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Impact of Team Formation Method on Student Team Performance Across Multiple Courses Incorporating Team-Based Learning

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ABSTRACT

Objective. To assess the impact of forming student learning teams based on problem solving styles on: 1) team performance, and 2) student perceptions of team quality.

Methods. This was a prospective observational study including students in the first year of the doctor of pharmacy degree program. Collaborative learning teams remained consistent across all courses for the 2015-2016 academic year. Teams were created based on results of the Basadur Creative Problem Solving Profile Inventory: 1) balanced; 2) implementer; 3) optimizer; 4) random assignment. Courses that incorporated team-based learning (TBL) were included in the study. Team performance was assessed by the team readiness assurance tests. Quality of team interactions were assessed using the team satisfaction domain in the Comprehensive Assessment of Team Member Effectiveness (CATME) Smarter Teamwork system, and the Team Performance Scale.

Results. There were 237 students enrolled that were placed into 41 teams. All teams participated in the study. A statistically significant difference in team performance was observed in the Principles of Patient Centered Care course (Fall semester; Block 1). Significant differences in team performance were not observed for all other courses. There were no statistically significant differences observed in quality of team interactions.

Conclusion. Neither team performance, team satisfaction, nor quality of team interactions were impacted by method of team formation. Given the existing evidence in addition to the results of this study, it is possible that team formation process, regardless of method used, has negligible influence on team performance of collaborative learning teams in courses taught using TBL.

Keywords: team-based learning, collaborative learning, team formation, team performance, team cohesion

INTRODUCTION

When forming student teams in a team-based learning (TBL) classroom, experts recommend creating heterogeneous teams.[1] The hypothesis is that once teams move through Tuckman's stages of team formation (forming, storming norming, performing) a heterogeneous team will perform better than a homogeneous team by having expanded collective knowledge.[2] Current evidence supports the use of heterogeneous teams in the work place setting, as these teams have been able to achieve better team performance.[3] However, learning teams complete tasks in a different context than teams in work place settings. The primary goal of learning teams focuses on developing or expanding knowledge, skills, and abilities, whereas the primary goal of many teams in a work place setting is to focus on performance results.

There are no standards for creating heterogeneous teams, nor are there accepted criteria to define a team as being heterogeneous for either learning teams or work place teams. If the intent of creating heterogenous teams is to expand collective knowledge, one may consider creating teams based on prior educational experiences. However, colleges and schools of pharmacy often find it difficult to create heterogeneous teams in this manner because doctor of pharmacy degree program students typically have

similar experiences prior to enrolling in the program (i.e. completed similar course-work). Common methods used in pharmacy education to create learning teams include randomization, student self-selection, prior work experience, grade point average, gender, personality testing, race, and strength/weakness testing.[4]

Pociask and colleagues compared three methods of team formation in different sections of an undergraduate general education science course taught using TBL.[5] Teams were formed by the instructor, student self-selection, or random assignment. Using personality, class year and gender as diversity criteria, the teams formed by the instructor were more diverse. Whether teams were formed by the instructor, self-selected or randomly selected, there were no observed differences in student performance on team assignments including team readiness assurance tests (tRATs) and team projects (p=.14).

Camiel and colleagues compared homogenous and heterogeneous teams that were formed based on academic abilities in a doctor of pharmacy degree program.[6] Students enrolled in a single course taught using TBL were placed into high GPA (cumulative GPA 3.00-4.00), lower GPA (cumulative GPA 2.00-2.99), or mixed GPA teams. They found that team performance, as measured by tRATs was statistically different when comparing high GPA teams (99%) to lower GPA teams (97%), p<.05. However, all teams performed well on tRATs, which makes differentiations of performance difficult. The authors also reported that student perceptions of team work were higher in the homogenous teams than within mixed GPA teams. Since heterogeneous teams require more time to progress through Tuckman's stages of team formation, these observations may reflect teams' insufficient time to progress through those stages.

In our curriculum, teamwork requires significant reliance on problem solving. Moreover, problem solving, adopted by multiple courses in the curriculum, is the conceptual underpinning of applications used in the TBL method. Without clear direction on a method to form heterogeneous teams, we elected to form learning teams using the Basadur Creative Problem Solving Profile Inventory (CPSP-2).[7-9] The CPSP-2 identifies peoples' preferred style for problem solving. Results from the CPSP-2 can be used to heighten self-awareness and to form heterogeneous teams using a unique approach. We hypothesized that

teams who had a blend of all styles of problem solving would evolve to become higher performing and develop higher quality of team interactions. The purpose of this study was to assess the impact of forming student learning teams based on problem solving styles on: 1) team performance, and 2) student perceptions of team quality.

METHODS

This was a prospective observational study including students enrolled in the first year of the doctor of pharmacy degree program at the University of Florida who entered the program in Fall 2015. Students in the program were assigned to a learning team and remained with the same team across all courses in the program for the 2015-2016 academic year. Every team provided informed consent to participate in the study. Prior to the program orientation, students completed the CPSP-2.[7-9] The CPSP-2 classifies problem solving styles among four categories (generating, conceptualizing, optimizing, implementing), and identifies the individuals preferred style or identifies you prefer a balanced blend of all four styles. Basadur and colleagues have documented the predictive validity of the CPSP.[9] Teams were created based on campus location (Gainesville, Jacksonville, Orlando) and then placed into one of four groups: 1) balanced, consisting of at least one member that was dominant in each of the four styles; 2) implementer, all students in the team had implementing as their preferred style; 3) optimizer, all students in the team had optimizing as their preferred style; 4) random assignment. There were insufficient numbers of students that were categorized as generators and conceptualizers, therefore these homogenous teams could not be formed. Students were informed that their teams were created based on results of their CPSP-2, or random assignment, but were not told what indicator was used to form their own team.

As part of the doctor of pharmacy degree program orientation, teams had time to meet for the first time and get to know the team members. During that time, they completed a team contract to assist with setting team norms and expectations, as well as identifying a method to manage conflict when it occurred. The team contract developed was modified from Ofstad and colleagues, to fit the needs of our program.[10] The team contract is available from the authors upon request.

Courses that incorporated team-based learning as a primary active learning method during the 2015-2016 academic year are listed in Table 1. Scores from the team readiness assurance tests (tRATs) were used to assess team performance. Each course incorporated a different number of tRATs and a varying number of items on each tRAT. Scores for each tRAT were normalized to a scale of 100 possible points for statistical comparisons.

To assist with team development and functioning, teams completed peer evaluations at four time points throughout the academic year including the middle and end of the Fall and Spring semesters. Peer evaluations were conducted using the Comprehensive Assessment of Team Member Effectiveness (CATME) Smarter Teamwork system.[11] The dimensions selected for inclusion on the peer evaluations from CATME include: contributing to the teams work, interacting with teammates, keeping the team on track, expecting quality, and having related knowledge, skills and abilities. Each individual on the team was assessed on these dimensions. The data provided were used as exploratory variables to compare results of the student of their self-assessment, how their peers rated them, and how the entire team was rated. We also incorporated the team satisfaction domain in CATME to assess the overall satisfaction of the team as a whole. The team satisfaction domain is a 3-item tool, measured on a 1-5 Likert scale (1=strongly disagree; 5=strongly agree; maximum composite score of 15).[12] Additionally, students completed the Team Performance Scale (TPS) at the conclusion of the spring semester to assess the quality of team interactions.[13,14] The TPS is an 18-item tool. Each item is measured on a 0-6 Likert scale (0=none of the time; 6=all of the time; maximum composite score of 108). Scores from the team satisfaction domain obtained during the final peer evaluation period and the TPS were used to assess the quality of team interactions. The University of Florida institutional review board approved the study protocol.

Statistical Analysis

Kolmogorov-Smirnov test was conducted to assess normality of data distribution. Based on Kolmogorov-Smirnov test results, team readiness assurance test scores were compared across the four groups using Kruskal-Wallis test for non-normally distributed data (Principles of Patient Centered Care

and Personal and Professional Development II courses), and ANOVA for data that was normally distributed (Pathophysiology and Patient Assessment I and II, Pharmacy and Population Health courses and all courses combined). Team satisfaction scores were compared across the four groups using Kruskal-Wallis test for non-normally distributed data (team satisfaction at the end of spring semester) or ANOVA for normally distributed data (team satisfaction at the middle of fall, end of fall, middle of spring, and the average of all data). Team Performance Scale results were normally distributed, so data was compared across the four groups using ANOVA.

RESULTS

There were 237 students enrolled in the class who entered the University of Florida College of Pharmacy in the Fall 2015 semester. The students were placed into 41 teams, with the target team size being six members, but ranged from four to seven members (4 members, n=1; 5 members n=9; 6 members n=29; 7 members, n=2). All teams participated in the study. Team distribution into the four categories studied included balanced (n=9), implementer (n=9), optimizer (n=9), and random assignment (n=14).

The results of assessing the group difference on team performance for each course and across all courses are listed in Table 2. A statistically significant difference was observed in the Principles of Patient Centered Care course (p=.002). Significant differences in team performance were not observed for all other courses (p>.05). The follow-up procedure for the Principles of Patient Centered Care course revealed significant differences when comparing the balanced and implementer teams to randomly formed teams (p=.002, p=.001, respectively).

The results of assessing the group difference on team satisfaction are summarized in Table 3. Statistically significant differences were not observed among the four team formation method groups on the team satisfaction at any time point (p>.05). Similarly, there was no significant differences among team formation method for the TPS (p>.05, Table 4). Teams that were formed in a balanced group had higher numerical scores on the TPS, though this was not a statistically significant difference.

DISCUSSION

The findings from this study demonstrated that neither team performance, team satisfaction, nor quality of team interactions were impacted by method of team formation when assessing longitudinal collaborative learning teams enrolled in a variety of courses. Prior published work on team formation methods in TBL have focused on a single course or experience with teams working together for short periods of time.[5,6] However, one innovative feature of this study is that team performance was followed across the duration of an academic year among students who were enrolled in courses with differing content. Thus, using time as the parameter, we believe that the teams had sufficient duration of interaction to progress through Tuckman's stages of team formation. Teams also experienced different learning contexts in the various courses included in the study. Though there was a statistical difference observed in the tRAT score in one course (Principles of Patient Centered Care), it was not educationally significant, because the small difference in percentage grade does not reflect a notable distinction in student knowledge. This course was also early in the process of team development which may reflect the notion that the team had not yet developed agreed upon norms. However, there was another course included in this analysis that was offered at the same time (Pharmacy and Population Health) with no observed difference in team performance.

Previous research on the ideal characteristics that are recommended when forming teams has focused on work place teams, not collaborative learning teams. Stewart conducted a meta-analysis to identify the relationships between team design features and work place team performance.[3] Team member skill and ability levels, personality traits, background and experience, team size, task meaningfulness, and intra-team cooperation, correlated positively with team performance. The effect of team member heterogeneity varies based on type of team (production, project, management), with moderate, positive correlation existing for teams that require creativity, such as when solving problems. Studies assessing heterogeneity included various characteristics such as demographics (e.g. age, gender, race/ethnicity), personality traits (e.g. agreeableness, introversion/extroversion), or prior experiences (e.g. academic performance, past work experience, education).

Current literature focused on team formation methods for courses taught using TBL are limited.[5,6] Pociask and colleagues used personality traits and demographics to form diverse teams.[5] However, these teams performed as well as student-selected teams and randomly formed teams. Camiel and colleagues used prior academic performance to form homogeneous and heterogeneous teams.[6] Though a statistical difference was observed in team performance, the difference in scores was too small to demonstrate significant variations in student knowledge.

Espey examined factors that influence team success in an undergraduate introductory microeconomic theory course that had used TBL for 10 years (n=114 teams).[15] Teams in all course offerings were formed similarly by the instructor to enhance diversity on the team with respect to cumulative GPA, class (eg, freshmen), hometown location, and major. Factors influencing team success, as measured using tRAT scores, included the highest individual RAT score on the team, and class diversity. Team cohesion did not significantly influence tRAT scores.

Thompson and colleagues explored factors that alter team performance among third year medical students on a psychology rotation that incorporated TBL. They found that team cohesion and team size positively correlated with team performance.[16] van Schaik and O'Brien commented that the performance of learning teams can be impacted by heterogeneity, context of the teamwork, and the task the team is charged to complete.[17]

Given the existing evidence in addition to the results of this study, it is possible that team formation process, regardless of method used, has negligible influence on team performance of collaborative learning teams in courses taught using TBL. However, there are several methods of team formation, the current literature has only explored a small fraction of these methods.

There are several limitations in this study. Perhaps the team formation method used may not have been the most appropriate to develop teams or to assess impact on team performance and quality of interactions. Another limitation of the study is the lack of significant variability in team performance. Student teams performed high on the tRATs making it difficult to detect a difference in team performance. However, the level of performance observed in this study is consistent with prior reports.[5,6]

Team developmental stage was also not assessed in the study, which has potential to influence team performance. One can surmise, teams in the storming stage of team development may not perform as well as team in the norming or performing stage.

Future research should focus on identifying the factors (eg, team size, team cohesion, team longevity, task type, task context) that influence team performance in collaborative learning teams, as the majority of existing literature on team performance is focused on teams in the work place setting.

CONCLUSION

Despite student team longevity and experience in the context of courses addressing varying content, neither team performance, team satisfaction, nor quality of team interactions were impacted by method of team formation when teams were formed using the Basadur Creative Problem Solving Profile Inventory. Given the existing evidence in addition to the results of this study, it is possible that team formation process, regardless of method used, has negligible influence on team performance of collaborative learning teams in courses taught using TBL.

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Table 1. Course Titles and Placement in the First Year Curriculum

Course Title	**Semester**	**Block**
Pharmacy and Population Health	Fall	1
Principles of Patient Centered Care	Fall	1
Pathophysiology and Patient Assessment I	Fall	2
Pathophysiology and Patient Assessment II	Spring	3
Personal and Professional Development II	Spring	3 and 4

Table 2. Team Performance on Team Readiness Assurance Tests[a] Based on Team Formation Method

	Balanced (n=9)	**Implementer** (n=9)	**Optimizer** (n=9)	**Random** (n=14)	**All Teams** (n=41)	
Course Title	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	***p* value**
Pharmacy and Population Health	96.1 (2.6)	94.5 (3.3)	92.0 (6.2)	94.8 (5.2)	94.4 (4.7)	.299
Principles of Patient Centered Care	96.2 (2.1)	95.2 (3.3)	97 (2.8)	98.8 (1.3)	97.1 (2.66)	.002[b]
Pathophysiology and Patient Assessment I	95 (5.3)	91.7 (6.9)	93.6 (3.7)	92.6 (5.8)	93.1 (5.5)	.627
Pathophysiology and Patient Assessment II	94.9 (2.5)	94 (3.8)	93.1 (4.8)	96.8 (2.5)	94.9 (3.6)	.075
Personal and Professional Development II	97.8 (1.7)	97.7 (1.1)	97.2 (1.7)	98.3 (1.4)	97.8 (1.5)	.410
All Courses Combined	96 (1.8)	94.6 (1.5)	94.6 (2.6)	96.3 (2.2)	95.5 (2.1)	.136

[a] Scores were normalized to a scale of 100 possible points.
[b] Follow-up procedure identified a difference when comparing Balanced (p=0.002) and Implementer (p=0.001) teams to teams formed using other methods.

Table 3. Team Satisfaction[a] Based on Team Formation Method

	Balanced (n=9)	**Implementer** (n=9)	**Optimizer** (n=9)	**Random** (n=14)	**All Teams** (n=41)	
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	***p* value**
Middle of Fall semester	14.4 (0.8)	14.5 (0.6)	13.5 (1.4)	13.8 (1.1)	14 (1.1)	.134
End of Fall semester	14.3 (1)	14.1 (0.7)	13.6 (1.7)	13.7 (1.3)	13.9 (1.2)	.598
Middle of Spring semester	13.9 (1.1)	13.9 (1.6)	14 (1.4)	13.8 (1.2)	13.9 (1.3)	.993
End of Spring semester	14.1 (1.3)	14 (0.7)	13.4 (1.9)	13.8 (1.4)	13.8 (1.4)	.436

Average of all ratings	14.2 (0.9)	14.1 (0.6)	13.6 (1.5)	13.8 (1.1)	13.9 (1)	.614

[a]Team satisfaction was measured with a 3-item Likert scale (score range 1-5) with maximum composite score of 15.

Table 4. Quality of Team Interactions Based on Team Formation Method

	Balanced (n=9)	**Implementer** (n=9)	**Optimizer** (n=9)	**Random** (n=14)	**All Teams** (n=41)	
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	***p* value**
Team Performance Scale[a]	99.8 (7.2)	95.8 (7.6)	94.5 (12.5)	93.8 (12)	95.7 (10.2)	.580

[a] Team Performance Scale was administered at the conclusion of the spring semester. It is an 18-item tool measured on a Likert scale (score range 0-6) with maximum composite score of 108.