Empirical Evidence on the Effectiveness of the Learning by Teaching Technique among University-level English as a Foreign Language Students

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Learning via teaching has been accepted as one of the best ways to achieve a deep understanding of a topic. This research was aimed at seeking scientific evidence to support this claim by comparing the scores the university-level EFL students obtained through the learning by teaching technique and those obtained by students who were taught traditionally using a teacher-centered approach. The experimental group consisted of 22 students who were taught pedagogical content knowledge, i.e. English Language Testing, traditionally for half of the semester and then teaching students at another university afterward. The control group consisted of 24 students who were taught language testing traditionally by the same instructor for the whole semester. Both groups were given a test to measure their content knowledge achievement; one test at the beginning of the semester and one at the end of the semester. Two-way ANOVA was used to compare the two groups' scores, and find out how the differences in the scores was affected by the type of instruction. The results showed that there was significant evidence that the students' scores improved significantly in both groups. However, the difference in test scores between pre-test and post-test did not depend on the type of instruction. Because the experimental group could achieve the same performance as those of the control group regardless of the shorter instruction period, it can be concluded that learning by teaching has potential as an effective method for teaching pedagogical content knowledge. Suggestions for possible modifications of this technique are discussed in this paper.

Keywords: learning by teaching, workshops, pedagogical content knowledge, language testing, statistical evidence

Introduction

Teaching has been recognized as the best way to learn something in detail (Tsui, 2010). When students teach their peers, they undergo a process that Roscoe and Chi (2007) termed knowledge-building. It is a process of creating knowledge and integrating it into prior knowledge (Scardamalia & Bereiter, 2010). Furthermore, according to Roscoe (2014), this process is correlated to a deeper understanding. In addition, many teachers believe that they can understand a topic better after they teach the topic to their students (Blair et al. 2007). The knowledge-building that comes from the process of teaching other students is a result of the teaching preparation, their students' comprehension problems, and questions asked by their classes (Hunt & Hunt, 2005). For pre-service teachers, they will learn how to teach in addition to understanding the content by practicing teaching in front of a class (Graves, 1972).

The idea of learning by teaching others was first proposed as early as the beginning of the 17th century, if not earlier (Bowermaster, 1978). This idea was found in many early publications such as, among others, Allison (1976), Graves (1972), Change, Dec, and Feeney (1969), Frager and Stern (1970), and McWhorter and Levy (1971). In these publications, the authors implied that the students who were taught through the learning by teaching technique outperformed those who were taught by traditional instructor-delivered materials. Duran (2017) revealed that empirical research on the topic covered the areas of peer teaching, teaching preparation, and explaining materials. In addition, a survey by Grzega and Schöner (2008) showed that learning by teaching

was effective and efficient for learning content knowledge. However, there is limited empirical evidence on whether students teaching the materials to a real class learned better than those who were simply taught the materials. Therefore, this study compared scores between two groups of students using statistical analysis to seek scientific evidence on the effectiveness of learning by teaching in terms of students' achievement. The results of this study provide insights into how learning by teaching contributes to the learning of content knowledge.

Literature Review

The Emergence of the Learning by Teaching Technique

The idea of learning by teaching dates back to the era of John Comenius, a teacher, educator, philosopher, and writer who is considered the father of modern education. His famous wise words are "He who teaches others, teaches himself", found in his famous work Didactica Magna written circa 1631 (Bowermaster, 1978). However, this method has been practiced since the first century AD (Krouse, Gerber, & Kauffman, 1981). More proposals on learning by teaching were found in the second half of the 20th century, and it has become a subject of research ever since (Trovato & Bucher, 1980). Those research studies reported the process of learning by teaching implementation in a classroom. Topping (2005) states that this teaching technique was first implemented in language skill classrooms but it has now been introduced to a wide range of subjects.

Currently, the learning by teaching technique in Asia is being popularized by Turku University of Applied Sciences under the INDOPED (Indonesian Pedagogy) program financially sponsored by Erasmus++ (Munawar & Zulfahrizal, 2019). Its implementation is now restricted to the university level, with the intention of teaching content knowledge. The program has been implemented in five universities in Indonesia, supervised by five European universities (Kairisto-mertanen & Budiono, 2019). In Indonesia, the Ministry of Education has agreed to adopt this teaching technique and will financially support the implementation of this program. Therefore, scientific evidence of its effectiveness is urgently required.

Advantages of the Learning by Teaching Technique

The advantages of learning by teaching lie in what teachers do as preparation, which includes "organizing the content, selecting materials and teaching strategies, and preparing instruction according to the needs of a particular group of learners" (Gülten, 2013, p. 1409). In this preparation process, teachers need to read materials critically (Tsui, 2003), which improves teachers' understanding of the material. The learning components in this preparation process benefit the students being taught using the learning by teaching technique. Although planning activities for teaching is helpful for learning in the classroom, the focus of this technique is on exposing students to content knowledge, which seems convincingly achievable in this process (Podl & Metzger, 1994).

The advantage of lesson planning is also enhanced by the fact that students who are taught using the learning by teaching technique are pre-service teachers. Because they are pre-service teachers who are often inexperienced at teaching, they put more effort in reviewing the material in comparison to other class preparations such as planning activities, designing a syllabus, or preparing assessments (Derri et al., 2014). As a result, they will master the material, which is in line with the purpose of university classroom instruction (Hutagaol-Martowidjoyo & Adiningrum, 2019). This conclusion is supported by an experimental research study conducted by Bargh and Schul (1980), who found that students learn better when they believe that they need to re-teach the materials than those who learn for reasons such as for passing an exam.

The next process of learning by teaching is explaining the material to students or peers. Students review and evaluate the information they learn from the material while they are explaining it to others (Duran, 2017). This process increases the students' retention of the information (Fiorella & Mayer, 2013) and turns the information into knowledge (Duran, 2017). An experimental study conducted by Annis (1983) confirmed that students perform better when they are learning to prepare themselves for explaining the materials and actually do it. The reason for the effectiveness of this process is given by Roscoe and Chi (2007). They proposed that explaining

material to others allows students to experience reflective knowledge-building and deepen their already-built knowledge.

The last process of learning by teaching is the interaction with students. In this interaction, one of the most significant opportunities for learning occurs, i.e. questioning (Duran, 2017). This process includes the student tutors asking questions to stimulate student tutees' schemata and answering questions asked by the tutees. When asking questions, students need to assess what they already know in order to determine what they do not yet know (Chin & Osborne, 2008). According to Aflalo (2018), this question generation enhances learning because it improves students' cognitive abilities. The major benefit of questioning occurs when student tutors respond to questions (Roscoe & Chi, 2007). Albergaria-Almeida (2010) hypothesized that answering questions can improve a tutor's conceptual understanding of the materials.

Challenges with the Learning by Teaching Technique

In addition to its promised advantages, learning by teaching also poses some potential challenges for students and professors. Like the presentation technique, i.e. learning by presenting in front of the class in groups or individually (Tsang, 2017), the topic taught by a group or an individual only benefits the group or individual teaching it. There is very limited information from the literature about the effectiveness of this technique. Therefore, students taught using teaching by learning can only be expected to deeply understand the topic that they are teaching. However, this disadvantage can be minimized by including the rest of the class as the audience and providing some assessment activity at the end of the class. There is some consensus that students understand better when taught by their peers (Aburahma & Mohamed, 2017; Naeger et al., 2013).

Another possible challenge of the learning by teaching technique is that it requires a lot of effort on the part of students (Hutagaol-Martowidjoyo & Adiningrum, 2019) and professors alike (Fibra, 2019). When students are assigned to teach students outside their university or members of the public, the process is longer and more involved. The students need to negotiate with the head of the target institution and collaborate with the institution to recruit prospective students (Kasim, 2019). However, each of these steps in the preparation and teaching provides many other benefits for students, as listed by Fibra (2019). Students will learn skills required in a working environment, including complex problem-solving, critical thinking, creativity, people management, coordinating with others, judgement and decision making, service orientation, and negotiation.

The Current Study

The current literature has shown evidence that learning by teaching was an effective technique that can be used to teach procedural skills, conceptual skills, content knowledge, and soft-skills. The current research was intended to find out whether this technique is superior in terms of students' achievement of content knowledge. Therefore, this research was intended to answer the research question "Is there any significant difference in achievement between students taught using the learning by teaching technique and those taught using a teacher-centered approach?"

Methodology

Research Design

This research was a quantitative research study with a true-experimental design. The study involved two groups, where one group received the instruction using the learning by teaching technique, and the other received traditional instruction through lectures.

Participants

The data for this research study were collected using a pre-test and a post-test administered to two groups of undergraduate students majoring in the English Language Teaching Department at Samudra University, which is a state university in one of the districts in Aceh, Indonesia. The samples for the research were collected in a randomly selected language testing course. All students enrolled in the course were selected to be the research

participants. The university divided the course into two groups. For the purpose of this research, one of the groups was assigned as the experimental group and the other the control group. The students' participation in all class activities was a requirement for successful course completion, and thus only the students who participated in more than 75% of all activities were included in this research. The first group, i.e. the experimental group, consisted of 25 students and the second group, the control group, consisted of 30 students. The students were between 18 and 20 years of age, with an average age of 19 years old. The tests were conducted in a language testing course offered to 6th-semester students. A detailed description of the students is presented in Table 1.

Table 1
Description of the research sample

Groups	Males	Females	Total
Experimental group	5	20	25
Control group	0	30	30

The pre-test was conducted at the beginning of the semester, and the post-test was administered at the end of the semester.

Research Procedure and Ethical Considerations

In this experimental research, *Language assessment: Principles and classroom practices* written by Brown (2004) was used as the primary teaching material. The topics covered in the book are presented in Table 2.

Table 2
Topics covered in the language testing course

No	Topics	Workshop provided by	Group members
1	Introduction to language testing	-	-
2	Principle of language assessment	Group 1	4 students
3	Designing classroom language tests	Group 2	4 students
4	Standardized testing	Group 3	5 students
5	Standard-based assessment	-	-
6	Assessing listening	Group 4	4 students
7	Assessing speaking	Group 6	5 students
8	Assessing reading	-	-
9	Assessing writing	-	-
10	Authentic assessment	Group 5	5 students
11	Alternatives in assessment	-	-

As presented in Table 2, due to time limitations and the number of groups, not all topics were included in the workshop, although the remaining topics were taught traditionally by the professor.

The experimental group received traditional classroom interaction for half a semester, i.e. eight meetings, while the control group received a full semester of classroom instruction. After the second meeting, the students were placed into six groups consisting of four or five students, as in Table 2, to work on teaching preparation, which included seeking permission from the target institution, negotiating the schedule, requesting class participants, and preparing materials. Each group was assigned one of the topics to teach, as shown in Table 2. Students regularly had a group meeting outside of class to prepare the materials and invited their professor to help them with the preparation. While preparing the materials, the students also discussed how the materials could be presented. In the preparation period, the group members helped each another understanding the material and they worked together to design the teaching activities. They re-read the material together several times to gain a level of understanding adequate for teaching. Students kept asking questions to their peers and lecturer when they had a problem understanding the materials. Because they took turns teaching, they planned what they should say together, so their teaching performance was coherent. This preparation was significant because it helped the students build knowledge by asking questions and reading actively.

The teaching was delivered through a workshop, and the workshop participants were students also majoring in English language teaching at another state university in the same city. Before the workshop, the students prepared a banner and certificates for student trainers and workshop participants. They also designed a questionnaire for feedback from the participants. In the workshop, the group members took turns presenting the selected material. Each group took about 90 minutes to present the material and facilitate other learning activities. Other groups also participated in the workshop as observers. Although the students had been advised to employ innovative expert-recommended teaching methods and techniques, such as the jigsaw technique and the Student Team Achievement Division (STAD), none of the groups seemed to use any of those in the workshop. All of the groups started the class with an icebreaker activity, then presented the material using PowerPoint, and concluded the class by conducting a student understanding confirmation activity such as a written quiz or inviting volunteer participants to answer one or two questions orally. Since the students were majoring in English language teaching, they had completed many courses on language teaching. During the workshop, they seemed to incorporate some concepts of language pedagogy such as providing rewards, inviting participants to pay attention, presenting them with leading questions, and making an effort to promote engagement among the workshop participants.

Instrument

The pre-test was designed to be similar to the post-test. The test covered all the materials on the syllabus, with an average of five questions for each topic. The test was made of multiple-choice questions developed by the authors. The test consisted of 50 questions, where each question had a weight of one, and thus the possible score range was between 0 and 50. The questions on the test focused on students' ability to recall the concepts they had learned in the course. There was one correct answer for each question, accompanied by three other distractors. The distractors were meant to pull test takers away from selecting the right answer when they did not know the correct answer (Brown, 1996). In writing the distractors, the authors followed the distractor requirements proposed by Cohen (2012) and Allan (1992), i.e. the distractors should not be easily eliminated without knowing the correct answer, and they should not paraphrase each other. Based on the reliability analysis, the test was highly reliable, with the internal consistency of 0.77 based on Cronbach's Alpha at 95% confidence boundaries after reversing items that were negatively correlated. Hair et al. (2014) categorized this reliability level as higher than the acceptable level for a research study.

Data Preparation for Analysis

Prior to this analysis, the data were carefully analysed for normality distribution. The normality test was performed using the Shapiro-Wilk test because the sample size was smaller than 2,000. All statistical calculations in this research were performed using R, an open-source statistical package. The results of the normality test are presented in Table 3.

Table 3
Test of data distribution

Groups	Test	Statistic (W)	p-value
Experimental Group	Pre-test	0.98193	0.9285
	Post-test	0.96371	0.5173
Control Group	Pre-test	0.94396	0.2387
	Post-test	0.97131	0.7413

Based on the Shapiro-Wilk test results shown in Table 3, all data were normally distributed ($p > 0.05$); therefore, parametric tests could be used for the data analyses.

Statistical Analysis

The scores obtained by the students in the pre-test and post-test for both groups were compared simultaneously using a two-way repeated measures ANOVA to find out whether each group's pre-test scores were significantly different to the post-test scores, and whether the improvement between the two groups were equal. A two-way ANOVA with interaction effect was also calculated to find out whether the differences in scores between the

pre-test and post-test were a result of the treatment. The differences and improvements were decided at a significance level of 95% (α = 0.05). This small significance level was used to avoid type 1 errors, i.e. to reject the null hypothesis when it is actually true (Stangor, 2011).

Results

For better visualization of the data, Table 4 presents the descriptive statistic based on five number summary and standard deviation for all data used in this research study. The five number summary includes minimum (Min) and maximum (Max) scores, first quartile (Q1), which is the score higher than 25% of other lowest scores, third quartile (Q3), i.e. the score lower than 25% of other highest scores, and median (Med).

Table 4
Descriptive statistics

Test	n	Min	Q1	Med	Q3	Max	Mean	sd
Pre-control	22	9	14	16	18	21	15.6	3.67
Post-control	22	12	15.25	18.5	20.75	26	18.5	3.74
Pre-Exp.	24	7	12.75	15	17	23	14.71	3.69
Post-Exp.	24	11	14	16.5	20	27	17	4.15

Table 4 shows that the scores were very low for both groups even after the treatment. They could only answer about half of the questions correctly in the post-test. The mean scores were also low although there were some improvements after the treatment.

Two-Way ANOVA Test

For the first analysis, the scores between the pre-test and post-test for experimental and control groups were calculated simultaneously using a two-way repeated measures ANOVA. For this purpose, students who were absent in one of the tests were not included in the analysis. As a result, there were 24 students in the experimental group and 22 students in the control group. The results of the ANOVA test are presented in Table 5.

Table 5
Results of two-way ANOVA for pre-test and post-test of both groups

Measure	DF	SS	MS	F	P
Teaching technique	1	0.524	0.523	2.305	0.13248
Tests (pre-test and post-test)	1	2.405	2.405	10.586	0.00161**
Residuals	89	20.22	0.2272		

Note. *p< 0.05, **p<0.01

Table 5 shows that there was significant evidence that the scores obtained by the students in both groups were statistically significant, $F(1, 89)=10.586$, p=0.001 with an effect size of 0.10. However, the differences between the pre-tests and post-tests was not significantly different between the two groups, $F(1, 89) = 2.305$, p > 0.05.

Two-Way ANOVA with Interaction Effect

The finding in the previous analysis shows that the scores for both groups improved significantly. To determine whether the improvement was due to the treatment, another ANOVA test was calculated. The results of the two-way ANOVA with interaction effect are provided in Table 6.

Table 6

Results of two-way ANOVA with interaction effect

Measure	DF	SS	MS	F	P
Treatment	1	32.6	32.58	2.23	0.13895
Tests (pre-test and post-test)	1	153.9	153.92	10.54	0.00166**
Treatment and tests	1	2.2	2.19	0.15	0.69972
Residuals	88	1285.8	14.61		

Note. *p< 0.05, **p<0.01

Table 6 shows that the interaction effect between scores and method of instruction was non-significant, $F(1, 88) = 0.15$, $p = 0.699$. Therefore, the difference in test scores between pre-test and post-test does not depend on the method of instruction.

Discussion

The objective of this research was to determine whether students who were taught through the learning by teaching technique outperformed those taught by using traditional teacher-centered instruction. Based on the results of two-way ANOVA, the research results did not show any evidence of differences in content mastery between students taught using the learning by teaching technique and those taught using a teacher-centered approach. However, both groups showed significant improvement in scores before and after the treatment, regardless of the type of teaching technique employed.

These results are unexpected but interesting. Previous publications have agreed that learning by teaching is a good teaching technique to promote content mastery (Allison, 1976; Blair et al., 2007; Matsuda et al., 2013; Mills, 1995; Podl & Metzger, 1994; Tsui, 2010). However, we did not find any statistical evidence that the learning by teaching technique was better for content mastery than traditional teaching and learning techniques. One possible reason for this unexpected result is explained by the discrepancy in the number of meetings for classroom instruction. The learning by teaching group had half a semester of instruction, and the other half of the semester was used for teaching preparation. Meanwhile, the control group was given a full semester of instruction. Based on the results of the analysis, the experimental group could still match the achievement of the control group regardless of the lower number of meetings for traditional instruction. Therefore, the similar achievement levels in the two groups can be interpreted as a success for the experimental group. Another possible reason for this unexpected result is explained by the nature of the technique, where students were only taught one topic. Therefore, they only learned the given topic and had little interest in learning the rest of the topics in the syllabus. However, they observed their classmates when they were teaching, and thus it was possible for them to pick up some information from the activities. The better mastery of the assigned material through the learning by teaching technique seemed to compensate for course mastery in general, which had contributed to their ability to match the achievement of the control group, which received far more instruction.

The failure to outperform the control group was exaggerated by the fact that the students were assigned to work in groups. While working in groups, each member of the group was usually responsible for a particular part of the topic. If they did not work in a group and have discussions with the other group members when preparing the materials, each member would have only mastered a small fraction of the material. Therefore, if content mastery is the only target of teaching, the implementation of the learning by teaching technique at five universities in Indonesia, as suggested by Kairisto-mertanen and Budiono (2019), should be adjusted to ensure that all groups teach all of the topics on the syllabus.

As much as this teaching technique has a primary weakness of inhibiting better content mastery, students are provided with many other benefits that equip them with the skills they need for the 21st century. In this research, students had to work in a team to prepare for the workshop, and thus they continued to develop their teamwork skills. Teamwork is one of the most significant skills required for their future careers. In fact, Gray (2016) listed nine other required skills in 2020, in addition to teamwork, as follows:

1. Complex problem solving
2. Critical thinking
3. Creativity
4. People management (teamwork)
5. Coordinating with others
6. Emotional intelligence
7. Judgement and decision making
8. Service orientation
9. Negotiation
10. Cognitive flexibility

According to Fibra (2019), students could learn eight of those skills, including teamwork, through the learning by teaching technique. In our research, students practiced critical thinking when they planned their workshop and prepared their teaching materials. Based on our observations, they started the workshop by presenting interesting icebreakers, which required creativity because each of the students in the class needed to come up with different icebreakers. In addition, because the students were asked to conduct the workshop off campus, they needed to contact and work with a partner university, where they practiced coordinating with others and utilizing their negotiation skills. The department at the partner university where they conducted the workshop had not conducted any academic or non-academic collaborative work recently. Therefore, the students felt that they needed to maintain the well-established reputation of their department by making the workshop participants pleased with their workshop and service. Therefore, they needed to practice a very significant skill, service orientation. Finally, although the content mastery was not as successful in the current research, students should enjoy being workshop facilitators, feel that they were useful to the participants, and most importantly think that they learned more by participating as the instructor, as revealed by Naeger et al. (2013).

Pedagogical Implications

Based on the results above, the implementation of the learning by teaching technique needs to be modified for optimal content mastery. First, since students seemed to focus more on their assigned topic, all students should be present as non-participant observers in every workshop, as in the present study. This way, they can be asked to write a review of the topics discussed by their classmates in the workshop. In writing the review, they need to first pay very close attention to their classmates' presentations and they also need to read the materials critically in order to be able to write a good review, as revealed by Yu (2019). To ensure that the students do so, the professor can explicitly instruct them and include it in their grading.

In the current research, not all topics could be accommodated in the workshop due to time limitations because the professor spent half of the semester teaching students before they started to organize the workshops. To accommodate all of the topics, the workshop can be conducted every week (for a course that meets once a week). The students should have finished preparing the materials before the class. To reinforce the need for early preparation, the professor can ask the groups to help the professor facilitate the class discussion. Therefore, not only will they benefit from earlier preparation, but they will also benefit from the professor's feedback, classmates' questions, and an opportunity to confirm their mastery of the material.

Limitations and Recommendations

The results of the current research are subject to some limitations. First, the sample size was rather small for a conclusive generalizable quantitative research study. Should the sample size be bigger, such as 30 for each group, the researchers would be more confident in generalizing the results of the research to the context outside the current research context. Second, the students' English proficiencies were mixed, and most of them had a lower level of English proficiency, which could affect their understanding of the test materials. Therefore, the results of the current research might not apply to advanced EFL learners or to courses taught in the students' L1. Third, each group of students in the class was asked to teach only one topic, which was a different topic from the other groups. The results might have been different if all groups were asked to teach the same topic. Finally, the current research only focused on content mastery. Further research needs to address whether the students' 10 significant worker skills listed by Gray (2016) significantly improved through the implementation of the learning by teaching technique.

Conclusion

The objective of this research was to find out whether the learning by teaching technique could improve students' content mastery better than the current teaching practice. To answer the research question, a course offered for students of the English Language Teaching Department at Samudra University in Aceh, Indonesia, was randomly selected. The students enrolled in the course were divided into two groups. The groups were randomly placed in control and experimental groups. The learning by teaching technique was implemented in the experimental group with half of the semester spent on instruction followed by students' hosting workshops for students from another university, while the control group was taught using a teacher-centered approach for the entire semester. The data were collected by administering tests at the beginning and the end of the semester. The conclusion was made through two-way ANOVA to analyze whether the groups improved their content mastery after one semester, and whether the improvement was significantly different between one group and the other. The analysis results showed that the students' scores improved significantly, but the improvement was similar between the two groups regardless of the smaller amount of instruction for the experimental group. This results suggest that the teaching by learning technique has potential because the students in the experimental group could match the performance of the control group who received more instruction.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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