DOI: 10.1002/tl.20435

ORIGINAL ARTICLE

WILEY

Application exercise design for team-based learning in online courses

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Abstract
This chapter describes best practices for adapting traditional, face-to-face, team-based learning principles to develop online application exercise design, support effective facilitation, and use appropriate technology to promote effective online team collaboration. The unique challenges of online TBL applications include maintaining effective team collaboration, discussion facilitation, and simultaneous reporting. A framework is proposed to guide practitioners to make appropriate, systematic choices in the development of online TBL applications.

The aim of this chapter is to address the challenge of adapting the traditional, face-to-face team-based learning (TBL) application exercise to an online experience for students at a distance. This aim is built on the premise that online TBL application exercises are able to serve the same role as their counterparts in face-to-face applications, when attention to special conditions for asynchronous, distributed learner interactions are deliberately planned.

The TBL Collaborative (TBLC, 2019) describes TBL as "a collaborative learning teaching strategy comprised of units of instruction that are taught in a three-step cycle: (outside-of-class) preparation, in-class readiness assurance testing, and application-focused exercise." The focus of this chapter is on the application-focused exercise step of the cycle (see Figure 1 for a TBL module overview). The application phase culminates the TBL module experience, challenging students to engage in deeper and more complex learning tasks (Sweet

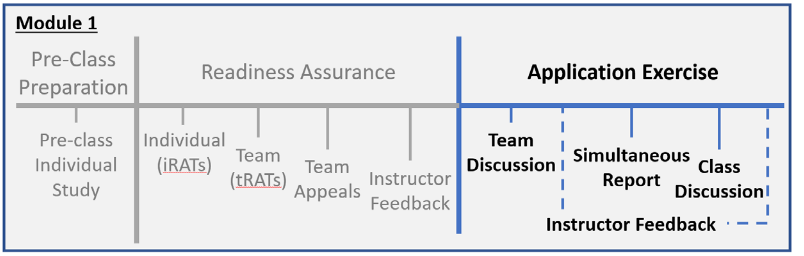

FIGURE 1 The application exercise culminates a TBL module, preceded by preclass preparation and readiness assurance

& Michaelsen, 2012). Application exercises held in the face-to-face setting of the classroom supports team member development of collaboration skills, provides the opportunity for facilitators to contribute real-time feedback and guidance to learners, and depends on well-designed application exercises to stimulate group interaction (Michaelsen et al., 2004). The design of effective TBL application exercises follows the "four S's" (Michaelsen & Sweet, 2008) to ensure meaningful discussion (within and between teams) and accountability (individual and team): same problem, significant problem, specific choice, and simultaneous report.

Face-to-face classroom TBL best practices are well-established and serve as a starting point to consider the unique challenges of online TBL applications (Palsolé & Awalt, 2008), including maintaining effective team collaboration, discussion facilitation, and simultaneous reporting. For instance, teams in online settings working asynchronously do not have the rich interactions that come naturally in face-to-face settings, due to a loss of back channels (e.g., listener interjects responses to the speaker), common ground (i.e., mutual knowledge and understanding), and nonverbal cues. Unlike a face-to-face classroom, where the instructor can actively observe and interact with teams, in a virtual setting the instructor must be more proactive to engage with teams and make his or her presence appreciated. Furthermore, student engagement and participation in the application exercise is easy to gauge in a face-to-face context. However, in an online setting, team dynamics are more difficult to gauge, both between team members and for the instructor. Finally, simultaneous reporting, designed to prevent the "me too" response found in serial reporting, must be redesigned when teams finish their work at different times. The flexibility of mixed synchronous and asynchronous elements in online TBL design provides greater latitude for students, but also increases the need for instructors to design collaboration sequences which retain the rich student learning experience of face-to-face TBL, while not placing an undue administrative and overhead burden on instructors.

In group work, student satisfaction highly correlates with team dynamics, team acquaintance, and instructor support (Ku et al., 2013; Muljana & Luo, 2019; Thomas & Thorpe, 2019). These elements of satisfying learning experiences are also important as objectives for effective collaborative learning in online TBL exercises. Established practices in online learning indicate that the requirements for student interaction should be clearly articulated (Quality Matters, 2018). In addition to setting the expectations for student-to-instructor and student-to-student interaction, required tasks of collaborative engagement in TBL application design should be made explicit. This would also include providing students with expectations for the role of the instructor, known in face-to-face courses as facilitation, and online as teacher presence (Muljana & Luo, 2019) or group facilitator (Thomas & Thorpe, 2019; Thorpe, 2016).

There are a number of design considerations when integrating the TBL three-step cycle into an online environment to ensure effective course delivery and student success. This paper aims to provide a roadmap to faculty interested in developing high-quality

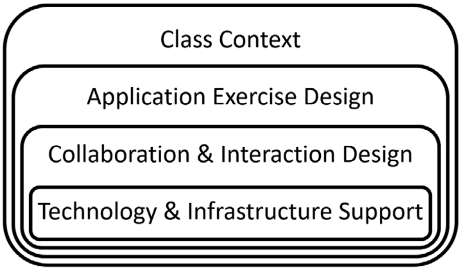

FIGURE 2 The four key aspects of the online application exercise design framework. Class context serves as the basis for practical decisions related to design and support of the collaborative experience

application exercises for online TBL sessions. First, we propose a set of best practices to guide development of effective online TBL application exercises, addressing the special requirements of asynchronous, distributed contexts. Second, a framework is proposed to guide practitioners to make appropriate, systematic choices in the design and development of online TBL applications. Third, we provide guidance on supporting facilitator "presence" in online settings. Finally, application exercise design, technology resources, and assessment considerations were aligned with the Quality Matters (QM) Rubric, which has established eight general standards and 42 specific review standards for effective online and blended course delivery (Quality Matters, 2018).

BEST PRACTICES FOR ONLINE TBL APPLICATION EXERCISE DESIGN

A framework for online application exercise design is illustrated in Figure 2. There are four key aspects to designing online TBL application exercises: (1) description of the context of the class, (2) design of the application exercise (the 4 S's), (3) design of the collaboration and interaction, and (4) technology needed to support collaboration. In addition, the emerging area of data analytics has the potential to utilize the online environment to capture and analyze interaction, performance, and assessment data.

In Figure 2, *class context* is illustrated as an aspect inclusive of all the other aspects and is the foundation for any decisions on application exercise design. *Application exercise design* includes consideration of expectations for exactly how *collaboration and interaction design* will inform what t*echnology and infrastructure support* is needed. *Data analytics* has the potential to be informed by all aspects, depending upon the specific nature of the data captured.

In this work we have developed three best practices that are the result of applying the functional requirements of TBL application exercises discussed above to the special needs of online TBL application exercises (see Table 1). The supporting Quality Matters standards are listed for each best practice.

Best practice AP-1

This recommendation considers the method of delivery and location in the design of application exercises interactions.

Class context

The context for a TBL class can be classified by the two dimensions of the Time/Space Matrix (See Figure 3) used in Computer-Supported Collaborative Work (CSCW) (Johansen

TABLE 1 Online TBL applications best practices and corresponding QM standards

Principle	Online TBL best practices	QM standards
AP 1	Consider the method of delivery and location in the design of application exercises	3.4, 4.1, 4.2, 5.3, 5.4, 8.1, 8.5
AP 2	Employ technology to support the chosen application design that promotes collaboration, and provides feedback and evaluation of individuals and teams	1.5, 5.2, 6.1, 6.2, 6.3, 6.4, 8.1
AP 3	Use analytics to support and measure collaboration, appropriate to stated application design incentives	2.1, 2.4, 3.1, 3.2, 3.3, 3.4, 3.5, 5.4, 6.1, 6.5

	Co-located	Remote
Synchronous	Traditional in-class TBL experience	Simultaneous presence in a virtual collaboration space
Asynchronous	n/a	Online TBL that does not require students to interact simultaneously (virtual)

FIGURE 3 Time/Space Matrix describing the class context for TBL

et al., 1988). The *Time* dimension describes when students interact, and can range from completely synchronous to completely asynchronous, with hybrid levels in between. The *Space* dimension describes the physical location of the students, ranging from colocated to remote, with mixed levels in between.

The Time/Space Matrix is a useful framework to classify the diversity of online TBL collaborations. Hybrid classes may include more than one quadrant. Critical parameters of class context are at what time students are required to engage with class material and limitations, if any, on the places in which students are expected to participate. The focus of this paper is in the rightmost column, "online TBL" where students are remote from each other and interact in a combination of synchronous and asynchronous ways. Since a change to asynchronous remote TBL from face-to-face TBL represents a considerable change of class context, this transition is emphasized. Transitions to synchronous and hybrid online TBL approaches will also be guided by general considerations of the QM Standards, as cited in the text.

Application exercise design

The "four S's" represent essential elements of TBL application success, and have been extensively reviewed in the literature (Burgess et al., 2014; Sweet & Michaelsen, 2012). The first three "S's" (same problem, significant problem, specific choice) apply equally to each of the four quadrants of the Time/Space Matrix. The fourth "S" (simultaneous report) is of particular interest in a collaborative setting. Asynchronous participation in application exercises requires special timetabling of the simultaneous report to preserve educational value.

Figure 4 illustrates one possible design for an asynchronous, remote application exercise. The black vertical bars represent events or deadlines for information exchange. These time points are established in advance for all student participants. Application questions are simultaneously released to teams. Students then work individually or collaboratively in

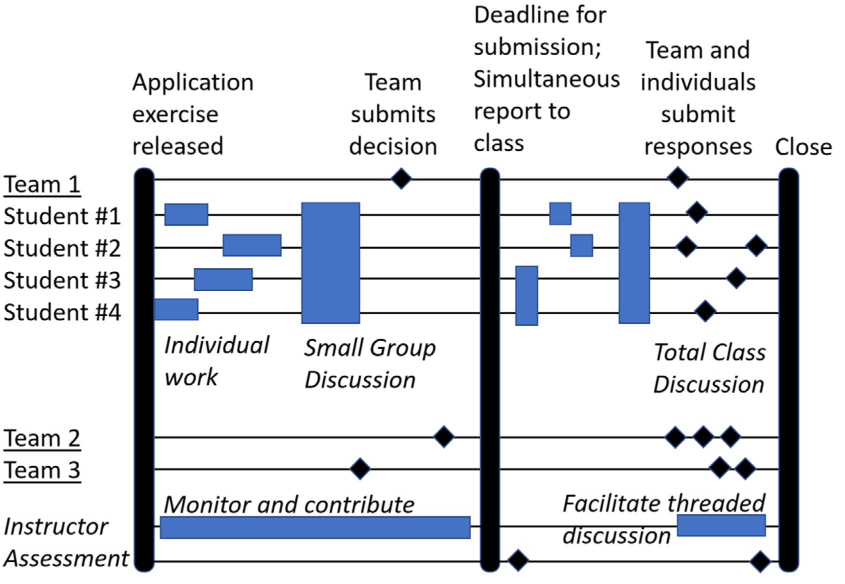

FIGURE 4 One possible application design for asynchronous online TBL, illustrating collaboration within teams, between teams, and the instructor. Black vertical bars represent events in which information is exchanged at fixed times

assigned teams to form their initial specific choice(s). Teams may also decide to arrange a whole-group meeting to finalize a consensus response. Teams submit responses when prepared, before an assigned task deadline. Similar formats of the application shown schematically in Figure 4 have been used earlier in asynchronous team learning (Palsolé & Awalt, 2008). This design maintains simultaneous reporting, a central tenet of TBL application exercises. Schematic illustrations of process timelines can guide student expectations, and may be especially useful to facilitate course navigation and course readability standards (Quality Matters, 2018).

Delivery of team specific choices occurs asynchronously, following the decision of the team to close the discussion period and report to the instructor and class. The second vertical bar in Figure 4 represents when all team specific choices are published simultaneously to all teams. The instructor requires individuals and teams to comment on other team reports, supporting student reflection on the application task, in an asynchronous class discussion format. Teams may be required to present written justifications together with their specific choices. Afterwards, the instructor may facilitate an asynchronous threaded discussion with all teams to discuss, debate, and build upon the individual team reports. Throughout the application phase, the instructor has tools to monitor and contribute to the discussion at any stage, and target any subset of students (individual, team, or whole class). Students were found to participate more and retention was higher in the classes where faculty provided immediate feedback and were more present (Thomas & Thorpe, 2019; Phirangee et al., 2016; Hosler & Arend, 2012).

Simultaneous reporting in the online setting can be analyzed in terms of the matrix of Figure 3. The key to simultaneous report, particularly in asynchronous settings, is the absence of advance knowledge of other team results before the initial team report deadline. This is especially important if written rationalizations are required of teams together with specific choices. In online TBL, the submission of team reports and the time at which an instructor publishes those reports can be separated into two stages. Thus, in online settings, a deadline for all teams to submit, can be followed with a "publish" event, when all team answers are exposed simultaneously. This places more responsibility to document a rationale supporting specific choice. In this process, teams have to commit to their initial answer, and be prepared to defend it to other teams in the class.

After the team deadline for application task submission, there are several options for how sessions could be designed. Some possibilities include: (1) instructor feedback only to each team, and/or made public to all teams, (2) team feedback on each team's work reposted asynchronously for comment, or (3) a synchronous session to allow teams to interactively exchange comments, followed by time to review all submitted team work. The quality of the student experience will depend to a large extent on how the design facilitates team exchange and also includes teacher presence. Increasing teacher presence through feedback and facilitating questions can increase students' engagement, collaboration and critical thinking (Thomas & Thorpe, 2019; Phirangee et al., 2016; Hosler & Arend, 2012). Teacher presence could, for instance, be involved in developing focused review questions for submissions before these are exchanged with all teams, or giving specific feedback on individual team work only to teams privately to anticipate critical discussion themes which emerged in all submissions. Noteworthy in considering design choices for simultaneous report is the duration of time needed to allow meaningful student consultations. Enabling instructor presence and allowing enough time to generate and process feedback may extend the overall module duration by several days to a week.

In a traditional setting, a facilitated class discussion occurs immediately following the simultaneous report by individual teams. However, in an asynchronous setting this may happen at different times for each team, as they evaluate other teams' reports, and may require more explicit instructions about how to provide peer feedback and participate in online (asynchronous) discussions (e.g., via an open discussion board). The application exercise sessions can provide students the opportunity to develop group facilitator skills as the course progresses (Thomas & Thorpe, 2019; Thorpe, 2016). The design of the application should allow the instructor an option to demonstrate teaching presence (Phirangee et al., 2016; Hosler & Arend, 2012).

Collaboration and interactive design

The collaboration within teams, between teams, and with the instructor (facilitation) must be carefully designed in online TBL. In synchronous face-to-face TBL settings (Figure 3, upper left quadrant), the collaboration comes about naturally through in-person interactions. However, in an asynchronous, virtual setting, each type of collaboration must be designed with respect to both the Time and Space dimensions. For instructors expecting students to be able to facilitate teamwork in a collaborative environment such as TBL, scaffolding this process should be considered in the beginning of the course to enhance the team interdependence (Muljana & Luo, 2019; Thomas & Thorpe, 2019; Phirangee et al., 2016).

Careful planning is needed to configure the student incentive structure to promote collaboration amongst team members and teams. Assessment possibilities depend upon how team participation is captured, and what emphasis is placed on the required task in grading rubrics. Possible assessment includes instructor feedback of individual student contributions, instructor feedback on synchronous activities of a team captured via audio or video (Ifenthaler, 2014), written reasoning of team specific choices (Weinberger & Fischer, 2006), individual or team evaluations of other teams' specific choices, and peer evaluation of individual and team participation. With each of these opportunities, individual and team accountability becomes more robust, as does student participation (Thomas & Thorpe, 2019; Phirangee et al., 2016), and instructional oversight becomes more involved,

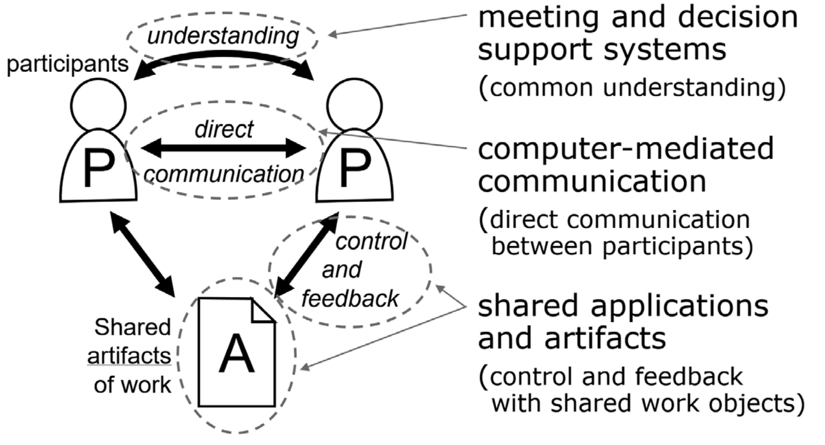

FIGURE 5 Collaborative learning technology support. Based on the framework of Dix et al. (2004)

particularly for larger class sizes. Two opportunities for summative or formative instructor assessment are also suggested in Figure 4. These time points coincide with the reporting of student teams, but might also include individual task reports to assist in validation and promotion of individual accountability toward learning outcomes. As indicated in these examples, assessment tools selected should be sequenced, varied and appropriate to the work being assessed (Quality Matters, 2018). Thus assessment strategies may be adjusted depending on the time and space dimensions of the classroom context.

Many application designs are possible, depending on class context and other requirements. For instance, if there are dedicated times when remote students are able to meet synchronously, an inclusive class discussion may be conducted in real-time.

Best practice AP-2

This recommendation advocates employing technology to support the application design to promote collaboration, and provide feedback and evaluation of individuals and teams

Technology and infrastructure support

Teams engage in collaborative work by communicating with each other to develop a shared understanding. In addition, teams often collaborate to produce work artifacts (e.g., narrative assignments or responses to a formative quiz), or artifacts are produced to capture aspects of the work. A thorough history of collaborative online learning theory is out of the scope of this report, but informs questions relating to essential requirements (Bender, 2012). Figure 5 represents a minimum team size: two participants and one shared work artifact, produced through collaboration (based on Dix et al., 2004). Learning technologies may be categorized by the aspect of the collaboration they are designed to support: Meeting and decision support systems assist the development of a shared understanding between team members; computer-mediated communication technologies support the direct communication between participants, either synchronously or asynchronously; and electronically shared applications and artifacts support development of work products.

Changes made by team members to a common-access work artifact is a form of communication itself, because other team members see changes and comments reported by their team members. For example, a team may meet and communicate using a computer-based video conferencing system to synchronously discuss the writing of a final report (computer-mediated communication). They may capture their discussion using a custom note-taking tool (meeting and design support system). They may write the report together by logging into a common, shared document to collaboratively edit and exchange comments in real time (shared application and artifacts). Thus, the collaboration component of TBL may be supported using the technology tools individually or in combination (examples of which are discussed in the next section). Trainings, privacy and data protection to support student accessibility often require advance planning and need to be anticipated at the time that required use of technology tools are introduced (Quality Matters, 2018).

Technology tools

It is out of the scope of this paper to identify and rank available software platforms and learning management systems. However, there are several categories of technology tools which have been used to support online TBL as listed in Table 2. Costs of available technology, though institution-dependent, is also a factor that course designers should take into consideration.

Best practice AP3

This recommendation advocates the use of analytics to support and measure collaboration, appropriate to application design incentives.

Analytics in online TBL application exercises

Analytics has the potential to help educators and learners by facilitating efficient class flow, identifying learner difficulties, and improving assessments (Giesbers et al., 2014). Like many aspects of online TBL practice, the use of analytics in teaching is emerging (Siemens, 2012). In part, this is a result of changing technology to support online TBL. Frequently faculty members will link together multiple technology tools to scaffold a learning experience, which can limit the ease of data analysis across platforms and data sources. Despite this practice, data analytics are used today and there will be additional opportunities in the future.

Current data analysis

Several areas of analysis include interaction and timing, multiple-choice question application exercises, and free response applications. Practitioners of online TBL generally agree that time management becomes much more important in online environments. Learning activities often take longer in an online environment to support necessary communications. It can be difficult to visually observe and track team progress online, making monitoring tools vital to establish facilitator presence. For instance, knowing the time teams require to complete an application exercise within a given timeframe may be helpful to identify potential topics of concern which require greater facilitator presence. Educators may find it useful to review the distribution of team responses to assess the level of team comprehension and possible sources of confusion. In addition, educators may find that

TABLE 2 Selected online TBL learning tools

Category	Scope and description	Examples	Collaboration support type
All-in-one TBL technology	Support all key areas of online team-based learning including iRAT, tRAT, Applications and Peer Evaluation. Typically only used by TBL educators. Support simultaneous reporting and automates peer evaluation input, analysis and dissemination.	InteDashboard	Meeting and decision support Computer-mediated communication
Dedicated case learning technology	Create, distribute, and share case-based learning material.	ShareCase ThinkSpace	Shared applications and artifacts
Team formation and development technology	Specifically designed for team formation, may include peer evaluation tools. Used by educators using different methodologies, including TBL. Support simultaneous reporting and automates peer evaluation input, analysis and dissemination.	CATME iPeer SparkPlus Teammates	Shared applications and artifacts Meeting and decision support systems
Learning management systems	Provide robust functionality for online course content management. Use in many institutions. However, not specifically designed for TBL and may not support TBL specific processes such as the tRAT.	Blackboard Canvas Moodle Sakai	Computer mediated communication Shared applications and artifacts
Online learning systems	Provide web conference solutions for online learning along with content exchange such as file, wiki and email exchanges.	BigBlueButton Adobe Connect WebEx Zoom	Computer mediated communication
Session design	Provide course design software, including graphic design element access, team authoring capability, timeline creation with locking/releasing objects.	Articulate Storyline Camtasia Studio (techsmith.com) VoiceThread	Meeting and decision support systems

tracking team response data (from a free response application) can identify misconceptions that can be used as plausible distractors for future multiple-choice question applications. Educators can analyze the length of responses (word counts), format of responses (free text versus files versus images) and usage of keywords. Electronic gallery walks, in which teams vote for the best team response other than their own team, may give further insight to educators on what teams are thinking.

Analytics and quality matters

Online TBL instructors should be transparent as to what data is collected and how it is used (Drachsler & Greller, 2016; Quality Matters, 2018). Privacy policies should be available for all external tools required for the course, in addition to general course policy (Quality Matters, 2018). A key resource for instructors should be IT department personnel with familiarity of LMS capabilities and integrated data capture which might be readily accessed. A cost and benefit assessment will be helpful to review available resources for data capture and will help determine the value of potential outcomes of automated data capture, and dashboarding of student performance metrics. The U.S. Department of Education (2012) has described more thorough recommendations for implementing learning analytics.

Instructors may also use analytics to consider the requirements of students to effectively manage their available time and should ensure that the relation between course grades and evaluations of online collaborative work is explicit (Quality Matters, 2018). The benefit to instructors of using analytics relies upon the value of the collected data to improve individual and team activity.

Potential areas for data analysis in the future

In the future, online text chat or writing functions could be used to analyze the relative contributions of team members. Furthermore, if chat functions could capture team discussions and provide the necessary data to train artificial intelligence teammates, then they may be useful to simulate a team learning environment, even for teams missing some team members or even for an individual learner. Discourse analysis, as an automated form of analysis, is still a new field of analytics. Future use may become more widely adopted as trust in particular data metrics are valued by instructors and students as valid student feedback (Dascalu et al., 2015). Ethical and theoretical considerations relevant to implementation of online learning analytics must also be considered (Knight & Buckingham Shum, 2017).

Learning analytics tools present an opportunity in online TBL applications, not readily available in face-to-face sessions. In particular, CATME, iPeer, and InteDashboard provide instructors with data and information regarding collaborative behaviors of students (see Table 2). Interest in analytics specifically for group learning has been developed in addressing instructional challenges in delivery of connected massive open online classes (cMOOCs) (Wang et al., 2017) and as a means for instructors to regulate student collaboration (Van Leeuwen et al., 2015). Progress has also been made to identify variables of asynchronous online discussions, which can guide instructors to early interventions to improve online interaction (Kim et al., 2016).

TBL application data captured by LMS systems may include the level of participation in discussion boards, number of emails, number of video exchanges with team members, and other measures of text exchanged through messaging and documentation. In all cases, the information captured should be described to course participants, and students should be made aware of the need for data capture to provide meaningful evaluation of team and student performance. Additionally course assessments should be related to learning objectives and be directly related to learning activities.

CONCLUSION

This chapter reviewed key aspects of online learning and TBL to identify best practice principles, specific to the design of application exercises for online TBL. Critical to the design of application exercises is for the designer to identify which quadrant within the space/time matrix to build applicable activities for student engagement. Determining whether asynchronous or synchronous application activities align with the course design will help make systematic choices in the design and development of online TBL. The QM standards for higher education also served as a useful basis for considering design changes and upholding educational standards.

Another key component to building effective application exercises is to define the type of facilitator presence needed and to clearly communicate this with students. Research supports that clarity of how an instructor will facilitate and instructors' presence will positively influence student performance and retention. Faculty must also determine the appropriate technology resources needed to deploy the respective activities. Selecting ineffective tools or utilizing multiple tools to accomplish the application exercise may be cumbersome or deter faculty from deploying TBL online. Finally, the use of analytics to improve individual and team activity should be considered when determining if such data will be collected. Regardless of the type of analytics selected, research supports that transparency of data collection and use is important.

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How to cite this article: Dorneich, M. C., O'Dwyer, B., Dolowitz, A. R., Styron, J. L., & Grogan, J. (2021). Application exercise design for team-based learning in online courses. *New Directions for Teaching and Learning, 2021:*41–52. https://doi.org/10.1002/tl.20435