Alphabet Soup of Active Learning: Comparison of PBL, CBL, and TBL.

Mari K. Hopper*

*Corresponding Author: mkhopper@iu.edu

HAPS Educator. Vol 22 (2), pp. 144-149. Published August 2018.

doi: 10.21692/haps.2018.019

Hopper M.K. (2018). Alphabet Soup of Active Learning: Comparison of PBL, CBL, and TBL. *HAPS Educator* 22 (2): 144-149. doi: 10.21692/haps.2018.019

Alphabet Soup of Active Learning: Comparison of PBL, CBL, and TBL

Mari K. Hopper, PhD
Department of Cellular and Integrative Physiology, Indiana University School of Medicine – Evansville,
515 Walnut Street – 4th Floor, Evansville, IN 47712
mkhopper@iu.edu

Abstract
Faculty in higher education strive to prepare students who have mastered discipline specific content, are adept at using "soft skills" required in the workplace, and have the ability and motivation to pursue life-long learning. A variety of methods including problem, case, and team-based learning have been developed to achieve these outcomes. These three approaches have similar acronyms, share common elements, and have been vastly modified to achieve various outcomes. As a result, a great deal of confusion has arisen. The aim of this paper is to provide clarity by contrasting and comparing these three methods. Additionally, brief reports from the literature will be discussed, as well as guidance for use of each method. Faculty are encouraged to choose methods that are best suited to the characteristics of their students and their own personal skill-set and preferences. Furthermore, faculty are encouraged to follow best practice in establishing clear objectives, assessing outcomes, and sharing successes and failures through publication. This article contrasts and compares problem-based (PRL), case-based (CBL), and team-based learning (TBL). https://doi.org/10.21692/haps.2018.019

Key words: problem-based, case-based, team-based, small group, collaborative learning

Introduction
Faculty in higher education have been called to modify our methods and utilize strategies to more fully engage our students. Desired outcomes include preparing students who have mastered discipline specific content, are adept at using "soft skills" required in the workplace, and have the ability and motivation to pursue life-long learning. Over time, a variety of methods have been developed to achieve these outcomes. Three commonly utilized methods include: problem-based learning (PBL), case-based learning (CBL), and team-based learning (TBL). These three approaches have similar acronyms, share common elements, and have been represented in the literature with vast variety of modification. As a result, a great deal of confusion has arisen, and faculty often have misperceptions concerning implementation.

To provide clarity, the objectives of this paper are to:

1. Describe the history and aims for each method.
2. Contrast and compare essential elements of each method.
3. Share a sampling of reports from the literature addressing use of each method.

Problem Based Learning (PBL)
Problem-based learning was first developed for use in medical education by Howard Barrows in the late 1960s (Barrows 1986). Barrows developed this method for use with students at McMaster University Medical School with hopes of making medical education more interesting and relevant for his students. The primary aim of this method was to incorporate patient and community health problems in the instructional delivery. According to Barrows (1986), the objectives of PBL include:

1. Structuring knowledge for use in clinical contexts.
2. Developing effective clinical reasoning process.
3. Developing effective self-directed learning skills.
4. Increasing the motivation for learning.

Barrows gleaned ideas from the work of others (Cabot 1906) and developed PBL to prepare his students for their clinical training. Although we now recognize that this method relies on constructivist thinking, Barrows had no background in educational psychology or cognitive science. PBL has a number of theoretical underpinnings from the psychology literature and has previously been referred to as discovery learning, enquiry learning, experiential learning, and constructivist learning.

continued on next page

PBL sessions involve small groups of four to eight students working together to confront "real world" problems often presented as clinical cases (Table 1). Cases are presented during the first of several sessions, and students are not required to prepare prior to the session. This mode of instruction is considered open inquiry, as there is not a correct answer for the case. After receiving case information, students organize their prior knowledge and attempt to identify the nature and scope of the problem. Students pose questions about what they do not understand, and utilize a self-directed learning approach to seek answers to their questions. Students are expected to learn from one another and from learning resources identified by the students themselves. Students are typically left on their own to conduct their research, and faculty intervention is minimal. PBL sessions often run over the course of several days or sessions, and additional information may be added to the case in each subsequent session. After gathering the appropriate resources and conducting their research, students collaborate within their group to organize their case solutions and present their work. Groups may offer differing resolutions and recommendations and should be prepared to elaborate on their decisions. During the case presentation, students respond to questions posed by peers and facilitators. Ideally, the entire class reaches consensus as to the "best case" solution for the problem.

Table 1. Characteristics of PBL, CBL and TBL

Characteristic	PBL	CBL	TBL
Advance preparation	No advance prep	Advance prep	Advance prep - IRAT
Activity	Case based	Case based	IRAT, TRAT, brief lecture & activity
Learning objectives	Written by students	Provided to students	Provided to students
Organization	Small groups (4-8 students)	Small groups (4-8 students)	Small groups (4-8 students)
Learning method	Self-directed	Shared facilitator and self-directed	Shared facilitator and self-directed
Role of faculty	Limited guidance	Active guidance	Active guidance
Inquiry style	Open inquiry	Guided or structured inquiry	Guided or structured inquiry
Number of sessions	Multiple sessions	Single session	Single session
End of session	Student presentations	Wrap-up by faculty	Wrap-up and peer evaluation

Despite little evidence that PBL was effective in preparing clinicians, the Association of Medical Colleges and World Federation of Medical Education endorsed the method and a vast body of literature addressing the use of this method has been amassed. Despite several systematic reviews and meta-analyses, divergent opinions have formed as to the effectiveness of this method (Albanese 2000, Neville 2009, Smits *et al*. 2003, Vernon and Blake 1993). It is not surprising that differing opinions exist since there are many different definitions of PBL, and its delivery has commonly been modified to achieve diverse outcomes. Although students participating in PBL sessions generally report positive attitudes, several studies report no difference in factual knowledge gained (Albanese 2000, Vernon and Blake 1993). It has also been noted that some students report feeling less prepared when participating in PBL-based curricula (Albanese 2000). In contrast, Koh and colleagues (Koh *et al*. 2008) report that PBL has positive effects on physician competency after graduation, mainly in social and cognitive dimensions. Similarly, others generally agree the PBL enhances professional competency (Neville 2009, Vernon and Blake 1993).

Barrows hoped that students would acquire skill in evaluating a patient's condition, identifying the problem(s), and making appropriate clinical decisions to manage the patient's care. Some PBL supporters contend that this method is most successful when utilized with more advanced students. In the strictest sense, this method requires the student to self-identify and address learning gaps. Early in the students' academic career they may not be developmentally ready, or possess the basic foundational knowledge to be able to do this within a clinical context. Relying on this method too early in the students' academic career may have negative outcomes. It is possible that that this method places too much load on working memory. There is evidence that working memory cannot problem solve and learn at the same time (Kirschner *et al*. 2006). It is also likely that the process of learning how to practice medicine and actually practicing are cognitively very different (Kirschner *et al.* 2006, Neville 2009).

Although PBL has continued to be a common methodology utilized in medical education, its limitations have been noted. Shortcomings of PBL have been addressed in the development of similar, yet distinctly different approaches including case-based learning (CBL).

Case Based Learning (CBL)

Although CBL was first described in 1912 by Lorrain Smith at the University of Edinburgh, and adopted by Harvard Business School in the 1920s, its instructional use in the areas of health and medicine did not become commonplace until the 1990s.

PBL and CBL share common objectives, and both rely on collaborative learning as students work in small groups (Table 1). Case-based learning differs from PBL in that it requires students to develop a knowledge base prior to exposure to case-based problems. CBL attempts to link basic scientific understanding (commonly delivered via lecture) to future clinical practice. Typically, students are expected to

continued on next page

complete readings or assignments prior to the CBL session, and learning objectives are clearly communicated before the session begins. During CBL sessions, faculty take a more active role and interact with students to provide feedback, answer questions, guide discussion and direct progress. When learners explore tangents, facilitators use guiding questions to bring them back to the learning objectives. During the session, students are encouraged to ask questions, and facilitators actively engage in correcting incorrect assumptions of the learner. Students are directed to specific learning resources, but are also encouraged to seek additional resources as needed. With CBL, the facilitator shares with students the "best possible" or correct solution as part of a wrap-up near the end of the session. Typically, CBL is delivered via a single working session and students are not assigned follow-up work or group presentations.

Similar to PBL, CBL has a large body of work describing its use and effectiveness. It is most commonly reported that students and faculty enjoy CBL and think it enhances learning and motivation (Thistlethwaite *et al.* 2012). However, at least one study reported a negative student attitude as students did not believe CBL prepared them well for exams (Blewett and Kisamore 2009). In other reports, students share dissatisfaction due to the adverse amount of time required and the resulting workload.

When limiting review of literature to health professions, a systematic review including 104 independent studies concluded there is insufficient evidence to support perceptions of enhanced learning (Thistlethwaite *et al*. 2012). Although students self-report increased confidence, communication skills, beneficial interaction between classmates, clinical reasoning and decision making, there is little empirical or objective evidence provided. When objective measures are made, there are conflicting results (Thistlethwaite *et al.* 2012). For example, in specific educational settings, CBL is associated with higher exam scores (Cliff and Wright 1996, Dupuis and Persky 2008), no difference in exam scores (Gemmell 2007), and even a lowering of exam scores (Thistlethwaite *et al.* 2012).

Many factors likely play a role in explaining the diversity of results reported in the literature. There has been a wide range in the type, timing, number, and length of student exposure to cases as well as in the instructor's level of training and experience in facilitating case studies. In some instances, students were exposed to single CBL sessions while other programs adopted entire courses or curricula embracing CBL methodology. Group sizes also varied greatly with some students working independently and other groups including 30 or more students (Thistlethwaite *et al.* 2012). Furthermore, there is evidence that sessions may be more beneficial when led by a content expert rather than a non-expert (Hay and Katsikitis 2001). It has also been suggested that faculty trained in facilitation skills will likely be better facilitators. Of interest is the fact that female students may perform better than men in a case-based learning environment (Williams 2005) and higher performing students demonstrate no differences in knowledge related to method of learning (Koles *et al.* 2005). When directly comparing CBL to PBL, two California medical schools administered a 24 item survey and discovered that 89% of the students and 84% of faculty favored CBL over PBL (Srinivasan *et al.* 2007). Students indicated fewer unfocused tangents, less busy-work, and more opportunities for clinical skills application when modules were presented in CBL format. Students were frustrated by PBL due to perceived lack of closure (no correct answer), additional work between sessions, tangential exploration of topics, and lack of direction in developing case presentations. Students also note that student PBL presentations were often inaccurate or incomplete when considering the complexity of the problem. These findings indicate that PBL may be better suited for more advanced learners who already have context for solving the PBL problem and have greater mastery in self-directed research and learning. Faculty comments were similar to students. Faculty were particularly concerned with PBL as they felt they should provide direction and feedback when students were unskilled. It was also interesting that ten to fifteen percent of students surveyed were persistently unhappy with small group work of either type.

Team based learning (TBL)

Most researchers credit Larry Michaelsen for first describing TBL in the early 1980s (Michaelsen *et al.* 1982). Since then, TBL has become popular for use in health and medical education. This method emphasizes student preparation prior to class, application of knowledge in class, and development of effective small group dynamics (Table1). Similar to PBL and CBL, TBL may rely on cases to engage students in using course content to solve problems likely to be encountered in future practice. However, TBL activities are not limited to cases and can incorporate a variety of problems. TBL, more so than CBL, places emphasis on assuring students have mastered course content before entering the problem solving stage of the session (Michaelsen and Sweet 2008).

Prior to a TBL session, students are expected to read and study the materials provided in preparation for a series of "readiness" activities (Table 2). The first step in a TBL session is a short quiz referred to as the Individual Readiness Assurance Test (IRAT). The IRAT evaluates understanding of key items from the pre-session assignments, and is intended to motivate the student to study and prepare prior to the session. Following the IRAT, students work in groups to address the same set of questions, and this is termed the Team Readiness Assurance Test (TRAT), which is sometimes referred to as group readiness or GRAT). It is emphasized that students receive immediate feedback on the TRAT since feedback is essential to learning and retention of concepts (Hattie and Timperley 2007). There is also an opportunity for students to submit (in writing) an evidence-based challenge to answers. Once appeals have

continued on next page

been resolved, the instructor has the opportunity to deliver a short lesson and clarify misperceptions. At this point, students are now ready to convene their groups to engage in problem solving activities. Although TBL sessions often include clinical cases, they can alternatively engage the students in other original learning activities including concept mapping, product development, or finding solutions to a problem set. Whatever the task, small groups in TBL sessions all work on the same significant problem, are given specific choices to make, and complete the session by sharing (usually simultaneously) their choices.

Table 2. Elements of Team Based Learning

1. **Strategically formed teams**
    - Diverse permanent teams throughout unit
    - Teams progress through stages – "form, storm, norm, and perform" (Tuckman 1965)
2. **Readiness assurance**
    - Pre-class preparation (assigned readings and study)
    - iRAT – individual (individual prepares prior to class)
    - tRAT – team – peer discussion, report simultaneously
    - Written Appeals
    - Clarifying lecture
3. **Application activities that promote both critical thinking and team development**
    - Cases
    - Concept mapping
    - Product development
    - Problem set
4. **Peer evaluation**
    - Anonymous feedback

According to Michaelson and Sweet (2008), it is important to form diverse groups that are retained for the entire course. It is believed that having groups stay together provides the opportunity for groups to move through the key stages essential to developing high-performing teams: forming, storming, norming, and performing (Tuckman 1965). Additionally, strict adherence to TBL format includes peer evaluation. It is hoped students who stay in the same group for an extended period develop strong interpersonal relationships and are able to observe and share useful feedback to each other.

Similar to PBL and CBL, reports of TBL use in the literature vary as specific steps and core design elements are frequently modified (Parmelee *et al.* 2012). In a recent review of TBL use in medical education, the authors first identified a total of 147 studies, but only 14 strictly adhered to the classic TBL approach (Burgess *et al.* 2014). The authors conclude that lack of adherence to design, implementation, and reporting of TBL make it challenging to critique, replicate, and compare learning outcomes. However, individual studies do report positive student perceptions (Parmelee *et al.* 2009), improved test performance on questions aligned with TBL concepts (Koles *et al.* 2005), and improved student understanding of difficult concepts (Zgheib *et al.* 2010). Additionally, studies indicate that IRAT scores are good predictors of examination performance (Nieder *et al.* 2005) and thus have the opportunity to serve as "early alert" for students who may need additional assistance. It has also been shown that students performing in the lowest quartile demonstrate the greatest gains in exam scores when participating in TBL-based modules (Koles *et al.* 2005).

Summary

In order to more effectively prepare our students to meet the demands of the workplace, faculty have pursued creative ways to engage students addressing "real-world problems". Although PBL, CBL and TBL follow different protocols, all rely on collaborative small group work. Although working effectively as a member of a group is considered essential to the development of today's learner, this approach makes it difficult to ascertain the benefits of PBL, CBL and TBL independent of the benefits of small group collaboration. Group learning is generally highly rated, and there are problems disentangling cause and effect due to confounding factors (Curran *et al.* 2008).

As indicated throughout this report, outcomes for each method vary greatly. In all cases, the method is impacted by the fact that instructors modify the approach to meet their preferences and constraints. Although modification makes comparison and reproduction more challenging, this type of adaptability has long been encouraged in educational training.

Perhaps it is most important that faculty choose methods best suited to the characteristics of their students (level, demographics, and prior experience) and their own personal skill-set and preferences. When choosing to use PBL, CBL or TBL, faculty may be best served by using a backward design approach, which entails first determining what students are expected to know or do, and then choosing the method most likely to achieve the desired outcomes. Faculty are also encouraged to reflect on their personal abilities and preferences, and select methods of best fit. Although students often describe PBL, CBL and TBL as enjoyable, it is important to avoid a "gimmicky" approach and look for ways to promote

continued on next page

deep thinking, enhance learning, drive curiosity, generate passionate life-long learning, and develop skills for success in today's work environment.

Speaking from personal experience, it can be challenging, yet enjoyable and rewarding to develop original small group learning activities. Best practice is to establish clear objectives, assess effectiveness in achieving objectives, and follow through with sharing successes and failures through publication. Know that what you are doing is working for YOU, and share with others so that they might be inspired by your ideas and insights.

Acknowledgment

The author thanks the engaged and receptive audience attending the 32st Annual HAPS Conference in Columbus, Ohio for their warm reception and encouragement to submit this manuscript.

About the Author

Mari K. Hopper, PhD, is an Associate Professor at Indiana University School of Medicine. She serves as the Director of Research, Hospital Medical Education, and other Scholarly work. Prior to this position, she taught physiology-based courses at the undergraduate level for over 20 years. She is currently on the HAPS Conference Site Selection Committee, Chair of the Chapter Advisory Committee of the American Physiological Society, and Past-President of the Indiana Physiological Society. Her research interests include both student academic engagement (active learning) and student health.

Literature cited

Albanese M (2000) Problem-based learning: why curricula are likely to show little effect on knowledge and clinical skills. *Medical education*. 34(9): 729-738.

Barrows HS (1986) A taxonomy of problem-based learning methods. *Medical education*.20(6): 481-486.

Blewett EL, and Kisamore JL (2009) Evaluation of an interactive, case-based review session in teaching medical microbiology. *BMC medical education*. 9(1): 56.

Burgess AW, McGregor DM, and Mellis CM (2014) Applying established guidelines to team-based learning programs in medical schools: a systematic review. *Academic Medicine*. 89(4): 678.

Cabot RC (1906) *Case teaching in medicine*: DC Heath & Company.

Cliff WH, and Wright AW (1996) Directed case study method for teaching human anatomy and physiology. *Advances in Physiology Education*. 270(6): S19.

Curran VR, Sharpe D, Forristall J, and Flynn K (2008) Student satisfaction and perceptions of small group process in case-based interprofessional learning. *Medical Teacher*. 30(4): 431-433.

Dupuis RE, and Persky AM (2008) Use of case-based learning in a clinical pharmacokinetics course. *American journal of pharmaceutical education*. 72(2): 29.

Gemmell HA (2007) Comparison of teaching orthopaedics using an integrated case-based curriculum and a conventional curriculum: A preliminary study. *Clinical Chiropractic*. 10(1): 36-42.

Hattie J, and Timperley H (2007) The power of feedback. *Review of educational research*. 77(1): 81-112.

Hay PJ, and Katsikitis M (2001) The 'expert' in problem-based and case-based learning: necessary or not? *Medical Education*. 35(1): 22-26.

Kirschner PA, Sweller J, and Clark RE (2006) Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational psychologist*. 41(2): 75-86.

Koh GCH, Khoo HE, Wong M, and Koh D (2008) The effects of problem-based learning during medical school on physician competency: a systematic review. *Canadian Medical Association Journal*. 178(1): 34-41.

Koles P, Nelson S, Stolfi A, Parmelee D, and DeStephen D (2005) Active learning in a year 2 pathology curriculum. *Medical education*. 39(10): 1045-1055.

Michaelsen LK, and Sweet M (2008) The essential elements of team-based learning. *New directions for teaching and learning*. 2008(116): 7-27.

Michaelsen LK, Watson W, Cragin JP, and Dee Fink L (1982) Team learning: A potential solution to the problems of large classes. *Exchange: The Organizational Behavior Teaching Journal*. 7(1): 13-22.

Neville AJ (2009) Problem-based learning and medical education forty years on. *Medical Principles and Practice*. 18(1): 1-9.

Nieder GL, Parmelee DX, Stolfi A, and Hudes PD (2005) Team-based learning in a medical gross anatomy and embryology course. *Clinical Anatomy*. 18(1): 56-63.

Parmelee DX, Michaelsen LK, Cook S, and Hudes PD (2012) Team-based learning: a practical guide: AMEE guide no. 65. *Medical teacher*, 34(5): e275-e287.

Parmelee DX, DeStephen D, and Borges NJ (2009) Medical students' attitudes about team-based learning in a pre-clinical curriculum. *Medical education online.* 14(1): 4503.

continued on next page

Smits PB, D de Buisonjé C, Verbeek JH, van Dijk FJ, Met JC, and Cate OJ (2003) Problem-based learning versus lecture-based learning in postgraduate medical education. *Scandinavian journal of work, environment & health*. 280-287.

Srinivasan M, Wilkes M, Stevenson F, Nguyen T, and Slavin S (2007) Comparing problem-based learning with case-based learning: effects of a major curricular shift at two institutions. *Academic Medicine*. 82(1): 74-82.

Thistlethwaite JE, Davies D, Ekeocha S, Kidd JM, MacDougall C, Matthews P, Purkis J, and Clay D (2012) The effectiveness of case-based learning in health professional education. A BEME systematic review: BEME Guide No. 23. *Medical teacher*. 34(6): e421-e444.

Tuckman BW (1965) Developmental sequence in small groups. *Psychological bulletin*. 63(6): 384.

Vernon DT, and Blake RL (1993) Does problem-based learning work? A meta-analysis of evaluative research. *Academic medicine*. 68(7):550-563.

Williams B (2005) Case based learning—a review of the literature: is there scope for this educational paradigm in prehospital education? *Emergency Medicine Journal*. 22(8): 577-581.

Zgheib NK, Simaan JA, and Sabra R (2010) Using team-based learning to teach pharmacology to second year medical students improves student performance. *Medical teacher*. 32(2): 130-135.

Back to TOC