statements of students at the interview, as follows:

"This learning trains our collaboration. Because completing the tasks are divided, if someone is difficult to ask questions with friends "[PD4]

"When solving problems in LKPD, if there are no answers obtained from the book, we can exchange opinions with other friends" [PD3]

"Practicing our collaboration because if there are opinions that disagree, we ask the opinions of other friends to agree with each other's opinions" [PD9]

Learning with Flipped Classroom-Collaborative Problem Solving can develop students' collaboration skills because this learning makes students do different activities in a team, manage student learning in teams, and to build a sense of responsibility and ability to learn individually, the ability to work together to solve certain problems, the ability to communicate with each other, the ability to interact, and the ability to evaluate others. This enhances team learning ability with the Flipped Classroom model (Sojayapan & Khlaisang, 2020). Meanwhile, Collaborative Problem Solving provides space for students to conduct discussions, and design talks on each member in the group to solve problems and provide mutually agreed solutions.

Data showed that students learning with Flipped Classroom-Collaborative Problem Solving can grow their 21st century skills. Although the 21st century skills possessed by students have not been seen as significant but students believed that creativity, collaborative skills, communication skills, and critical

thinking skills occurred in their learning with this model.

4. CONCLUSION

Based on the result and discussion, learning with Flipped Classroom combined with Collaborative Problem Solving made students accustomed to exchange ideas and opinions that can train students' critical thinking skills to be better, students collaboratively can discuss to produce certain ideas. Students were given the opportunity to talk to each other both spoken and unspoken it enables students to have good communication skills, and provide space for students to have discussions, and design talks on each member in the group to solve problems and provide mutually agreed solution. This activity is able to train students to have critical thinking skills, collaborative abilities, creative abilities, and good communication, so it can be concluded that with the Flipped Classroom-Collaborative Problem Solving learning model can train and grow 21st century skills of students in equilibrium learning chemistry.

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