

## Comparing the Effect of Lecture and Cooperative Learning Teaching Strategies in Signals & Systems Course

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### Abstract

Cooperative learning teaching strategies structures students into groups which every member has their own role and task for the group to attain. Therefore, this learning strategies involve all the students in the class and can increase students' engagement during the class. The aim of this study is to investigate the performance of the students by comparing lecture and cooperative learning teaching strategies. The study was conducted from September to December 2018 on 23 students who enrolled in Signals & Systems course. The course has four Course Learning Outcomes (CLO). Lecture was conducted during delivering content of CLO1 whilst Jigsaw and Teams-Games-Tournaments were introduced in delivering content of CLO2-CLO4. The performance of the CLO was measured based on quiz, test and final examination. The result between CLO 1 and CLO2-4 was compared with students in 2017 which were experienced lecture and collaborative learning strategies only. In addition, CLOs performance was compared with other sections in 2018. Overall performance students who had experienced cooperative learning strategy is better compared to lecture learning strategies. In conclusion, cooperative learning strategies can be conducted in delivering theoretical course to improve the self-regulated learning among the students.

Keywords: Cooperative learning, Collaborative learning, Jigsaw, Teams-games-tournaments

### Introduction

Cooperative learning is one of the active learning strategies. Active learning is a general term where any teaching method that can make students involve actively during the class. However, cooperative learning is a structured way of learning strategies. According to (Keyser, 2000), cooperative learning needs advance planning, appropriate size of group, role for each member and how the results will be evaluated. Lecturer's role during cooperative learning strategies is to facilitate students to equally participate in the group discussion (James & Robert, 2005). On the other hand, lecture learning strategy makes students passively involve where they just sit and listen.

Edgar Dale introduced the Cone of Experience in 1946 that shows the progression of experiences from the most concrete (at the bottom of the cone) to the most abstract (at the top of the cone) (Davis & Summers, 2015). It can be summarized that after two weeks people can only remember 10% of what they read (the top of the cone), 20% what they hear, 30% of what they see, 50% of what they see and hear, 70% of what they say and 90% of what they say and do (the lowest of the cone). Hence, learning by doing is more effective compare to sit down and listen.

Researcher in Sanaie, Vasli, Sedighi, & Sadeghi (2019) makes a comparison between lecture and Jigsaw learning strategies among nursing students. The purpose of doing that is to investigate the students' self-regulated learning and academic motivation. From the analysis, it is proven that Jigsaw can improve the self-regulated leaning and academic motivation.

Gamification based is introduced in Reaction Engineering course in Azizan, Mellon, Ramli, & Yusup, (2018). That learning strategy helps the students to be creative and acquire teamwork skills. Another researchers investigate on gamification which can increase students' engagement, motivate and promote learning (Buckley & Doyle, 2017). In this study, researchers find that gamification needs to be carefully integrated into the learning context since learning styles is influenced by the personality traits of the students. Jigsaw learning style was introduced in Signals & Systems course in a junior-level engineering course in Yousafzai, Damaj, & Yousafzai (2017). Students' performance showed improvement after Jigsaw is implemented in the course.

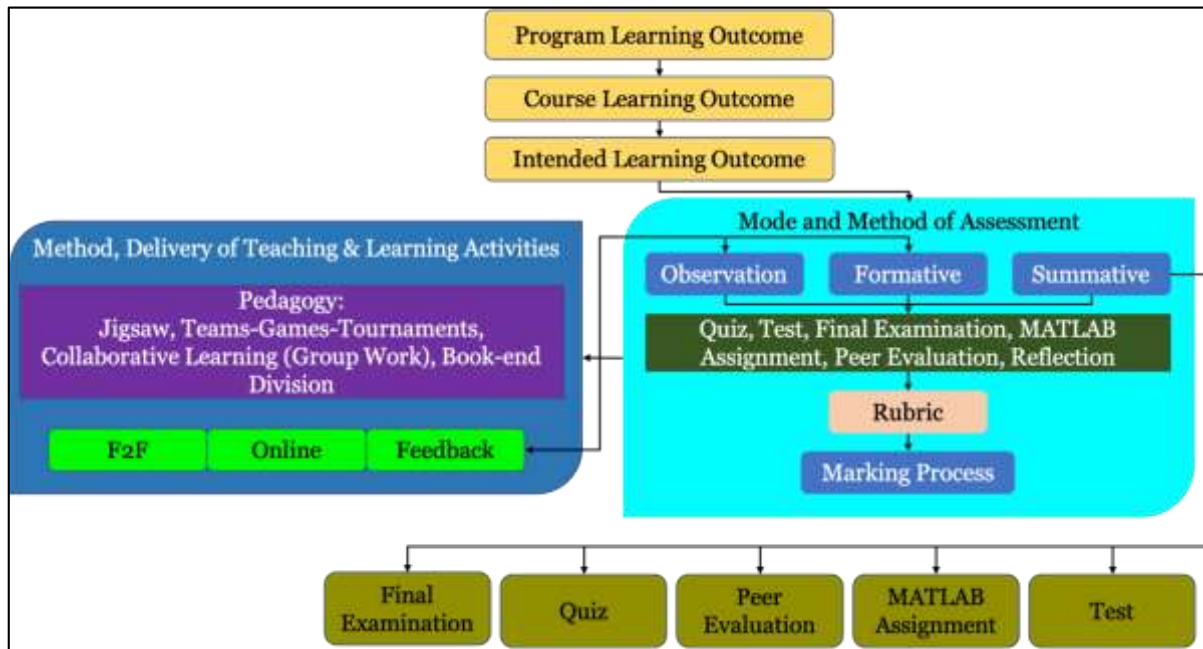
This paper is structured as follows. First, an overview of the course followed by the methodology of implementation. Then, data analysis section before the last section, conclude this paper.

### Course Overview

School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia (UTM) offers Signals and Systems course for second year students. The course introduces the fundamental ideas of signals and systems analysis which will serve as a central building block for students in studying information processing in many engineering fields such as control systems, digital signal processing, communications engineering and circuit design. The course is designed with five Course Learning Outcomes (CLO) which is listed in Table 1.

**Table 1: Course Learning Outcome (CLO)**

Number	CLO	Assessment
1	Demonstrate the characteristics and properties of continuous-time and discrete- time signals and systems	Quiz (3%) Test (7.5%) Final (12.5)
2	Use Fourier series analysis to describe signals and linear time-invariant (LTI) continuous- time systems in time domain	Quiz (3%) Test (7.5%) Final (12.5%)
3	Demonstrate different usage of Fourier and Laplace transforms and its inverse in frequency domain	Quiz (4%) Test (15%) Final (12.5%)
4	Apply Fourier theory to first-order analog filter design based on frequency response	Final (12.5%)
5	Work collaboratively with a group of people in order to achieve common objectives	MATLAB Assignment (10%)



**Figure 1: Class Design**

In order to achieve the CLO, we design our class for Semester 1, 2018 such as in Figure 1 above.

In every class, we set our own Intended Learning Outcome (ILO) based on CLO to align with the learning activities and the assessment. As can be seen in Figure 1, three methods of assessment are used in this course which are observation, formative and summative assessment. Observation and formative assessment obtain from face-to-face activities, online activities using UTM e-Learning platform and student’s feedback in each class. In other hand, the summative assessment obtained from quiz, test, peer evaluation, MATLAB assignment and final examination.

A few methods of face-to-face activities are introduced in this course such as Book-end Division approach, collaborative learning, e.g. group work and cooperative learning, e.g. jigsaw and Teams-Games-Tournaments. As we know, Signals and Systems course has four CLOs to be covered throughout the semester. CLO 1 was conducted using the traditional method where the students sit and listen only. The rest of the CLOs were conducted using active learning activities as stated in Figure 1. As mentioned before, this approach was introduced to students in Semester 1, 2018. In

Semester 1, 2017, we did not introduce cooperative learning to the students. They only had Book-end Division approach and collaborative learning which were working with their group members throughout the semester.

**Methodology**

Implementation was different between two cohort of students which were students in 2017 and 2018. Students in 2017 was introduced with group work activities only whilst students in 2018 were introduced with all the methods that will be described in this section. Figure 2 shows class planning for 2018 implementation.



**Figure 2: Class Planning Methodology**

Lecture slides and YouTube videos which are related to the content of the class were uploaded in UTM e-Learning a week before the class. To achieve CLO 2-4, no more lecture was conducted during the class session, the students had their activities such as group work or jigsaw. In order to make sure that the students really understand the topic, quiz was conducted at the end of the class. In addition, extra exercises were given to them. Teams-games-tournaments was conducted at the end of the session as their revision activity before final examination.

**A. Group Work Setup**

Different group distribution was applied for students in 2017 and 2018. In 2017, students were divided into group, based on their gender and Cumulative Grade Point Average (CGPA). At least one group had a female student and highest CGPA students were grouped with students that had CGPA between 2.5–3.4. However, average students were group among themselves. Problem that we identified was high achiever students had difficulty to communicate with students who had CGPA below 3. Therefore, they seem to be working individually, hence it was contributed to ineffective discussion within the group. On the other hand, average students had a good discussion within the groups. They can come out with ideas and questions, then try to find the answers. Nevertheless, same person presented the group work since we did not assign role to the students.

In 2018, the same criteria were applied for group distribution. Conversely, we did not group the weak students with the excellent students. Students who had CGPA below 2 were group with average students that had CGPA up to 3.4 only. Group discussion worked effectively where they can discuss, they can argue together. Even though the communication seems working well, certain groups were not really performed. We identified that, the group members did not perform in Differential Equation Course. Hence, they did not have a good prior knowledge for this course. In future, we will take into consideration grade of Differential Equation Course for group distribution.

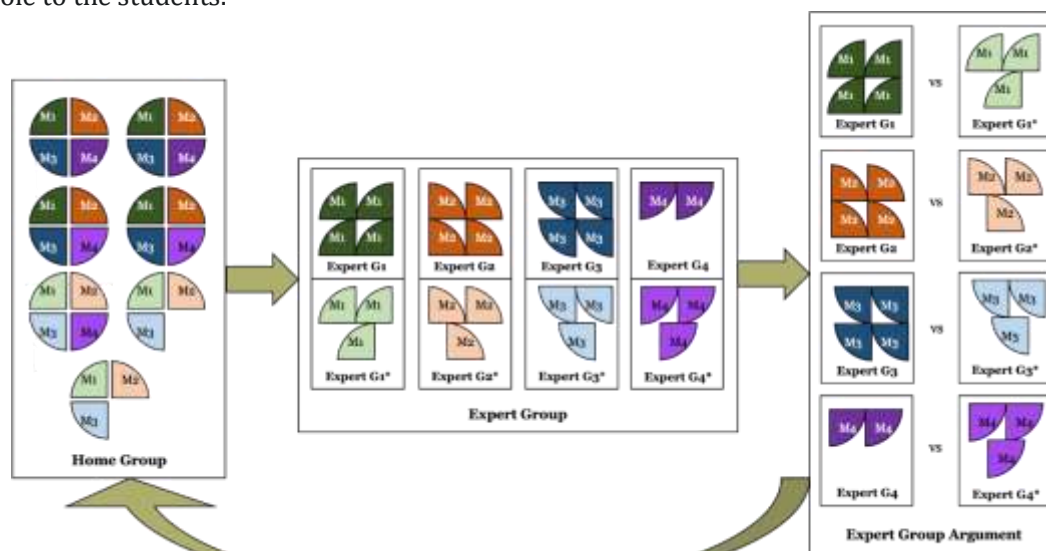
**B. Jigsaw Setup**

Jigsaw activity was conducted only for 2018 students and total of them are 26 students. We had seven groups of students, five groups had four members in the group whilst two groups had three members only. This activity was conducted to achieve CLO2-4.

For example, we take a topic of Properties of Fourier Transform. Four sub topics were identified which are:

- a) Linearity
- b) Time and frequency shifting
- c) Even and odd signal
- d) Time and frequency scaling

Figure 3 depicts how jigsaw was implemented in the class.



**Figure 3: Jigsaw setup**

We had seven home groups and each group had three to four members. Each member was assigned as M1 until M3 or M4. M1 covered sub topic linearity, M2 covered sub topic time and frequency shifting, M3 covered sub topic even and odd signal whilst M4 covered time and frequency scaling. M1, M2, M3 and M4 will sit down together to discuss topic that assigned to them. We call this group as expert group.

Members of expert group G1 were M1 from home group one to home group four while expert group G1\* from home group five to seven. Same method used for

M2 and M3. On the other hand, expert group G4 were from home group one and two while expert group G4\* from home group 3, home group 4 and home group 5. No M4 from home group six and seven.

After they had discussion with members in their expert group, expert group which had the same sub topic, had discussion and argument to check on either their finding or understanding before they go back to their home group and share their knowledge with their home group members. Group six and seven which do not have M4, were assisted by us for the fourth sub

topic. During this activity, we played our role in ensuring their understanding is correct. We checked their findings and understating during expect group argument activity.

### C. Teams-Games-Tournaments Setup

Teams-Games-Tournaments was implemented at the end of the semester for 2018 students. The purpose of doing this is to help the students in their revision. Group distribution is based on student's performance in quiz, test and class activity from Week 1-Week12. Therefore, each group had weak students and excellent students. During the game, weak students competed

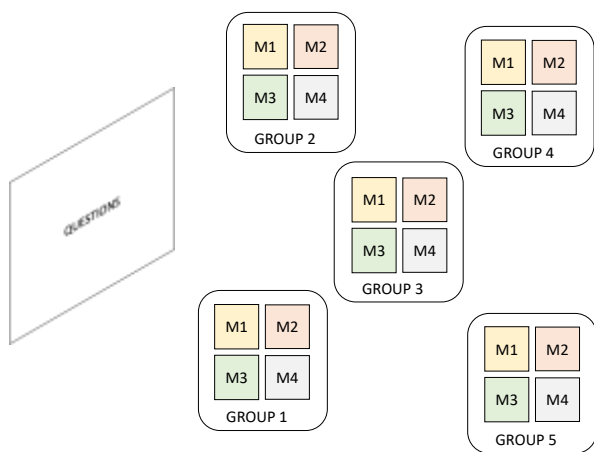


Figure 4: Teams-Games-Tournaments setup

with weak students, medium students with medium students and excellent students with excellent students. Figure 4 illustrates how the game was conducted where weak students to excellent students in each group is labelled as number one to four.

Before we showed the question, we called students name from each group as group representative to get ready. Questions were taken from previous final exam and it was equally given to the students regardless of their levels

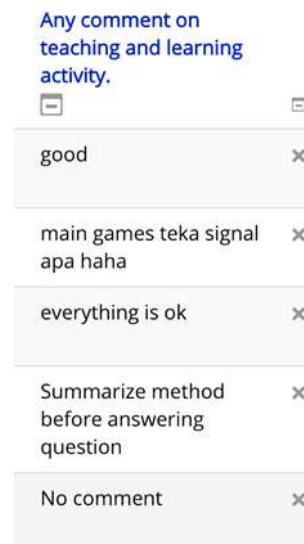


Figure 5: Comment from the students

### Data Analysis

Data analysis is done based on students' reflection and data performance. Students' reflection was taken from e-Learning with anonymous setting. On the other hand, data performance is analyzed between 2017 cohort and 2018 cohort as well as comparison with other sections in 2018 cohort.

#### A. Students' Reflection

Reflection from the students is important which can help us to understand their experience of learning during the activities. We conducted the reflection using e-learning platform provided by our university. We asked three questions which are:

- What is your best part?
- What is your blur part?
- Any comment on teaching and learning activities.

The reflections were collected at the end of the class. The pattern that we got from all the reflections, were quite same, where the students can be divided into two groups which were understand and not understand the content of the class on that day. However, the students who were not understand the content wrote their problems in the reflection and normally they were having the same problems. Therefore, we uploaded several examples in the e-learning after the class and asked the students to have a look on that example before they come to the next class. In addition, we revised the content in the next class before we proceed with a new content. Another technique that our students love was we summarized the content that we taught before we asked them to answer any questions. Figure 5 shows the comment from the students.

Reflections for the Teams-Games-Tournaments are very positive. Students really love the activity and that was their first experience having a gamification-based activity in their degree course. Figure 6 contains comment from the students.

Response number	Do you think gamification is a fun way to learn something?	Give your opinion on the gamification activity.	
Response number: 1	Yes	Give more question	✕
Response number: 2	Yes	Seronok	✕
Response number: 3	Yes	I felt glad participate in the gamification activity. I hope more activity like this can be done in class.	✕
Response number: 4	Yes	It's give the ability for student to think fast and accurate	✕
Response number: 5	Yes	Very good because its very fun and interesting and also make students awared with the part that they did not understand.	✕
Response number: 6	Yes	Time well spend in short time interval.	✕
Response number: 7	Yes	This game test my understanding and preparation before final exam	✕
Response number: 8	Yes	Its fun way to learn or refresh back about what we study before and quite effective for a revision	✕
Response number: 9	Yes	Dia membuka minda.. Dna lebih senang ingt sewaktu seronok	✕
Response number: 10	Yes	Maybe need more question for more understanding	✕
Response number: 11	Yes	everyone is very enjoy and can gain knowledge.	✕
Response number: 12	Yes	Good madam	✕
Response number: 13	Yes	More prepare next time for me 🥰🥰	✕
Response number: 14	Yes	I can check about my understanding level towards chapter 1.	✕
Response number: 15	Yes	It was so fun and I learned a lot of things. We can also share our information through the game with others. I need more gameeee!!	✕
Response number: 16	Yes	Faruq ckp tak puas, nak soalan lagi	✕
Response number: 17	Yes	Its very interesting as everyone can possibly share the correct answer..	✕
Response number: 18	Yes	Very good	✕
Response number: 19	Yes	Provide more questions	✕
Response number: 20	Yes	Thank you for the game it really motivate me to learn after this	✕
Response number: 21	Yes	On quiz we learn something from different perspective on answering question	✕
Response number: 22	Yes	Its so interesting!!! this activity makes students more focus and enjoy the learning process	✕
Response number: 23	Yes	I think it was a fun activity because It gets students to be more active, play and learn at the same time	✕

Figure 6: Comments on Teams-Games-Tournament activity

### B. Data Performance

The analysis of students' performance has been done based on CLO of the course. The performance of the students in 2018 is compared with the year before, 2017 as well as comparison with other section in 2018. As mention before, in 2017 students did not experience cooperative learning and gamification-based learning. They only had a normal group discussion and they decided their own representative for their groups and normally the same person. Meanwhile in 2018, every members of the group had their own responsibilities. In other word, everyone must get prepare and learn something. The performance of the students is given in Figure 7.

As can be observed in Figure 7, overall performance of students in 2018 is higher compared to students in 2017. As can be seen, achievement of students in 2018 is lower than students in 2017 for CLO1. As discussed previously, traditional method which is one-way teaching method was implemented in 2018 for CLO1 content. This is the reason why the achievement is slightly lower compare to 2017 students. As illustrated in Figure 7, achievement of 2018 students for CLO4 is tremendously higher than 2017 students. CLO 4 is measured only in final and the questions is based on filter design. Hence, it is an advantage for those who really practice the questions and the evidence is in Figure 7.

The comparison between other sections in 2018 is shown in Figure 8. There are five sections was considered for the comparison in 2018 since they were in the same cohort. Section 5 is the one which implemented cooperative learning strategy. As mentioned before, chalk and talk method was used to achieve CLO1 and cooperative learning was used to achieve CLO2-CLO4. As can be seen in Figure 8, based on CLO1 achievement, students in Section 5 were moderate students. However, by doing the cooperative learning strategy helps the students to improve in CLO2 and CLO3 whilst highest achievement in CLO4. During the cooperative learning activities, students were asked to understand the concept and solve the application questions, where the activity helps their achievements in the test and final. This is because the students learn by doing not only listening the explanation from the lecturer.

### Conclusion

Jigsaw and Teams-Games-Tournaments activities using cooperative learning strategy were introduced in Signals & Systems course. The course is a core course for 2<sup>nd</sup> year electrical students in UTM. The students had experienced new method of learning. The evidences are clearly obtained in the reflections. The data performance was compared between different cohort and different sections. The overall performance of the students was better compared to the previous cohort since everyone involved in each activity. In addition, the students who experienced cooperative

learning showed improvement compared to other sections.

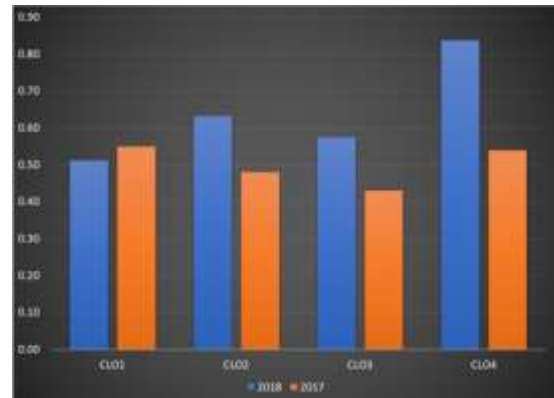


Figure 7: Students Performance between 2017 and 2018

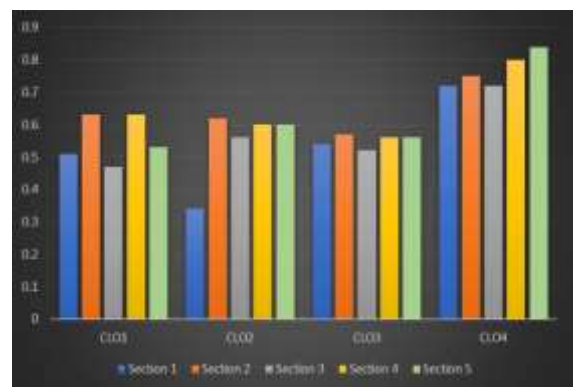


Figure 8: Students' Performance between Different Section in 2018

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