Cooperative learning through jigsaw classroom technique for designing cast partial dentures - a comparative study

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**Abstract**

**Objective:** Objective of the study was to compare the jigsaw cooperative learning technique to the traditional lectures for learning cast partial denture designing.

**Method:** Seventy-two fourth BDS students were randomly assigned into either the jigsaw or traditional lecture groups (n = 36). A pre-test on the topic ‘designing of cast partial dentures’ was administered to all students before the start of the study.

The Jigsaw learning method was administered to the experimental group for 4 weeks. At the same time, the control group experienced the lecture-based learning method. At the end of 4 weeks, all students were re-tested (post-test) on the subject. A retention test was administered 3 weeks after the post-test. Mean scores were calculated for each test for the experimental and control groups, and the data obtained was analyzed using independent sample t-test.

**Results:** No significant difference was determined between the jigsaw and lecture-based methods at pre-test. However, post-test and retention scores were better for jigsaw group with statistical significance. The highest mean test score was observed in the post-test with the jigsaw method. In the retention test, success with the jigsaw method was significantly higher than that with the lecture-based method.

**Conclusion:** The jigsaw method can be used as an effective learning tool. However, different topics with varying complexity and different cohorts of students need to be tested in future studies.

**Keywords:** Jigsaw classroom, Cooperative learning, Student centered learning
Introduction

For many decades, traditional lectures were the predominant mode of teaching and learning because students could not practically obtain full access to content central to the course. Today, information is rarely the limiting factor in a student's education. In addition to the evolution in information access and delivery, in recent years numerous studies have demonstrated that traditional lectures that rely on passive learning are not as effective as active, student-centered learning strategies. With this paradigm shift there is a drift in the professor's role from "sage on the stage" to "guide on the side" where helping students manage their information is critical to learning (King A 1993; Saulnier BM 2009; Tanner KD 2009).

Many creative instructors have transcended the limitations of traditional lecture hall architectures and times; they have designed smart and simple ways to make learning a memorable experience to their students. Some professors use their experience, intuition of what works in the classroom to guide their choices, and others have designed educational research strategies to test the efficacy of active learning methods. (Miller S & Pfund C 2007; Felder R & Brent R 2009 ). Active learning is based on the principle that when students do something they learn it better than if they hear about it.

One such active student centered approach is the jigsaw classroom technique introduced by Elliot Aronson in the early 1970's (Sagsoz O et.al 2017). The jigsaw technique is a method of organizing classroom activity that makes students dependent on each other to succeed. It breaks classes into groups and breaks assignments into pieces that the group assembles to complete the jigsaw puzzle. The technique splits classes into mixed groups to work on small problems that the group collates into a final outcome. (Moscardó DL, Rodríguez MA & Llopis JH 2014). It is a cooperative learning method, which consists of five basic elements. Positive interdependence, promotive interaction, individual accountability, teaching and social skills and quality of group processing (Sagsoz O et.al 2017). (Figure 1)

In Jigsaw, an atmosphere of increased collaboration is created because every member of the group is equally important. Students are valued by other group members and need to participate actively to add on to the group dynamics. This results in all members of the group helping to solve a particular problem, giving importance to all the members in the group. These advantages reduce competitive attitudes amongst students. This cooperative learning technique thus obviates the negative effects of other methods. Various advantages of the jigsaw technique compared to the traditional method have been cited in literature (Sagsoz O et.al 2017). (Figure 2)

Very few studies have been reported on application of jigsaw classroom technique in dentistry and none to the best of our knowledge in prosthodontics. The purpose of this study was to determine the effects of the jigsaw method and compare it to the traditional lecture based learning for designing cast partial dentures.

Figure 1: Five basic steps in cooperative learning
Figure 2: Advantages of jigsaw classroom technique

Advantages of Jigsaw technique

- Positive interdependence: Students work as cohesive groups to achieve shared learning objectives
- Individual accountability: Students do their best work, share ideas and help group function efficiently
- Promotive interaction: Students assist and interact with each other to solve problems
- Interpersonal and social skills: Students work together, trust each other and resolve conflicts constructively to achieve a common goal
- Group processing: By reflecting on the learning process the effectiveness of contribution of the members in the group improves
Methodology

This study was based on an experimental research model involving pre-, post- and retention tests administered to jigsaw and traditional lecture groups. The study population consisted of 72 fourth year students at Faculty of Dentistry, Melaka-Manipal Medical College, Malaysia during the 2016-2017 academic year. Students were randomly assigned into two groups (n = 36).

The Jigsaw (cooperative learning) method was applied to the experimental group, whilst lecture-based teaching was used in the control group. Three tests, consisting entirely of multiple-choice questions, were administered. Questions focused on evaluating learned knowledge, critical thinking and problem solving. A pre-test was applied to measure all students’ knowledge of the academic subject in question, which was the designing of cast partial denture.

In our routine practice, after completing the basic theory regarding the partially edentulous classification and the various components and principles of cast partial denture, the students are taught how to apply the principles in designing a cast partial denture for a given case. In the present study, for learning designing in cast partial dentures the experimental group used the jigsaw as a learning tool and control group continued with the traditional lectures.

In the experimental group, students were sensitised regarding the principals and practice of the Jigsaw method before the start of the study, and were divided into six heterogeneous main groups to facilitate learning in small groups. Each group was coded with a letter – A, B, C, D, E or F. (Table 1) Students were randomly coded as 1-6 in each group in terms of subtopics. (eg: A1, A2, A3, A4, A5, A6) (Figure 3). All topics were divided so that students with the same number code in all main groups took the same subject. These were categorised as the expert groups. (eg: A1, B1, C1, D1, E1 and F1 formed one expert group- Table 2)

Topics assigned to the expert groups were as follows: (Figure 4)

- A1, B1, C1, D1, E1 and F1: Major connector
- A2, B2, C2, D2, E2 and F2: Minor connector
- A3, B3, C3, D3, E3 and F3: Direct retainers
- A4, B4, C4, D4, E4 and F4: Indirect retainers
- A5, B5, C5, D5, E5 and F5: Rest and Rest seat
- A6, B6, C6, D6, E6 and F6: Denture base and tooth replacements

In the first week, students studied their own topics, for which the study materials were provided by the facilitator. In the second week, the six expert groups, each consisting of six members, were formed from students with the same number codes. (Figure 4)

In these groups, students discussed the same topics interactively and presented their learning in the form of attractive charts which they designed innovatively (Figure 5). This was followed by a brief presentation by all the six groups (Figure 6). In the third week, students returned to their main groups and taught their own topics to the other members of their group. In the fourth week, the students in the main groups were given a clinical scenario for which they had to design a cast partial denture with justifications for each component chosen.
During these 4 weeks, the instructor observed the students and answered their questions. In the control group, the topics were taught and the case based scenario was presented to the students through lectures given for 4 weeks in which the teachers answered students’ questions and repeated any points that had not been fully understood. At the end of the fourth week, a post-test was applied to the experimental and control groups. Three weeks after the post-test, another test was performed to determine students’ knowledge retention. Different questions with similar levels of difficulty were used in all three tests. Students scoring below 50% of the total marks were considered to have failed in all tests. The failure rate was recorded for each group. Results of the three tests were collected and compared between the experimental and control groups. Data was analysed using the independent sample t-test (P < 0.05).

Table 1: Main grouping in jigsaw technique

| Main Group A | Main Group B | Main Group C | Main Group D | Main Group E | Main Group F |
|--------------|--------------|--------------|--------------|--------------|--------------|
| A1,A2,A3,A4, A5,A6 | B1,B2,B3,B4, B5,B6 | C1,C2,C3,C4, C5,C6 | D1,D2,D3,D4, D5,D6 | E1,E2,E3,E4, E5,E6 | F1,F2,F3,F4, F5,F6 |

Figure 3: Main grouping represented in puzzle form
Table 2: Expert grouping in jigsaw technique

| Expert group 1 | Expert group 2 | Expert group 3 | Expert group 4 | Expert group 5 | Expert group 6 |
|----------------|----------------|----------------|----------------|----------------|----------------|
| A1,B1,C1,D1, E1,F1 | A2,B2,C2,D2, E2,F2 | A3,B3,C3,D3, E3,F3 | A4,B4,C4,D4, E4,F4 | A5,B5,C5,D5, E5,F5 | A6,B6,C6,D6, E6,F6 |

Figure 4: Expert groups of jigsaw technique represented in puzzle form

Figure 5: Students working in expert group
Figure 6: Students presenting their assigned topic
Results

The t-test revealed no significant difference between the Jigsaw and lecture-based groups in terms of pre-test values (P = 0.914). However, there was a statistically significant difference in the post-test and retention test scores. (Table 3) Difference between mean post-test and pre-test values was also greater in the Jigsaw group than in the lecture-based group. There was a higher pre-test failure rate in the Jigsaw group than in the lecture-based group. In the post-test, however, the Jigsaw group failure rate decreased more than that of the lecture based group. (Table 4) A significant difference was observed between the Jigsaw and lecture-based groups in the retention test. The retention test failure rate increased in both the Jigsaw and lecture-based groups compared with post-test values. However, the failure rate in the Jigsaw group was lower than that in the lecture-based group (Table 4). The comparison of pre-test, post-test and retention scores in both the groups is shown in Figure 7 and 8.

Table 3: Independent t-test comparing the experimental and control groups
Table 4: Number of failures in both the groups at pre-test, post-test and retention

| Tests          | Groups    | n  | Failed | Failure rate (%) |
|----------------|-----------|----|--------|------------------|
| Pre-Test       | Jigsaw    | 36 | 15     | 46.86            |
|                | Traditional | 36 | 12     | 37.5             |
| Post-Test      | Jigsaw    | 36 | 2      | 6.25             |
|                | Traditional | 36 | 4      | 12.5             |
| Retention Test | Jigsaw    | 36 | 3      | 9.375            |
|                | Traditional | 36 | 8      | 25               |

Figure 7: Mean scores in jigsaw group at pre-test, post-test and retention
Figure 8: Mean scores in lecture-based group at pre-test, post-test and retention
Discussion

Jigsaw is an efficient way for students to become engaged in their learning, share information with other groups, and be individually accountable for their learning. Since each group needs its members to do well and participate actively so that the whole group does well, jigsaw maximizes interaction and establishes an atmosphere of cooperation and respect for other students.

The results of our study are consistent with several previous studies (Johnson DW & Johnson RT 2005; Bertucci A et.al 2010; Huang YM et. al 2014; Tarhan L et al 2013). Sagsoz O et.al 2017, Johnson DW & Johnson RT. 2009, also compared jigsaw technique to traditional lectures and reported results similar to our study. Some authors (Tran VD & Lewis R. 2012; Arisoy B & Tarim K 2013) reported that academic achievement in students undergoing jigsaw technique was better compared to traditional lectures, similar to the results in our study. Sagsoz O et.al 2017 reported no difference between jigsaw and traditional lectures in pre and post test results. However retention scores
in jigsaw group were better. In our study post-test also revealed significant difference between the two groups indicating the students in the experimental group enjoyed greater success by helping each other, as well as a greater exchange of information, than they had experienced in traditional teacher centred lectures.

The difference between post-test and pre-test values in the control and experimental groups indicates that both Jigsaw and lecture-based learning methods are effective. However, the difference in pre-test and post-test scores was higher in the jigsaw group similar to the previous studies (Sagsoz O et.al 2017; Johnson DW & Johnson RT 2009)

When properly carried out, the jigsaw classroom technique can transform competitive classrooms in which many students are struggling into cooperative classrooms in which once-struggling students show dramatic academic and social improvements

**Conclusion**

Within the limitations of our study, jigsaw classroom technique proves to be an efficient student centred cooperative learning method. This technique needs to be tested further using different topics of varying complexity. The efficacy of the Jigsaw method in terms of long-term retention of knowledge acquired also needs to be evaluated by future studies.

**Take Home Messages**

1. Student-centred learning approaches aim to develop learner autonomy and independence by putting responsibility for the learning path in the hands of student.

2. Jigsaw is a cooperative learning technique, which promotes learning and fosters respect and friendships among diverse groups of students.

3. The results of our study indicate that jigsaw technique is an effective method for learning cast partial denture designing.

4. We recommend future studies to be done on this student friendly technique using complex topics and different cohorts of students.

**Notes On Contributors**

Dr. Prashanti Eachempati designed and conducted the study, did data collection, statistical analysis and wrote the manuscript.

Dr. Kiran Kumar KS helped in conducting the study, organise teaching sessions, data collection and referencing.

Dr. Abdul Rashid Hj Ismail helped by giving inputs and ideas for improvising and implementing the study
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Bibliography/References

1. King A. (1993) from sage on the stage to guide on the side. College teaching. 41(1):30-35.
   https://doi.org/10.1080/87567555.1993.9926781

2. Saulnier BM. (2009) from "sage on the stage" to "guide on the side" revisited: (un)covering the content in the learner-centred information systems course. Info Syst Ed J. 7:3–10. http://citeseerx.ist.psu.edu/viewdoc/download

3. Tanner KD. (2009) Talking to learn: why biology students should be talking in classrooms and how to make it happen. CBE Life Sci Educ. 8(2):89-94.
   https://doi.org/10.1187/cbe.09-03-0021

4. Felder R and Brent R. (2009) Active learning: An introduction, ASQ Higher Education Brief. http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/ALpaper(ASQ).pdf

5. Sagsoz O, Karatas O, Turel V, Yildiz M and Kaya E. (2017) Effectiveness of Jigsaw learning compared to lecture-based learning in dental education. Eur J Dent Educ. 21(1):28-32.
   https://doi.org/10.1111/eje.12174

6. Moscardó DL, Rodríguez MA and Llopis JH. (2014) The Jigsaw: A cooperative learning technique as a tool of teaching-learning facilitator in physical therapy. Effects of working with music as a motivational tool to enchance the jigsaw benefits EDULEARN14 Proceedings, 39:58-62.
   https://library.iated.org/view/DUENASMOSCARDO2014JIG

7. Johnson DW and Johnson RT. (2005) New developments in social interdependence theory. Genet Soc Gen Psychol Monogr 131 (4):285–358.
   https://doi.org/10.3200/MONO.131.4.285-358

8. Bertucci A, Conte S, Johnson DW and Johnson RT. (2010) The impact of size of cooperative group on achievement, social support, and self-esteem. J Gen Psychol. 137 (3): 256–72
9. Huang YM, Liao YW, Huang SH and Chen HC. (2014) A Jigsaw-based cooperative learning approach to improve learning outcomes for mobile situated learning. Educ Technol Soc. 17(1): 128–40. [http://www.ifets.info/journals/17_1/12.pdf](http://www.ifets.info/journals/17_1/12.pdf)

10. Tarhan L, Ayyildiz Y, Ogunc A, and Sesen BA. (2013) A jigsaw cooperative learning application in elementary science and technology lessons: physical and chemical changes. Res Sci Technol Educ. 31:184–203. [https://doi.org/10.1080/02635143.2013.811404](https://doi.org/10.1080/02635143.2013.811404)

11. Johnson DW and Johnson RT. (2009) An educational psychology success story: social interdependence theory and cooperative learning. EducRes. 38(5): 365–79. [http://dx.doi.org/10.3102%2F0013189X09339057](http://dx.doi.org/10.3102%2F0013189X09339057)

12. Tran VD and Lewis R. (2012) Effects of cooperative learning on students at an Giang University in Vietnam. Int Educ Stud.5 (1): 86–99. [https://doi.org/10.5539/ies.v5n1p86](https://doi.org/10.5539/ies.v5n1p86)

13. Arisoy B and Tarim K. (2013) The effects of cooperative learning on students'academic achievement, retention and social skill levels. HacettepeUniversitesi Egitim Fakultesi Dergisi-Hacettepe University Journal of Education. 28(3): 1–14. [http://www.efdergi.hacettepe.edu.tr/yonetim/icerik/makaleler/203-published.pdf](http://www.efdergi.hacettepe.edu.tr/yonetim/icerik/makaleler/203-published.pdf)

**Appendices**

**Declaration of Interest**

*The author has declared that there are no conflicts of interest.*