Topical Article

SOCIETY FOR THE TEACHING OF PSYCHOLOGY

Teaching of Psychology
2019, Vol. 46(4) 284-289

DOI: 10.1177/0098628319872411
journals.sagepub.com/home/top
SAGE

Evidence-Inspired Choices for Teachers: Team-Based Learning and Interactive Lecture

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Abstract

Research on team-based learning (TBL) generally supports its effectiveness over "traditional" lecture. In practice, however, lecturing rarely consists of teachers exclusively talking at their students, as many incorporate a variety of strategies to encourage active processing. This study compared an interactive lecture style with TBL on student performance. Generally, the results indicate that there are differences in particular aspects of course performance across conditions depending upon grade point average (GPA). Overall, these results support the findings that either teaching strategy is a viable option for teachers. We argue that there is no one right way to teach, and the scholarship of teaching and learning can best serve high-quality teaching by actively contrasting and evaluating a variety of techniques for the wide variety of teaching needs.

Keywords

team-based learning, interactive lecture, lecture, active learning, GPA

Team-based learning (TBL) is an example of a pedagogy that incorporates a variety of active learning strategies into structured pedagogical strategy. In a TBL classroom, students learn the primary course content outside of the classroom and spend class time working in permanent teams to engage with the material (Michaelsen, Knight, & Fink, 2004). Prior to coming to class, students complete preparatory work which can include readings, watching videos, and completing reading guides. Next, each student takes a quiz on the primary course content before or at the beginning of each class. These "prelecture" quizzes encourage students to come to class prepared (Akers & Flann, 2016; Geiger & Bostow, 1976; Narloch, Garbin, & Turnage, 2006). Next, teams work collaboratively and cooperatively (Prince, 2004) to complete the same team quiz they completed as individuals. This step requires students to discuss reasons for and against possible answers. Following the quizzes, students receive a muddiest points lecture (Angelo & Cross, 1993) based on topics that teams request for instructor clarification. The final step in the process involves teams completing application exercises that have been designed using the 4Ss (Michaelsen et al., 2004). The 4Ss include presenting all teams with the *same* problem that is *significant* in the context of the class, for which teams have to make a *specific* choice that can be reported *simultaneously*. Despite using pedagogical strategies that are individually demonstrated to be effective for learning, the literature on TBL's effectiveness on academic outcomes is not consistent.

TBL Academic Outcomes

The TBL literature is inconsistent in terms of whether it increases student understanding of course content. One factor that contributes to the problem is that the way TBL is implemented is not always clearly outlined or does not follow the prescribed structure of TBL, leading to difficulty in interpreting its effectiveness (Haidet et al., 2012). Furthermore, TBL has been compared to traditional lecture, active lectures, and other fully active classes (Carmichael, 2009; Jakobsen, McIlreavy, & Marrs, 2014; Koles, Nelson, Stolfi, Parmelee, & DeStephen, 2005; Levine et al., 2004; Travis, Hudson, Henricks-Lepp, Street, & Weidenbenner, 2016). Given these differences, some studies find that TBL is more effective than other forms of teaching (e.g., Carmichael, 2009; Vasan, DeFouw, & Holland, 2008; Zingone et al., 2010), whereas others find that it is as effective as other forms of teaching (e.g., Koles et al., 2005). Even reviews and a meta-analysis of the TBL literature include these numerous types of comparisons (Fatmi, Hartling. Hillier, Cambell, & Oswald, 2013; Sisk,

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2011) and examining potential moderators such as outcome measures (e.g., standardized exams, course grades), education level of the course (e.g., undergraduate, graduate), and course content (Liu & Beaujean, 2017). These reviews and meta-analysis conclude that TBL is at least as effective as other methods of teaching. In other words, none of the literature suggests that TBL harms student learning outcomes.

Importantly, the literature, especially with respect to comparisons of TBL with lecturing, is murky. There are few operational definitions of what is considered a "lecture," and several studies parenthetically report a variety of lecture-imbedded activities that extend beyond the common conception of traditional lecture formats. For example, Travis, Hudson, Henricks-Lepp, Street, and Weidenbenner (2016) compared TBL to lecture. However, a footnote describes a variety of possible activities that may have been used by teachers in their "lecture" condition that move beyond the definition of traditional lecture (e.g., demos, videos, or "other methods as they deemed appropriate," p. 106). Because many people who lecture likely incorporate interactive components within their standard lecture techniques (e.g., Holmes, 2016), it seems reasonable to compare TBL with a precise and representative example of lecturing to examine student learning outcomes.

Interactive Lecturing May Be the Norm

Traditional lectures may be thought of as the instructor being the "sage on the stage" (King, 1993) presenting information to students as they passively attend to the lecture. However, it may be rarer than one might think for an instructor to simply "talk at" students. Holmes (2016) argues that what teachers construe as lecture varies widely and that many lectures include interactive learning strategies. In fact, a survey of lecturers found a majority of instructors report that their lecturing is student-focused and that effective lectures often encourage active engagement from students (Burkill, Dyer, & Stone, 2008). To distinguish lectures that integrate interactive learning strategies into their structure and delivery from the seldom seen but often chastised traditional lecture, we argue here that many lectures are actually *interactive* lectures (ILs) that include opportunities for interacting with target material and concepts, including, but not limited to, the use of clickers (Draper & Brown, 2004), think-pair-share (Kaddoura, 2013), clarification pauses (Di Vesta & Smith, 1979; Ruhl, Hughes, & Schloss, 1987), and collaborative and cooperative learning (Prince, 2004).

Numerous studies have found that using ILs compared to traditional lectures increases student learning (Hake, 1998; Laws, Sokoloff, & Thornton, 1999) and decreases failure rates (Freeman et al., 2014). For example, IL strategies that incorporate clicker questions (Draper & Brown, 2004), think-pair-share (Kaddoura, 2013), and clarification pauses (Di Vesta & Smith, 1979; Ruhl et al., 1987) encourage students to actively engage with course material and encourage increases in understanding of course material compared to students who learned the material through traditional lectures. Hake (1998) completed a meta-analysis that showed that using interactive lecturing (i.e., involve discussion with peers and/or the instructor) results in higher scores on standardized tests compared to classes that use traditional lectures. Introducing even a few minutes of meaningful interactive lecturing (Wiggins & McTighe, 2005) increases short- and long-term retention (Di Vesta & Smith, 1979; Ruhl et al., 1987). Generally speaking, the literature seems to indicate that interactive lecturing is effective for student learning. Furthermore, although no formal metric is available, it is likely that the vast majority of lecturers include such strategies in their lecture format courses (Burkill et al., 2008).

Purpose

Given that comparisons between TBL and lecture include a variety of operational definitions of what a lecture is, we believe it is important to compare TBL to what may be considered representative practices in modern lecturing. The purpose of this study was to contrast the effectiveness of two evidence-inspired teaching methods: TBL and IL. Because TBL seems to particularly benefit lower achieving students (e.g., Koles et al., 2005; Koles, Stolfi, Borges, Nelson, & Parmelee, 2010), we examined how the two methods affect higher and lower GPA students' academic performance.

Method

Participants

During fall 2014, students from two upper division developmental psychology classes from a large southeastern university in the United States participated. All students were psychology majors. One class was taught using IL and the other using TBL. The same instructor (Krisztina Jakobsen)—who is proficient in both IL and TBL—taught both classes, which were 50 min in length and met three times per week back-to-back, at 9:05 a.m. and 10:10 a.m. There were 66 students enrolled in the two classes ($n_{TBL} = 33$, $n_{IL} = 33$). Students who withdrew from the class, did not give consent for use of their data, and did not allow for GPA verification were excluded from analyses. The final sample consisted of 58 students, 30 students in the IL class (27 females; $M_{age} = 20.13$, $SD = 0.78$) and 28 students in the TBL class (18 females; $M_{age} = 20.4$, $SD = 0.95$). The institutional review board (IRB) approved this study.

Class Procedures

At the beginning of the semester, students in both classes completed a multiple-choice pretest to assess their prior knowledge of developmental psychology. During the semester, students in both classes received questions for each chapter to guide their reading prior to coming to class, which were not collected or graded in either class. Both sections of the class took 12 identical individual quizzes consisting of multiple-choice questions, two identical noncumulative exams consisting of multiple-choice and short-answer questions, and identical

cumulative final exams consisting only of multiple-choice questions. The short-answer questions on the noncumulative exams were graded blindly by the instructor and teaching assistants.

IL. Students in the IL class received their reading guides for each chapter 1 week in advance of covering that chapter in class. Students in the IL class came to class each day and listened to lectures using PowerPoint. The lectures did not cover all of the material presented in the reading guide but focused on the more challenging concepts (e.g., providing additional examples, discussing current events in relation to concepts). The lectures incorporated interactive learning activities, including viewing short videos with follow-up discussion, think-pair-share discussions, and discussion between the teacher and students. Each chapter took three class sessions to cover, with a multiple-choice quiz at the end of the third day.

TBL. The instructor assigned students in the TBL class to teams using criteria that included what year they were, whether they had previously taken a developmental psychology class, and whether they were a transfer student. Each team had 5–7 students.

The TBL class used TBL throughout the semester. A week in advance of starting a new chapter, students received the reading guide. The first class period for each chapter started with an individual multiple-choice quiz, followed by completing the same quiz with their teammates. Students were allowed to bring one 3 × 5 index card for each individual quiz. During the team quiz, students could work only with their teammates and could no longer use the index card. Teams used immediate feedback assessment technique (IF-AT) forms (www.epsteineducation.com) to complete their team quiz, which allowed them to receive immediate feedback. Following the team quiz, teams could appeal any question the team—but not individual team member—got wrong using evidence from their textbook or other preparatory materials. The instructor reviewed appeals after class; any team whose appeal was granted received credit for that question and any individual on the team who also gave that answer received points back on their individual quiz. Finally, teams provided a list of muddiest points for which they would like a clarifying lecture.

The second class period started with a muddiest points lecture to clarify any material students indicated in the previous class that they did not understand. Following the muddiest points lecture—which usually lasted 15–20 min—and into the third class period, teams completed ungraded application exercises designed according to the 4S principles (Michaelsen et al., 2004), which allowed for effective intra- and inter-team discussions. The 4Ss included teams working on the *same* and *significant* problem, followed by teams *simultaneously* reporting a *simple* choice. In a 50-min class period, teams spent on average 20 min completing one to four application exercises and the rest of the class period engaging in inter-team discussions.

Students' individual performance constituted 78% of their grade, and the team performance constituted the other 22% of their grade, adjusted based on their team evaluation scores (Michaelsen et al., 2004). Students completed a formative team evaluation (including both quantitative and qualitative feedback) during the 6th week of the class. Students completed the same team evaluation at the end of the semester, which contributed to the total number of points individuals earned for their team performance.

Data Analysis

We examined the effect of TBL and IL on several measures of student learning, including the total number of points earned (quizzes + all exams), and the individual contributions of quizzes, the sum of Noncumulative Exams 1 and 2, and the cumulative final exam. In order to be able to make direct comparisons, we only included the individual quizzes for the TBL section.

As part of the analyses, we compared students with higher and lower GPAs. Students with higher GPAs were those who earned a 3.0 or above ($n_{TBL} = 19$, $n_{IL} = 19$) and those with lower GPAs were those who earned less than a 3.0 ($n_{TBL} = 9$, $n_{IL} = 11$). We also ran the analyses using GPA as a continuous variable in a regression, with generally the same patterns that we found with the analysis of variance (ANOVA).

Results

Student Demographics

An independent samples t test revealed that students in the IL ($M = 3.21$, $SD = 0.45$) and TBL ($M = 3.26$, $SD = 0.44$) classes were similar in terms of cumulative GPA, $t(56) = 0.421$, $p = .676$. At the beginning of the semester, students in the IL ($M = 17.4$, $SD = 2.25$) and TBL ($M = 16.3$, $SD = 2.82$) classes did not differ significantly on their performance on the knowledge of developmental psychology pretest, $t(56) = 1.616$, $p = .112$, $d = 0.42$. These analyses suggest that students in the two classes were similar in terms of their overall academic performance and knowledge about developmental psychology at the beginning of the semester.

Academic Performance

Total points. A univariate ANOVA with class (IL, TBL) and GPA (higher, lower) revealed no main effect of class, $F(1, 54) = 1.54$, $p = .219$; students in the IL class ($M = 556$, $SD = 35$) and the TBL class ($M = 568$, $SD = 55$) did not differ in the total number of points at the end of the semester. There was a main effect of GPA, $F(1, 54) = 79.35$, $p < .001$, $\eta_p^2 = 0.56$, in which higher GPA students earned significantly more points ($M = 591$, $SD = 29$) compared to lower GPA students ($M = 522$, $SD = 36$). There was also a Class × GPA interaction, $F(1, 54) = 12.54$, $p = .01$, $\eta_p^2 = 0.188$. To follow up the Class × GPA interaction, we conducted independent samples t tests, which revealed that higher GPA students in the TBL class ($M = 600$, $SD = 31$) earned significantly more points than the higher GPA students in the IL class ($M = 582$, $SD = 23$), $t(36)$

$= 2.05$, $p = .048$, $d = 0.66$. Lower GPA students in the IL class ($M = 539$, $SD = 37$) earned significantly more points than lower GPA students in the TBL class ($M = 501$, $SD = 21$), $t(18) = 2.73$, $p = .014$, $d = 1.22$. The addition of the pretest score as a covariate did not affect the results.

Quizzes. We sought to explain what was driving these effects, so we analyzed the role of the quizzes and exams on final grades. A univariate ANOVA on quiz grades with class (IL, TBL) and GPA (higher, lower) revealed a main effect of class, $F(1, 54) = 9.38$, $p < .001$, $\eta_p^2 = 0.148$; students in the IL class ($M = 200$, $SD = 12$) earned significantly more points on quizzes compared to students in the TBL class ($M = 189$, $SD = 12$). There was a main effect of GPA, $F(1, 54) = 89.2$, $p < .001$, $\eta_p^2 = 0.623$, in which higher GPA students earned significantly more points ($M = 210$, $SD = 11$) compared to lower GPA students ($M = 181$, $SD = 18$). There was also a Class × GPA interaction, $F(1, 54) = 26.17$, $p < .001$, $\eta_p^2 = 0.326$. Follow-up independent samples t tests revealed similar quiz scores for higher GPA students in the TBL class ($M = 213$, $SD = 11$) and higher GPA students in the IL class ($M = 206$, $SD = 11$), $t(36) = 1.85$, $p = .072$, $d = 0.54$. Lower GPA students in the IL class ($M = 193$, $SD = 12$) received significantly higher quiz grades compared to lower GPA students in the TBL class ($M = 166$, $SD = 13$), $t(18) = 4.58$, $p < .001$, $d = 2.06$.

Noncumulative exams. A univariate ANOVA on the sum of Noncumulative Exams 1 and 2 with class (IL, TBL) and GPA (higher, lower) revealed no main effect of class, $F(1, 54) = .29$, $p = .587$; students in the IL class ($M = 201$, $SD = 21$) and the TBL class ($M = 215$, $SD = 16$) did not differ in the points earned on Exams 1 and 2. There was a main effect of GPA, $F(1, 54) = 31.5$, $p < .001$, $\eta_p^2 = 0.368$, in which higher GPA students earned significantly more points ($M = 215$, $SD = 16$) compared to lower GPA students ($M = 187$, $SD = 21$). The Class × GPA interaction was not significant, $F(1, 54) = 1.99$, $p = .163$.

Cumulative final exam. A univariate ANOVA on the cumulative final exam with class (IL, TBL) and GPA (higher, lower) revealed no main effect of class, $F(1, 54) = 1.39$, $p = .243$; students in the IL class ($M = 163$, $SD = 10$) and the TBL class ($M = 162$, $SD = 12$) did not differ in the points earned on the final exam. There was a main effect of GPA, $F(1, 54) = 30.95$, $p < .001$, $\eta_p^2 = 0.364$, in which higher GPA students earned significantly more points ($M = 163$, $SD = 8$) compared to lower GPA students ($M = 154$, $SD = 10$). The Class × GPA interaction was significant, $F(1, 54) = 4.30$, $p = .043$, $\eta_p^2 = 0.074$. Follow-up independent sample t tests revealed similar final exam scores for higher GPA students in the TBL ($M = 168$, $SD = 7$) and IL ($M = 166$, $SD = 9$) classes, $t(36) = 0.79$, $p = .432$. Lower GPA students in the IL class ($M = 158$, $SD = 9$) received marginally more points on the final exam compared to lower GPA students in the TBL class ($M = 150$, $SD = 10$), $t(18) = 1.87$, $p = .078$, $d = 0.84$.

Student Perceptions

To address any potential biases due to the fact that the author taught both classes, we used independent samples t tests to examine end-of-semester online course evaluations. Students in the two classes were similar in their perceptions of the instructor's knowledge and enthusiasm, and that the classroom environment promoted learning, ps > .05. Students in the TBL class agreed more with the statement that the "instructor facilitated critical thinking" in the class than students in the IL class, $t(42) = 2.263$, $p = .028$, $d = 0.69$.

Discussion

We analyzed the data from several perspectives. First, we examined the total number of points students earned. Next, we examined noncumulative assessments that contributed to total points earned in the class, looking at the contribution of quizzes and Exams 1 and 2. We then analyzed cumulative final exam scores as an indicator of content mastery. Because some literature suggests that lower GPA students tend to benefit from TBL (e.g., Koles et al., 2005), we also examined how lower and higher GPA students performed in different class formats. Generally speaking, across all of our measures, higher GPA students earned more points than lower GPA students; however, GPA was differentially associated with performance in the TBL and IL classes.

At first glance, it appears that students in the TBL and IL classes earned similar total points, which is consistent with some previous findings that suggest that both IL and TBL are effective teaching methods (Jakobsen et al., 2014; Koles et al., 2005; Nieder, Parmelee, Stolfi, & Hudes, 2005). However, GPA differentially affected students' performance in the TBL and IL sections. Higher GPA students earned significantly more points in the TBL class compared to the IL class, whereas lower GPA students earned significantly more points in the IL class compared to the TBL class. Further analyses revealed that the individual components of the total points earned—quizzes and exams—explain these differences between groups.

The results of the quiz analyses revealed that students in the IL class earned more points on quizzes than students in the TBL class. This main effect was qualified by an interaction, which revealed that students with higher GPAs showed trends for earning more points on the quizzes in the TBL class than in the IL class. In contrast, the lower GPA students scored more points on quizzes in the IL condition than in the TBL condition. The fact that lower GPA students in the IL class earned more points on quizzes than the lower GPA students in the TBL class may be an artifact of the timing of the quizzes. Students in the TBL class completed the individual quiz during the first session of a module (before they received any corrective feedback), whereas students in the IL class received lectures prior to taking quizzes. It appears that lower GPA students may benefit from postlecture quizzing (Brink, 2013). Of particular note is that the benefit of the quizzes did not persist on noncumulative exams. Analysis of noncumulative exams (Exams 1

and 2) revealed that students in the TBL and IL classes performed similarly regardless of GPA. Thus, the effects of quizzes seem to be reflected in total points earned rather than on summative measures of learning.

Finally, we explored the potential effects of class format and GPA on performance on the cumulative final exam. The results revealed that higher GPA students earn similar scores in either class, whereas lower GPA students showed a trend for higher performance in the IL class compared to the TBL class. This is a finding worth further exploration. TBL contains a variety of components that build upon content mastery. Students who benefit from lecture may be those who are not able to build this foundational knowledge as effectively without the added explanation contained in lecture, at least with respect to longer term retention. This is supported by the finding that lower GPA students benefited more from postlecture rather than prelecture quizzing.

So, does TBL work better than lecture? It depends. First, the answer depends upon how we define lecture. For example, TBL seems to be superior to lectures that predominately utilize a "sage on the stage" format (e.g., Carmichael, 2009; Hubert Wiener & Plass, 2009). But, if we define lecture as including both speaking and opportunities for interaction (e.g., interactive lecturing), the present study argues TBL is neither better nor worse.

The answer also depends upon the student population. The present study demonstrated differential effects of the two tested strategies for higher and lower GPA students. It is quite possible that strategies may differentially affect distinct student groups (e.g., Eddy & Hogan, 2014), be they major/nonmajor, male/female, or higher/lower GPA, or work differently with different subject matters. These are important issues for further research.

Overall, these results support the findings that, while not necessarily superior, TBL is at least as effective as other evidence-inspired methods, including IL; in other words, teaching using TBL is a viable option for teachers who would prefer to teach in this style. Importantly, these results also indicate that lecturing that includes interactive components is also effective. It is important to note that both formats evaluated are *interactive* learning pedagogies, with neither holding an advantage over the other at the overall course level. In other words, the interactive components, rather than the system in which they are embedded, may be responsible for the learning gains. For example, Jensen, Kummer, and Godoy (2015) compared a flipped-classroom format, which is a format that includes active learning strategies, with a traditional (e.g., nonflipped) classroom with embedded active learning components. Their results indicate an effect for the interactive learning components, regardless of overall class format.

We extend the literature to encourage an appreciation for interactive lecturing as a viable classroom pedagogy. This is a valuable and important finding which uses an active control group. Rather than minimizing findings of nonsignificance when comparing pedagogical methods with those already demonstrated to be effective in the literature, we should look favorably on these outcomes, which allow us to have multiple evidence-inspired tools in our pedagogical toolbox (Jakobsen, 2018). As Daniel (2019) persuasively argues, the quest for a single best strategy for all teachers in all contexts is untenable. We should move away from searching for a single best technique and develop a flexible arsenal of strategies. This will more effectively allow us to figure out why things work and under what conditions, keeping in mind that the delivery of the content may not be as important as providing real-time opportunities for the student to process the information (van der Vleuten & Driessen, 2014).

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

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