Does team-based learning (TBL) format and administration influence second year medical students' attitudes toward this teaching modality?

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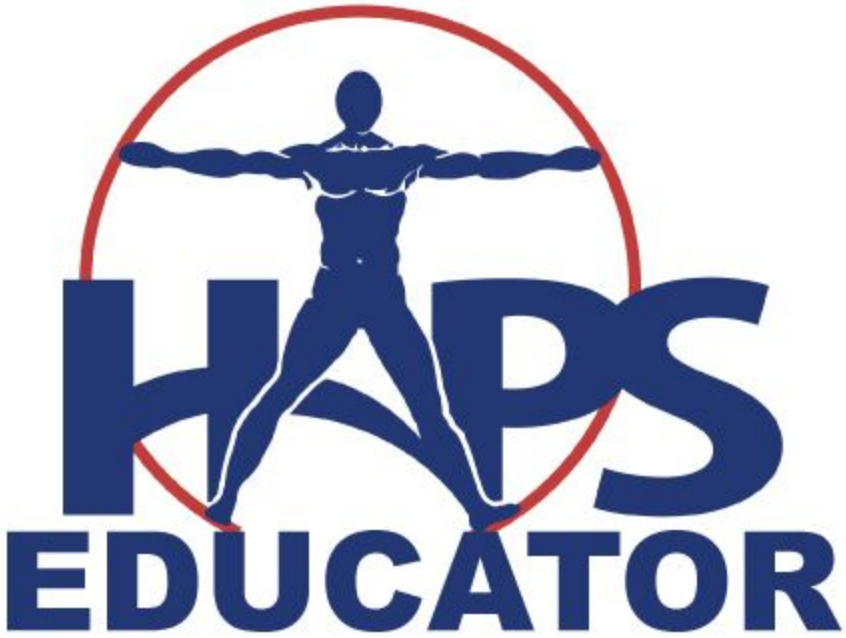

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Does team-based learning (TBL) format and administration influence second year medical students' attitudes toward this teaching modality?

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Abstract

Previous studies have examined team-based learning (TBL) efficacy in medical curricula, yet little research has been done to compare differences in TBL modalities (implementation and design). This study examines student perceptions of differing TBL modalities in two second-year medical courses (pathology and introduction to medicine) at Indiana University School of Medicine, Bloomington (IUSM-Bloomington). The medicine TBLs were traditional, standardized TBLs that use assigned groups and graded individual readiness assurance tests (IRATs) and group readiness assurance tests (GRATs), while the pathology TBLs were non-traditional in their use of self-selected groups and lack of graded IRATs and GRATs. At the end of the academic year, students were invited to complete an anonymous survey comparing and contrasting the two specific TBL designs. The survey contained both quantifiable Likert-scale questions and open-ended (qualitative) questions allowing students to provide feedback. Written comments were examined for common themes. Participants showed no preference for a specific TBL modality but did indicate preferences for particular aspects of each modality. Specifically, students preferred to be assigned to TBL groups, to have a non-graded IRAT/GRAT component, and they found TBLs the most effective when used as a review of material as opposed to a first exposure experience.

Keywords: team-based learning (TBL), health sciences, medical students, pathology, medicine

Introduction

Team-based learning (TBL) is an instructional strategy first implemented in business education by Larry Michaelsen in the 1970s, and refined over subsequent years (Michaelsen 1983, Parmelee 2008, Fink and Parmelee 2008). While TBL and problem-based learning (PBL) both focus on development of problem-solving skills in a group setting, TBL emphasizes teamwork and the utilization of readiness-assurance tests to gauge the preparation of students, both of which are lacking in the PBL. In recent years TBL has been introduced in the curricula of multiple medical schools in response to administrative calls for reform (Janssen *et al.* 2008; AAMC Task Force 2015), including implementation of group learning and application through problem solving of clinically relevant concepts. The traditional format of TBLs includes four essential principles: group formation, accountability, feedback, and assignment design (Michaelsen and Sweet 2008). According to Michaelsen and Sweet (2008), successful implementation of TBLs includes some combination of these four principles, but it is up to the discretion of the instructor to design a format for TBLs in their course.

The first principle, group formation, refers to the development of small TBL groups and their management by the instructor. The suggested TBL group organization is to have students of varied levels of expertise in order to achieve a heterogeneous group (Michaelsen and Sweet 2008), and that group formation should be done by the instructor to avoid homogeneity (Bie and Shapiro 1988). Instructors may potentially form groups using criteria such as medical school admissions test (MCAT) scores, undergraduate GPA, and student undergraduate majors/minor. However, a few studies (e.g. Zgheib *et al.* 2010) reported positive TBL effects even with student self-selected groups. Thus, one aspect of our study was to compare and contrast TBL effectiveness among instructor-formed and student-self-selected groups.

The second principle, accountability for individual and group work, is the assumption that students will develop a sense of ownership if their work is evaluated for quality (Michaelsen and Sweet 2008). The assumption is that utilizing a graded individual readiness assurance test (IRAT) at the beginning of the TBL increases student involvement, because students will invest more time in understanding

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the material and students will have more to discuss when they come together in groups to take the group readiness assurance test (GRAT) than had they simply answered questions together as a team (Gopalan *et al.* 2013).

Development of accountability is intimately associated with the third principle, that students have frequent and timely feedback (Michaelsen and Sweet 2008). Typically each individual's preparation is assessed through a graded IRAT. Students then work in groups to answer the same questions (with no external resources) in a graded GRAT. The GRAT is designed to demonstrate to students the efficacy of working in groups, as each group should be able to come to a correct conclusion when working together.

The general recommendation is that the IRAT and GRAT should be graded to encourage the development of accountability (Fink and Parmelee, 2008; Michaelsen and Sweet, 2008) and several studies have found this to be true for their specific courses (Vasan *et al.* 2008, Zgheib *et al.* 2010, Gopalan *et al.* 2013). However, some instructors choose not to grade the IRAT and GRAT. In one study in which the IRAT and GRAT were not graded, researchers reported that students felt they developed accountability to their team despite a lack of "stakes" when it came to their overall grade (Vasan *et al.* 2011). Thus, another aspect of this current study addresses utilizing ungraded versus graded IRATs and GRATs to determine whether feedback is necessary for developing a sense of ownership within a group setting.

The fourth and final principle suggests that a majority of the time allotted to TBL be dedicated to a team assignment that should include an application of concepts covered in the course. If utilized, the design of the team assignment should allow for interaction with group members; this is accomplished by requiring teams to come to some conclusion on a topic relating to course concepts (Michaelsen and Sweet 2008). TBLs have the capacity to be an efficient tool for delivering large amounts of information over a short period of time. Vasan *et al.* (2008) have shown that a majority of students tend to score better when asked questions on exams relating to material covered in a TBL versus material covered in a traditional lecture.

Many studies detailing the use of TBLs in medical school curricula report their efficacy for student learning of health concepts, as evidenced by comparable or improved student performance on unit exams or on comprehensive exams such as Step 1 and Step 2 United States Medical Licensing Examinations (USMLE) (Nider *et al.* 2005, Thompson *et al.* 2007a, Conway *et al.* 2010, Koles *et al.* 2010, Vasan *et al.* 2011). In addition, some of these same studies demonstrate that the lower-performing students tend to benefit most from this group learning method (Thompson *et al.* 2007a, Conway *et al.* 2010, Koles *et al.* 2010).

Despite a wealth of information on the benefits of using TBL, only a few studies have been done to examine differences in TBL team structure and student performance. Thompson *et al.* (2015) examined TBL team size and cohesiveness with respect to student performance on the National Board Of Medical Examiners (NBME) psychiatry subject test. They found that larger teams and teams formed during later rotations performed better on the subject exam. However, little research has been done to compare and contrast different TBL modalities, specifically their implementation and design. Thus, the goal of our study was to examine differing TBL modalities in use during the second year at IUSM-Bloomington. We use the same student population to compare two courses that utilize different strategies in their implementation of TBL. More specifically, we sought to determine if one modality was superior with respect to learning efficacy, student preference, and ease of use.

Methods

The second year medical curriculum at IUSM-Bloomington includes five courses—genetics in the fall, introduction to clinical medicine (medicine) in both the fall and spring, pathology (fall and spring), pharmacology (fall and spring), and biostatistics, which only meets in the spring. Team-based learning is used extensively in pathology and introduction to medicine. These two courses differ in organization and format of TBLs as well as the number of TBLs presented in a given semester, as shown in Table 1 and described in detail in the next sections. In general, the medicine course utilized a traditional TBL format while the pathology course utilized a non-traditional TBL format.

Medicine Course – TBL Design & Implementation

Students in the introduction to medicine course are exposed to a more traditional TBL experience. Groups are assigned beforehand based on previous performance in the first year courses along with other criteria, such as MCAT score, undergraduate institution, and undergraduate major/GPA. This is done in an effort to keep the groups comparable and competitive with one another as well as provide a more diverse set of skills and experiences within each group. Students typically have not been previously exposed to the material that is part of the TBL. They usually are assigned readings beforehand and must come prepared to take a graded IRAT. Once in their assigned TBL groups, the students take a graded GRAT and go through a case study with application exercises that pertain to pre-assigned readings. The medicine TBL assignments are a component of the final course grade.

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Table 1: TBL format comparisons between pathology and medicine courses		
TBL Features	**Medicine course (traditional TBL format)**	**Pathology course (non-traditional TBL format)**
Number of TBLs (per semester)	3	10
Group selection process	Determined by course instructor	Student self-selected
Some form of IRAT/GRAT used?	Yes	Yes
Traditional (graded) IRAT/GRAT used?	Yes	No
Clinical case presentation	During TBL	Before TBL as a supplemental reading
Is the TBL content the students' first exposure to the material?	Typically yes	No

Pathology Course – TBL Design & Implementation

The pathology TBL design and implementation have many nontraditional components. First, prior to the TBL session, students attend lectures and read assigned textbook sections that cover topics to be addressed in their TBLs. In this way, pathology TBLs are used more as an all-encompassing review, or capstone exercise, as opposed to a first-exposure experience. In addition, students in the pathology course self-select their groups and do not utilize traditional graded IRAT/GRATs. Instead, each TBL is accompanied by three to five ungraded short answer or discussion style questions pertaining to the case that are to be answered during the group application phase (GAP) of the TBL. Each TBL group is assigned different sets of cases to discuss and evaluate, and by the end of the session each group presents their information to the entire class. The groups work together and discuss the possible diagnoses and make decisions pertaining to lab work and medical imaging methods that would be utilized to formulate a treatment plan. Because the graded IRAT and GRAT are eliminated from this format, points for the TBL activity come from participation, and in this particular course attendance is required in order to receive full points. The goal of this TBL format is to allow students to broaden their understanding of the previously presented material. As with the medicine TBL material, concepts covered during pathology TBLs are assessed on graded unit exams.

TBL Survey Development and Implementation

IUSM-Bloomington second-year medical students (n=36) were invited to complete an anonymous survey in 2012 that addressed their perception of TBLs in the pathology and medicine courses. The survey began with basic demographic questions and asked about students' prior exposure to TBLs. Then, using a five-point Likert scale (ranging from "Strongly Agree" to "Strongly Disagree"), participants compared and contrasted their views on the two course's implementation and utilization of TBL. Following each question, respondents were encouraged to elaborate on that subject.

The Likert-scale survey questions (and their associated written comments) most relevant to this study were:

- My learning of **pathology** course content and principles is benefited by the use of team-based learning exercises.
- My learning of **medicine** course content and principles is benefited by the use of team-based learning exercises.
- It is ok with me having my TBL grade be a composite of my personal score of the IRAT plus the group score on the GRAT

In addition, participants were given open-ended questions on the survey to answer about TBLs, and those most pertinent to this study were:

- The medicine and pathology courses run the TBLs differently. Medicine adheres to a more standardized format of IRAT and GRAT. Do you feel there is a clear advantage to your learning with one approach or the other?
- Pathology allowed you to make up your own TBL groups, whereas medicine specified who was in which group. Which approach do you prefer?

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The qualitative data from the survey questions was examined using a grounded theory approach. Grounded theory involves immersing oneself in the qualitative data by reading and rereading the responses. From this immersion, quantifiable themes may appear from the data (Glaser and Strauss 1967, Egan 2002, Bernard 2006, Kennedy and Lingaard 2006). Our approach differed from a traditional grounded theory analysis in that we did not have enough qualitative data to develop a 'theory' from our qualitative responses; thus it is more appropriate to say we merely used a grounded theory approach in assessing our data.

Results

A total of 29 of 31 (94%) IUSM-Bloomington second-year medical students responded to the survey in 2012. Seventeen females and twelve males participated. Approximately 75% of the respondents (21 students) entered medical school directly after finishing their undergraduate education. Only three respondents (10.3%) had extensive experience with a TBL curriculum as undergraduates, while seventeen (58.6%) had minimal prior exposure to TBL and 9 respondents (31%) had no previous exposure to TBLs as undergraduates. Several students commented that their only exposure to TBLs was in their first year of medical school, so it is likely that the 'minimal prior exposure' number reflects the 1st year medical school experience versus the undergraduate experience.

Participants were asked to determine if they felt each TBL modality was beneficial to their learning, and overall they felt that both were helpful (Table 2). When asked to elaborate in written comments, participants felt that in both courses the effort put into the TBLs did not necessarily match the yield. One student reported, "I didn't like needing to do additional work with an already busy schedule when I perceived a low yield from my actions." Another offered that the TBLs were "ultimately too narrow to be practical for a larger scope." Still others felt they were useful, but more specifically they felt they were useful as a means to review material. Qualitative analysis of the written comments elucidated three main themes regarding TBL format: group selection, utilization of IRAT/GRAT, and when the related instructional material is first presented to students. Each of these themes is discussed in detail in the following pages:

Group selection preferences

When asked about preferences in TBL group selection in the survey, 34.5% of respondents preferred to have the instructor select the group for them, while 24.1% preferred to select their own groups; the remaining 41.4% were ambivalent. One student opined: "I think being assigned to a group might be more beneficial than choosing your group. By letting us choose our groups, we're more likely to choose friends we feel comfortable with, rather than people we might come together [with] better academically." However,

Table 2: Selected TBL survey questions and response rates

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
My learning of pathology course content and principles is benefited by the use of team-based learning exercises.	2 (6.9%)	20 (69.0%)	6 (20.7%)	1 (3.5%)	0
My learning of medicine course content and principles is benefited by the use of team-based learning exercises.	2 (6.9%)	20 (69.0%)	5 (17.2%)	0	2 (6.9%)
It is ok with me having my TBL grade be a composite of my personal score of the IRAT plus the group score on the GRAT.	2 (6.9%)	14 (48.3%)	4 (13.8%)	6 (20.69%)	3 (10.3%)

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some individuals expressed a strong dislike for instructor-selected groups: "Throw in that we were in groups that were randomly assigned, and things were even worse. Not only was there a lot of disagreement, but the unnatural group chemistry often created unnecessary disagreement and discord on the controversial topics." In the case of the medicine course, students were made aware of the strategy employed when choosing groups, and according to one respondent it "immediately created an atmosphere in the group…. Grades are supposed to be confidential, regardless of whether they are good or bad." Another student stated: "We are placed in groups with people we do not necessarily interact with regularly and there are varying degrees of preparation…this seems counterintuitive to me."

IRAT/GRAT utilization preferences

Traditionally, the IRAT and GRAT are both graded components meant to encourage accountability and ownership for ones learning (Michaelsen and Sweet 2008, Parmelee 2008). The IRAT and GRAT used in the medicine course were both graded elements of the exercise, and all were multiple-choice format. In contrast, the pathology course provided open-ended questions that were intended as discussion points that the groups were to answer collectively during the group period of the TBL exercise.

The participants were almost evenly divided about which approach they preferred, with 24.1% preferring the traditional graded multiple-choice IRAT/GRAT format, 37% preferring the nontraditional 'discussion point' format, and 34.5% finding both formats equally effective. The majority of written comments spoke in support of the nontraditional discussion point format, such as this student: "A relaxed approach to learning is always better. I like being able to focus on the subject at hand and try to learn what is important, instead of having to get hung up on the minutia of quizzes. We end up spending a huge amount of the class, both in group and class-wide discussions, just arguing about particular questions and how we interpret them."

In addition, students were equally divided about whether their TBL grade should be a composite of their IRAT and GRAT scores (Table 2). Almost 55% (16 students) agreed it was ok that their TBL grade came from the IRAT and GRAT, while 31% (9 students) disagreed with this concept; the remaining students were neutral.

First exposure vs. review of course material: TBL preferences

TBLs in health professions courses are sometimes used to expose students to new material through clinical case studies[1]. Pathology used case-based TBLs as a way to review material within a clinical context that had already been presented in lecture and through assigned readings. In contrast, students in medicine were assigned readings from journals or textbooks prior to the class session, and upon meeting in their groups they were given a clinical case study to work through with their team. The TBL was the only exposure medicine students had to that particular topic. While the survey did not include an explicit question regarding the use of TBL as a review (or capstone experience) versus a first exposure to material, students nevertheless addressed this difference within their written comments. Of those who commented on this, 7 of 9 stated that they prefer TBLs to function in the form of an all-encompassing review of previously covered material.

While survey respondents did not directly state their dislike of using the medicine course TBLs as a first exposure to material, they instead alluded to their preferences for having them as a form of review. For example, one respondent noted: "Sometimes these TBLs cover content we have yet to cover and that makes it challenging since I like to have a foundation or a good source to read before we begin these TBLs." Another commented: "…when we did the blood disorder TBL in medicine, we had not really covered everything in RBC and WBC disorders in pathology and medicine did not teach anything to do with those topics. The TBL was pretty much spent guessing and researching, and not really understanding."

General comparison of the medicine (traditional) versus pathology (non-traditional) TBLs

The survey did not prompt respondents to directly compare the traditional (medicine) versus non-traditional (pathology) TBL; rather, participants were asked to evaluate the efficacy of TBLs in both courses individually. An equal percentage of respondents (76%) found both medicine and pathology TBLs as beneficial to learning course content, while 7% (for medicine) and 4% (for pathology) found them unhelpful (the remainder of responses had no stated opinion). The quantitative results suggest that students found the TBLs useful, regardless of the format (traditional – medicine, versus nontraditional – pathology).

However, the open-ended survey responses paint a different picture about student preferences regarding TBL format. Of those who provided written comments, the majority preferred a less structured TBL to be used as a review, yet they also preferred to have their groups selected for them. While responses to the open-ended survey questions indicate a general acceptance of the traditional TBL structure, when respondents were pressed for details several mentioned they found the medicine TBL format drawn out and useful in only a handful of cases.

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Discussion

Medical education has changed dramatically over the past few decades, with increasing emphasis on problem solving, information gathering, group activities and collaborative leaning (Hanssen *et al.* 2008, AAMC Task Force 2015). Thus we now realize that one of the important non-academic elements of medical education is to redirect leaning strategies to include group activities and cooperation (Branch 2001, Tucker *et al.* 2003, Edwards *et al.* 2004, Michaelsen and Sweet 2008, Vasan *et al.* 2008).

Problem solving activities such as team-based learning have now become commonplace in the Indiana University School of Medicine curriculum. The second-year medical students at IUSM-Bloomington experience two courses utilizing distinct variations of the TBL format (traditional vs. nontraditional). This provided the opportunity to compare student preferences and perceived learning value of these two versions of team learning. As with other studies (Branch 2001, Tucker *et al.* 2003, Edwards *et al.* 2004, Parmelee *et al.* 2009), the majority of our survey participants appreciated the general learning value of the TBL approach. Yet several additional themes and issues emerged in our study.

Slight Preference for instructor-selected TBL groups

The participants in our study were split as to the method of group membership determination. A slightly greater percentage of students preferred to have the instructor select team members, while a minority preferred to select their own group. One detail stands out from the student survey comments; the criteria for group selection should remain confidential, especially considering how sensitive the issue of grades may be to some students.

Because a predetermined (and not self-selected) group is a more realistic representation of working on a team, many respondents felt this method was advisable, but still offered that group discord posed a potential problem. Students are aware that they will not be able to choose who they work with in a professional setting, but even so felt that the educational process was sufficiently different from the working world and that having no say in group composition was not best. It was suggested that disagreements, discord and variations in preparation often hamper the learning process, especially on new material. This may indeed be a hallmark of teamwork in a health professions setting (Oakley *et al.* 2004, Thomas and Bowen 2011).

Michaelsen and Sweet (2008) believe having the instructor select the group is best and in most settings this is the way TBLs are run. Thompson *et al.* (2015) have shown that larger teams tend to perform better than smaller teams, and that team cohesion is a strong predictor for team performance. Our data indicates that a minority of respondents preferred selecting their own groups, as they did in the pathology class, despite their admonition that it may not be the most realistic situation when working in a professional setting. They felt they were better equipped to communicate with their teammates and despite possible distractions were able to come together as a team and prepare equally for each TBL activity. While it isn't a guarantee, one would hope that teams would form friendships over time, especially if a sense of trust and camaraderie is developed between teammates (Shellenberger et al 2009). Regardless of how membership in the groups is determined, the variation in preparation among group members should be evened out, in theory, by inspiring accountability to the team.

Preference for a non-traditional IRAT/GRAT format

A greater percentage of students preferred the pathology course's nonstandard discussion-style IRAT/GRAT format (37.9%) versus the traditional, multiple-choice, graded format in medicine (24.1%). In addition, 10 of the 19 written responses about the IRAT and GRAT specifically stated their preference for the nontraditional format. Some respondents stated that the traditional IRAT/GRAT did not test understanding but rather the ability to pinpoint minute details. In addition, some suggested that the time spent on preparation was not equal to the yield or benefit they received from the in-class portion of the TBL, and a vocal minority did not agree with their TBL grade coming solely from a graded IRAT and GRAT.

Several respondents commented that having the IRAT/GRAT format at each TBL in medicine was repetitive and as such unnecessary. Conceivably, informing students about the TBL design and implementation as well as why the exercises are beneficial may engender a more positive attitude and improved participation (Thompson *et al.* 2007b, Nagaswami *et al.* 2009, Reinig *et al.* 2011). It is interesting to note that students didn't find the approach of non-graded discussion questions (in the non-traditional TBL format) stressful or repetitive, and many found it was beneficial to their learning. This seems an important observation, given the fact that groups in the pathology course were required to present their case observations and answers to the class as a whole.

Preference of TBL use for contextualizing prior materials (vs. first exposure to content)

Do students feel that TBL is most valuable for learning new material (as is done in a traditional TBL format) or do they prefer the TBL as a review and for contextualizing previously discussed content (non-traditional TBL format)? While the topic of the timing of presentation of the educational material was not explicitly asked in the quantitative portion of the survey, many respondents took it upon themselves to discuss this in their open-ended responses. Based on the comments of those who addressed this topic, participants prefer to use TBLs as a form of review and contextualizing prior information. Having a broader-based foundation before coming together as a team seemed to lend deeper

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understanding of the material. Some expressed the view that by not having had a 'lecture' pertaining to the content covered by the TBL, that they were left guessing when presented with a case study, this despite having been assigned readings over the new material. Whether this indicates a lack of preparation, an inappropriate selection of readings, or aural learning preference, is unclear. For whatever reason, some students felt it was more efficient to be given information beforehand in the form of a lecture.

The opinions surrounding this topic may have implications for frequency with which TBLs are offered. Perhaps if TBLs are a more frequent element of the curriculum, as opposed to an occasional event, students will view them as a more efficient use of their time. In any event, medical students on the Bloomington campus do not view TBLs as efficient learning exercises unless the TBL serves to review a wide range of material, and specifically augment the student's preparation for a major examination.

Traditional TBL vs. Nontraditional TBL: which format was preferred overall?

While both the medicine and pathology courses offer a TBL format that students found useful, further evaluation showed that students preferred selected elements of both formats. For example, our sample slightly preferred the traditional (medicine) instructor-selected groups versus self-selected groups (non-traditional). However, the respondents also preferred the non-traditional (pathology) discussion question-format of group assessment versus a traditional graded multiple-choice IRAT/GRAT. Further, our sample preferred the non-traditional use of TBLs to review and contextualize previously introduced material, rather than present new material. Given that students found utility in both TBL modalities, but had varying opinions on their specific aspects, we suggest that TBLs could be designed by instructors based on the population preferences to maximize their efficacy and efficiency.

Limitations and Future Directions

Despite careful design of this study, some limitations exist. Our sample was relatively small (n=29), although almost all 2nd year students at IUSM-Bloomington responded to the survey. It is possible that our student preferences are not similar to those of a larger student population; and further studies should explore this issue. As this survey was retrospective, it is possible that some initial perceptions about TBL format may have been forgotten. We had hoped to interview some students so as to gather richer information about their TBL perceptions, but response to interview requests was low. Our study merely examined student preference of TBL format, and did examine which TBL modality (traditional versus non-traditional) might be better for long-term content mastery and application of knowledge, if in fact there is a single best format. Future studies might look at specific measures of content mastery, longevity and application of knowledge to help answer this question.

Conclusions

Application oriented exercises, such as team-based learning, are now recognized as important elements in medical education. Some prior studies have reported general student perceptions of TBL (e.g. Thompson *et al.* 2007b, Nagaswami *et al.* 2009, Reinig *et al.* 2011), others alluded to modifying the TBL process (Goldberg and Dintzis 2008, Shankar and Roopa 2009, Conway *et al.* 2010, Zgheib *et al.* 2010) and several studies examined team size and composition along with team performance (Thompson *et al.* 2015). However, we are unaware of prior studies that explicitly compared traditional and non-traditional TBL formats. Our study examined how the same cohort of students perceived variances in the TBL process in two different second year medical courses at Indiana University School of Medicine - Bloomington. The TBL formats for the introduction to medicine (traditional TBL) and pathology (non-traditional TBL) courses were substantially different, thus allowing a side-by-side comparison. While both TBL modalities were regarded as helpful to learning, our students preferred certain methods of TBL implementation to others. The quantitative and qualitative results indicated students had a slight preference to instructor-selected groups, provided the group selection process was kept confidential. Secondly, students prefer a non-graded IRAT/GRAT. Finally, most students preferred TBLs to be used as a review of previously presented material, rather than for the introduction of new material. We anticipate that this information may help faculty fine tune future TBL design for similar student populations.

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