Team-Based Learning and Cooperative Learning: Lessons for Group Work in Economics Principles Courses

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Higher education instructors looking for guidance on using small groups in the classroom have two evidence-based and theory-based pedagogies available: Team-Based Learning (TBL) and Cooperative Learning (CL). In economics education these two approaches both have support in the literature, but little comparison between them. In this paper, I assess the two pedagogies for use in economics principles courses. I conclude that TBL has two components that instructors will want to consider: Immediate Feedback/Assessment Tests and specific choice Application Exercises. However, CL offers the most appropriate structures for group work when the goal is student understanding and application of basic concepts. This paper includes preliminary evidence and, based on work in other disciplines, suggestions for improved data collection. An appendix provides examples of cooperative learning structures for use in economics principles courses.

Team-Based Learning (TBL)

TBL was first developed by Larry Michaelsen in the late 1970s and since then has been adopted extensively in varied higher education environments, most notably in medical and engineering education. (Sibley and Ostafichu, 2014 Sweet and Michaelsen 2012; Michaelsen, Sweet and Parmelee 2009; Wallace 2014). Application in economics has been limited. (Imazeki 2015; Goffe 2016; Espey 2012; Wall 2016; Silz-Carson 2016). Briefly, TBL is a set of three distinct structures.

First TBL uses "Readiness Assurance Tests" (RATs) to ensure that students are prepared for work in class. RATs have two stages, an individual-RAT (or iRAT) taken by students either before class or at the very beginning of class. The iRAT is a multiple choice test on content in readings assigned for that class session. Next students take the *same* test in team-RATS (or tRATs) using scratch-off forms called Immediate Feedback/Assessment Technique, IF/AT (Epstein Education Enterprises). The scratch-off forms require teams to make a choice and then

learn if the answer is correct if a star appears. If wrong, the team keeps scratching until the correct answer appears, but less credit is earned for more than one attempt. In these team tests students start class with intense small group discussion about upcoming content and receive immediate feedback on correct answers. In the learning science literature, this format of self-testing has been shown to improve retention of new ideas. (Brown et al 2014).

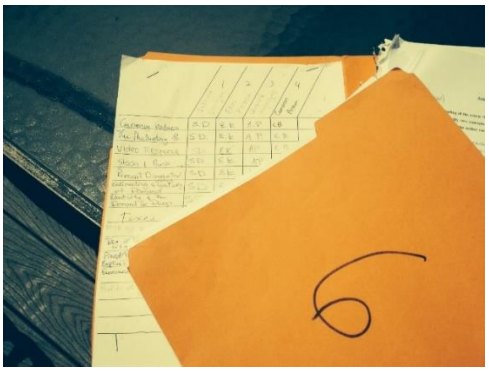
Second, teams of 5 – 7 students complete a 30 to 60 minute Application Exercise (AE) Each team works on the same significant problem applying newly-learned concepts in a context that is important and relevant to students. Teams are required to make a specific choice from at most five answers and then report their choice simultaneously to the entire class. Subsequent class discussion take place between groups based on what often are different chosen answers. Here, too, research literature specifically on TBL (Haidet et al 2014) and more generally on structured class activities (Snyder et al 2016) shows significant improvement in student learning. Third, team members assess the contributions by other team members using evaluation forms that count in each student's final grade. (Michaelsen et al 229-239)

Cooperative learning (CL)

CL also is a several decades old pedagogy with a structured approach to in-class small group activities. There is an extensive literature documenting its success in K-12 classrooms and several books and many articles on CL application in higher education including some specifically in economics. (Millis and Cottell 1998; Kagan 2014; Maier et al 2010; McGoldrick 2012; Emerson et al 2015).

In both TBL and CL teams work *in class*; out of class group projects are an entirely different approach. Except for occasional informal pair work, TBL and CL agrees that teams should be selected by the instructor, thus avoiding problems that occur when friends are in the same group. Also, TBL and CL suggest that groups remain together for all or most of a course term, allowing students to build trust in their team mates (Espey 2015). Finally, TBL and CL suggest the use of team folders and team self-reporting of completed work, practical suggestions

that reduce instructor grading time.



CL focuses on application of one concept rather than an open-ended problem as in TBL. As a result, CL recommends smaller groups—three or four rather than up to eight--typically with more written structures for the tasks than in TBL. And usually CL activities usually require less class time, sometimes as little as five to ten minutes, whereas TBL recommends much longer time for each team assignment.

As in TBL students work in small groups, but without explicit recommendations for pre-class preparation. Instead, CL's main contribution is to provide activity structures that are more specific than TBL AEs in terms of each student's role. CL structures provide a framework that requires all students to participate relatively equally and to listen to and take into account contributions of other team members. Students are held accountable by the subsequent individual assignments, not evaluation by team members.

What is best for the economics principles course?

From TBL

TBL's iRATs and tRATs are readily adaptable for use in economics principles courses. Multiple choice questions are readily available from textbook publishers, or from instructor's own past usage. As a result, setting up the RAT may require little instructor time. In addition, implementing the RAT approach can take little class time. If the iRAT is completed using a course management system, the tRAT requires only a few minutes at the beginning of class. This component can be adopted independently of the larger TBL framework, although instructors will

benefit from TBL and CL advice in terms of team formation and team recordkeeping. Research on the effectiveness of RATs in promoting student preparation for class is a fertile area for economic education research.

As evidence for student reading before class and improved learning after team discussion, data was collected from 3720 iRATs and 216 tRATs in principles of microeconomics and principles of macroeconomics course. Individual Readiness Assurance Tests had mean score of 59% and team Readiness Assurance Tests mean score of 81%. These results are slightly lower than scores recommended in the TBL literature, 65%- 70% for iRATs, and 95% - 100% for tRATs. (learnTBL 2016). Nonetheless the results in this community college application show iRAT questions were neither trivial (mean score was 59%) while at the same time students had reviewed the required reading, scoring higher than a 20% guess rate. Then in the tRATs, students participated in a discussion that significantly raised the score (to 81%) and then received immediate feedback for all incorrect answers.

In addition, recordings and observation of teams completing tRATs demonstrated on-task focus. As noted below for CL structures, tRATs create a situation in which there is intense discussion of economic concepts, in this case during the first five to ten minutes of class time. One motivation certainly is the score, even though in my courses it was only 0.5% of the final grade. In addition, students reported that they liked the novelty of scratching to find the answer. As noted above, immediate feedback and repeated testing are key recommendations from learning sciences.

More research is needed on both iRATs and iRATs. One avenue for exploring what occurs when students read before class is the program Perusall (www.perusall.com), developed by Eric Mazur (King 2016). Perusall has several attributes including easy upload of digital materials and automatic scoring of student comments. For the goal of understanding how students respond to assigned readings, Perusall could be used to collect student commentary on the reading. For tRATs, Espey has explored the importance of team composition (Espey, 2015) We also can better understand how students support one another in discussing economic problems. The CL literature, discussed below, describes findings from math education research (Vidakovic 1997 and Martin and Vidakovic 2004)

For principles of economics courses, a strict by-the-book adoption of TBL Application Exercises may be inappropriate for the undergraduate student. Unlike professional programs such as medicine and engineering in which TBL is used extensively, students in introductory economics courses often come to the classroom with limited academic experience in the discipline and less sophisticated engagement with the content compared to medical students (Siegfried and Walstad 2014). As a result, first or second year college students in economics may not be ready for lengthy discussion on a single problem. Moreover, an unstructured discussion likely will cause some students not to contribute, or for the team to fail to apply the concept to be learned.

Nonetheless, components of the TBL Application Exercise framework are readily applicable in economics principles courses. TBL uses a mnemonic for successful Application Exercises: four S's: Significant problem, Same problem, Specific choice, and Simultaneous Answering. (Sweet and Michaelsen 2012: 24-5; Roberson and Franchini 2014: 288-295). As described below, in combination with CL, the same problem with specific choice and simultaneous answering is a framework for improved small group work.

From CL

CL addresses the goal of more effective use of class time in which group work supplements a traditional lecture approach. The learning science literature stresses the importance of frequent processing of new ideas, that is student practice articulating and explaining new ideas, a goal met efficiently with cooperative learning. Interactive processing is effective because it clears working memory so that new ideas can be added, stores new learning in long-term memory, and cements that memory through emotional, novel and episodic interaction. (Kagan 2014: 122-6) CL provides guidance for ways to make certain that there is more equal participation by all students and accountability from individual students. In most CL activities the structure itself requires interdependence of group members so that no single student can dominate or complete the task individually. Thus CL directly addresses issues of free-riding, a topic frequently raised in the economic education literature (McGoldrick 2012; Bartlett 1995; Caropreso and Hagerty 2000.)

Drawing on research literature in cooperative learning (Kagan (2009; 2014), the CL literature uses a second mnemonic PIES (Positive Interdependence; Individual Accountability; Equal Participation; and Simultaneous Work). The key attribute of CL is "positive interdependence," defined by Kagan as the correlation of one student's success with other team member's success. In practice positive interdependence means that the structure of group activity encourages students to work together. There is little incentive for one student to dominate the interaction or for students to sit back and not participate. By contrast, TBL's Application Exercises assume that students are self-motivated as can be expected in professional programs, or, alternatively that the penalty of poor peer reviews will motivate students to be fully engaged. [1]

Activities

The advantages of CL are best understood by examining specific structures that promote CL goals. (See appendix 1 for examples in a Principles of Economics course)

- Jigsaw (Millis and Cottell: 126-32) is a CL structure in which individuals each have part of the "puzzle" needed to complete the task. In this way students are positively interdependent on one another, individually accountable for part of task, participating equally and working simultaneously (PIES in the CL framework). In other words, it is the structure of the activity itself that reinforces desirable group dynamics, rather than instructor exhortation or peer assessment as in TBL.
- Cards (Keenan 2005: 85-88) is a CL structure in which the group has a set of cards placed face down. The goal is to slow group work down, requiring each person to take turns selecting a card and then guide the group to a decision based on the card. In this simple addition to a traditional economics problem, tallies of participation show that it is

[1] Both the CL and TBL literature do not recommend standard worksheets, warning that "in the interest of efficiency, we may be tempted to present a sequence of small tasks all at once." (Roberson and Franchini 2014: 296) Problem sets of this sort may be appropriate for individual work out of class, but when assigned to small groups there is an incentive for one more-skilled student simply to complete the work. Or, the task may be divided up so each group member works individually, eliminating the benefits of group discussion

more equal than in open discussion. Tape recordings show that there also is more focused time on task.

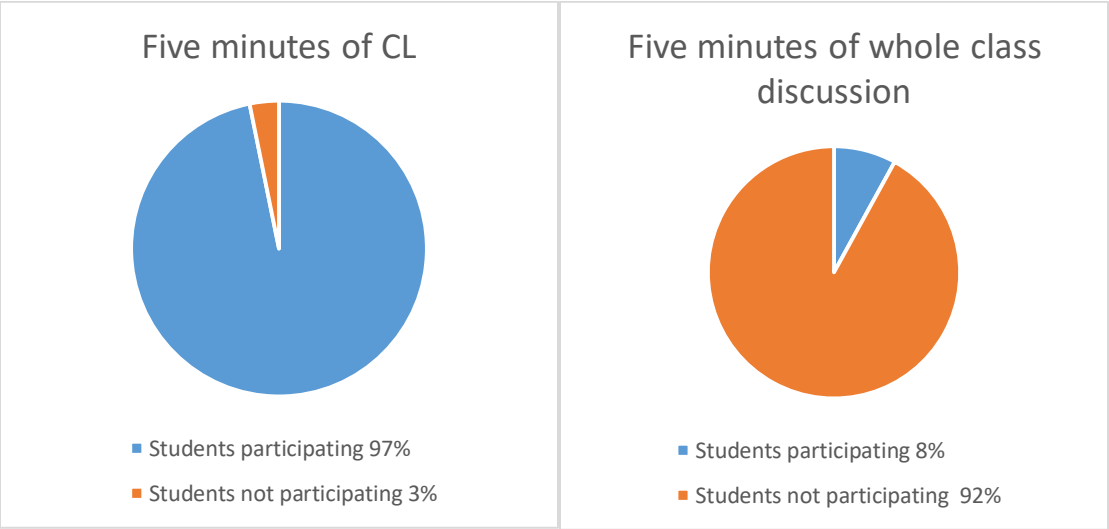
- Survey (Maier et al 2010: 173; Maier 2003) is a CL structure in which students analyze data collected from classmates. As in other CL activities, it is the structure itself that requires all students participate and require each other's data in order to complete the task.
- Cooperative controversy (Jacobs 2010; Smith et al 2010: 94-6) is a CL structure in which teams of four analyze a controversial topic. In the group of four, student pairs are assigned a pro or con position on an issue and list arguments for their position. Then each pair compares arguments with the other side and selects the most compelling argument for each position. Because students require each other's responses in order to complete the task, they are positively interdependent, individually accountable, and participating equally and simultaneously.
- Pass a problem (Maier et al 2010: 164-5) is a CL structure in which individual students create data for a problem and then pass the problem to another team member to solve. In this way there is positive interdependence since each student is solving a different problem and thus cannot wait for the answer to be provided. (For variation called Send A Problem see Millis and Cottell: 103-5).

Evidence

Quantity of talk time

Simply put, the major benefits of CL structures are efficiency and participation. In a well-structured CL framework all students interact and in less time than in a traditional lecture or lecture/discussion class. And, the differences are dramatic. In a traditional lecture/discussion there simply is insufficient time for each student to speak. And, when discussion does take place there are repeated studies showing that a few students often dominate. In data collected in my Principles of Microeconomics course, during whole-class discussion 8% students made 40% of the comments. By contrast, well-structured CL enabled all students to talk more, or in the learning science language, to process new learning more often. In data collected on 72 small

group activities with more than 300 students, there were only two instances in which a student did not participate at all. And, student participation occurred in a relative short time; 97% of the students spoke in five minutes.



Quality of talk time

To be productive student talk time in small group work must be on task. Students not only need to avoid distractions, but in the short time allotted to group work students need to sort out preconceptions, raising difficulties and objections, make corrections and reach well-thought out conclusions. These are ambitious goals for any group and often particularly daunting in a large undergraduate classroom with many students who are unfamiliar with academic discourse and behaviors that contribute to learning in groups. In this regard, the CL approach provides structures that contribute to effective group work. These are well suited for introductory economics courses in which students may not possess highly developed group work skills and in which instructors do not have the time or capability to teach them.

Assessing group process is, of course, difficult. In a sense, group work is a black box in which we assume good things happen, but we have can only theorize why. In audio tape recordings of groups in my principles courses I found that students were able to assist one another in resolving relatively minor barriers to understanding that were difficult to deal with a full class discussion because they were so varied and students were reluctant to articulate them

(Maier 2003). In small groups, my students were able to discuss and correct errors in vocabulary, historical events, mathematical procedures and graphing techniques. Encouraging deeper thought proved more difficult. Although students identified such issues, they preferred to focus on "right" answers and provide relatively short answers to complex phenomena or to set the issue aside.

It is precisely these higher level problems that TBL attempts to address in Application Exercises. Thus, I admit to making a deliberate trade-off, preferring efficient and complete discussion by all students of the targeted concept in the principles course. More sophisticated evaluation, involving for example policy or ethical decisions, I find better confronted by students in individual writing. In this way students will have time for the more difficult task. And, instructors can ask for revisions appropriate to each student's level of understanding that may vary considerably in a principles course. (See Bean: 33-38)

Better evidence

Research by mathematics educators Vidakovic (1997) and Martin (with Vidakovic 2004) shows that groups are able to solve problems more accurately than individuals working alone. Even when one member is more skilled, the collective group is able to correct errors that remain unnoticed when the skilled problem solver works independently without explaining his or her procedure. This work confirms my observation that small groups were best at error correction. Eric Mazur points out that recording and analyzing small groups is class is enormously time-consuming. In a recent paper (Tucker, Scherr, Zickler and Mazur 2016) he and colleagues tested exclusively visual analysis of group interactions, concluding that with a validated coding scheme, computer-automated visual coding can allow researchers to analyze group behavior for very large classes.

Combining TBL and CL

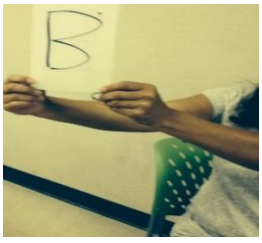
Instructors need not choose between TBL and CL. Eclectic adaptation is an obvious alternative, combining what works best in TBL and CL. For example, iRATs can be used before class and tRATs in class without fidelity to the entire TBL Application Exercise format. In this way the iRAT procedure encourages students to prepare for class, while the tRAT provides quick

remediation for those who are not fully prepared and does so in a collaborative format that encourages students to teach one another in a manner likely to keep them on task. This TBL innovation deserves dissemination, independent of TBL itself. At my institution other instructors have readily adapted RATs if not full TBL and students have responded: "why are these scratch-off forms not used in every course."

However, much is to be gained by attention to the fully-realized and evidence-based formats recommended in TBL and CL. For example, tRATs work best when used with teams organized along TBL principles including instructor-designated groups lasting for the entire term. And, the content covered in a RAT, likely lower level concepts, will be reinforced and shown to be important, if the RAT is followed by an Application Exercise.

Similarly, fidelity to CL recommendations can increase student learning in commonly-used pedagogies. For example, think-pair-share benefits from instructor designation of pairs (to encourage students not to work with friends), direction for how long each student will speak (until students become accustomed to the technique), and a requirement that students report out their partner's contributions, not their own. Similarly, classroom experiments can be combined with Jigsaw or Send-a-problem so that students analyze results in small groups (Maier et al 2010: 169-70).

The most promising adaptations combine features of TBL and CL. For example. traditional CL activity structures listed above (cooperative controversy, inclass surveys, and jigsaws) can include the TBL recommendation for specific choice. That means the team must choose among prior options (usually four or five). In this way discussion is focused on a restricted set of outcomes (is it A, B, C, D or E?) and the team can be asked to justify its specific choice. In this combination, the CL structure supports efficient, on-task participation by all group members while TBL's specific choice format encourages more focused reporting out than would occur if teams were asked to summarize their prior discussion.



As advocates for TBL and CL point out (Fink 2004), eclecticism with not without trade-offs in which advantages of either approach will be lost. Most importantly, the CL approach recommended in this paper moves away from fully-realized TBL Application Exercises involving a "significant problem." A CL activity that involves relatively simple application of one concept may not include the TBL goal of a problem that involves higher level thinking. The CL structure of cooperative controversy can examine a significant problem, but even in this structure the emphasis is on identifying strong arguments on either side of an issue, not working toward a solution.

On the other hand, fidelity to the TBL format requires that students move directly from the highly concrete RAT multiple choice questions to the Application Exercise significant problem. Instructors may intervene with mini-lectures on content that many groups did not understand before moving on to the Application Exercise. However, even with this intermediate step, students will not have the opportunity to apply newly-learned concepts in new contexts, a key recommendation from learning research (National Research Council: 6). CL structures can provide precisely such practice with a format that is efficient with regard to class time and requires all students to participate. It may be more realistic for students to address the difficult and significant problems in follow-on writing assignments completed individually.

Putting together the desirable aspects of TBL and CL suggest the following scenario for student learning:

- iRAT on assigned reading (either out of class submitted on Learning Management System, or in class)
- tRAT (in class in instructor-assigned, term-long teams)
- Mini-lecture if needed on concepts revealed as poorly understood in the tRAT
- Introduction of a new problem using concepts studied in RAT
- In a think-pair-share students make a prediction based on the problem using Instructor does not reveal any answers.
- Teams complete an activity using a CL structure such as survey, cooperative controversy, jigsaw, or classroom experiment.

- Teams select a specific choice answer, reveal it simultaneous and discuss.
- Mini-lecture by instructor summarizes what was learned about the concept
- End of class student writing using a classroom assessment technique (Bean: 132-3)
- Out of class writing by individual students. Requires application of the concept to a new context, thus validating learning. Commentary by instructor appropriate to student understanding; revision by individual student.

The model described above involves a combination of innovations, complicating efforts to test the impact of each innovation. Physics education researchers have confronted this issue, pointing out that it is precisely the combination of new pedagogy that may increase student learning (Pollock and Finkelstein 2012). Nonetheless, they have been able to build a substantial cumulative knowledge base with compelling evidence. (Deslauriers et al 2011; Maier and Simkins 2012). Although economics education may not have resources for such studies, we can begin by looking more closely at Team-Based Learning and Cooperative Learning. These pedagogies, individually and in combination offer a rich territory for improved student learning and economic education research.

Appendix: Examples of cooperative learning structures for use in an economics principles course

Jigsaw

In a simple jigsaw each student has cost data for one production scale. (Maier 2016) Together the group determines if there are economies of scale based on different cost data presented by each group member.

In a more complex jigsaw, each team member evaluates a different change in the tax structure (for example changing personal income tax rates; payroll tax rates or excise tax rates). Individuals then meet with students from other teams who are evaluating the same tax structure to share their analysis and practice a presentation they will give to their home team. Individuals

then rejoin their home team and take turns presenting their analysis. Together the team makes a decision about the total tax incidence.

Cards Cards may be an economic activity and the decision is to determine where the category the activity falls in GDP-- or it is not counted at all in national income accounts. (Keenan 2016) In a more complex example, each card lists a fiscal or monetary policy for which a decision must be made (raise taxes/lower taxes; raise interest rates/lower interest rates) based on the current status of a fictional economy. (Keenan 2005: 85-88)

Survey Teams can calculate price elasticity of demand for an assigned good or service based on a survey of their own team members combined with surveys of other teams. (Maier et al 172-3)

Cooperative controversy An example is a small group debate on proposed corporate merger with one pair preparing arguments in favor and the other pair preparing arguments against the merger. (Maier et al 2010:167)

Pass a problem First student generates nominal data on wages (or GDP) and second student calculates real wages (or GDP.) Or, first student generates marginal tax rates and second student calculates tax due and average tax rate.

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