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Team-Based Learning In Medical Education

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Team-Based Learning in Medical Education

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Biographical Sketch

Kathryn W. Smith was born on November 23, 1984, in Louisville, Kentucky. She received a Bachelor of Arts degree in Elementary Education from Elon University in 2007 and, after graduation she took a job teaching fourth grade teaching in Burlington, North Carolina. In 2012, after teaching four and a half years, she took a position at the University of North Carolina School of Medicine as an Educational Consultant. She is a candidate for the Master's Degree in Instructional Technology.

Dedication

To my family, for all of your love and support.

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Abstract

The main purpose of this study is to determine if the use of Team-Based Learning as a method of instruction is more effective in terms of student achievement than the traditional lecture method in an anatomy course at a state university medical school. Student scores from two academic years (2011-2012 academic year and the 2012-2013 academic year) for the average of four exams were analyzed using an independent sample t-test to determine if the intervention of Team-Based Learning made a difference on student achievement. Students were paired from each academic year based on final entering MCAT score, age at matriculation, and gender. While there are concerns because the samples were not randomly selected, the matching was used to control for possible difference between the two groups. An independent samples t-test was calculated to determine if there was significance between the two groups. No significant difference was found. The first attempt at using the Team-Based Learning method of instruction at the state university medical school anatomy course did not appear to significantly improve achievement; it did, however, improve scores of “at-risk” students with the smaller standard deviation on the average of the exam scores.

CHAPTER 1

Introduction

It is important to know what teaching methods are the most effective for medical school students. Previous research shows the Team-Based Learning (TBL) method to be an effective method for delivering instruction to medical school students as opposed to the lecture method (Sibley & Parmelee, 2008). Since the focus of learning is becoming more student-centered and learner-focused, the method of Team-Based Learning for small group learning has seen an increased use in Medical Schools.

There is not a lot of literature about Team-Based Learning; therefore, significant data does not currently exist concerning the outcomes of Team-Based Learning, especially in a Medical Education setting. Since there is not a lot of data, the purpose of the current study is to explore whether Team-Based Learning is more effective than the traditional lecture method.

This study will explore whether Medical School students in the first year Structure and Development Anatomy course will have a similar outcome on the course exams even though the method of instruction, either through lecture method or through Team-Based Learning, is different. The material that is covered due to the strict method of Team-Based learning will not allow the difference of instructor to have a major impact on the student performance as assessed by the average of four course exams.

Importance of the Study

This study will determine the effects of Team-Based Learning (TBL) on the academic performance of first year Medical Students in the Structure and Development Anatomy course on the average of their course exams. Using the course exams throughout the block, the exam

scores for each year will be compared to see if there is a significant difference in the student's scores on the exams throughout the course.

The method of Team-Based Learning is a very specific method to follow. Since the Team-Based Learning method is a precisely defined method—first, students complete a pre-reading assignment, then they take an iRAT, followed by a gRAT, and finally, students perform an application activity—the instructor who is presenting the information in each small group room should not make a difference for student performance on the exams. Each group will be following the same steps with the same information, and thus the instructor much opportunity to veer from the prescribed lesson.

Research Question

The researcher seeks to determine whether there is a difference in achievement between the students in a Team-Based Learning environment or those being instructed using a lecture method.

Is there a difference between the achievement of medical students who are taught using lecture method and those taught using Team-Based Learning method?

Definition of Terms

For clearer understanding of the terms used in this study refer to the meanings below.

IF-AT – Immediate Feedback Assessment Technique. A scratch off card with multiple permutations with a key that are matched to the iRAT or gRAT that students take during the small group.

iRAT (Individual Readiness Assurance Test)- Multiple choice quiz consisting of 5-20 questions that students answer individually.

gRAT (Group Readiness Assurance Test)- Multiple choice quiz consisting of 5-20 questions that students answer in their predetermined groups.

Small Group – A group of 5-7 students.

Small Group Room- A group of 30 students in a lab working with one main instructor.

Team-Based Learning- An instructional method based on procedures to develop learning situations for small groups of students.

CHAPTER 2

Literature Review

Team-Based learning (TBL) is an instructional strategy developed by Professor Larry Michaelsen at the University of Oklahoma's Business School in the early 1990's. He developed this method because his class rolls were increasing and this method could be used in large groups to promote active learning (Parmelee, 2010). Team-Based Learning is learner-centered but instructor-led, uses a very structured individual and group accountability process, and requires small groups to work together to solve problems (Parmelee, DeStephen, & Borges, 2010). The back-bone of TBL is self-directed learning and pre-exposure provides learners with a foundation to build connections (Persky, 2011). Instructors take a managing role within the classroom rather than an information dispensing role and organize students into permanent meaningful groups of five to seven for the entirety of a semester to promote collaborative, active learning (Michaelsen & Sweet, 2008). Working in the same team throughout an entire semester allows students to learn to work collaboratively to solve problems and grow together in the learning process. Developed originally for business schools TBL is gaining use in medical education since it allows for many small groups to occur simultaneously in one classroom with one faculty member or instructor managing all groups (Thompson, Schneider, Haidet, Levine, McMahon, Perkowski & Richards, 2007). Baylor College of Medicine was the first to use TBL in medical education in 2001 (Grady, 2011) and has become more wide spread among many medical education settings.

The familiar roles of instructor and student must be shifted in order for TBL to be successful. Students are required to become active learners and be prepared prior to a TBL session. Instructors move away from being lecturers and information dispensers to facilitating

learning through designing and managing the learning process. Four components are essential for a successful TBL: properly formed and managed groups, student accountability, effective feedback, and meaningful assignments that foster learning and team development. (Michaelsen & Sweet, 2008). The TBL process is well tested and students benefit the most when all of the components are used (Parmelee, 2010).

Prior to attending a TBL class, students prepare using assigned study materials because each session begins with an individual readiness assurance test (iRAT). The iRAT is comprised of synthesizing multiple choice questions and key points from the study materials that students complete (Koles, Stolfi, Borges, Nelson & Parmelee, 2010). After students complete the iRAT they work together to complete the group readiness assurance test (gRAT), coming to a group consensus on answers for a group grade. The gRAT is comprised of the same questions as the iRAT; however, this time students receive immediate feedback on the gRAT by using an Immediate-Feedback Assessment Technique scratch-off cards (by Epstein Education, in Cincinnati, OH) and have an opportunity to write appeals for questions they answered incorrectly (Michaelsen & Sweet, 2008).

Students then work in collaborative, never student-selected, but carefully "spread the wealth of resources" (Sibley & Pamelee, 2008) small group teams to solve real-world application problems different from the iRAT or gRAT questions. At this time, all teams work on the same problem or question at the same time. At the end of a designated time period or when all teams are coming to an answer, teams display answers to the application problems simultaneously using large color-coded response cards to compare answers among the groups (Thompson et al, 2007). A discussion among teams and the instructor follows the revealing of answers and every possible answer is examined. Explanation of the correct answer is given usually followed by a

review of the most difficult aspect of the problem in a matter of five minutes and teams continue answering real-world application problems for the remainder of the session (Wiener, Plass & Marz, 2009).

One of the key components of TBL is the use of peer feedback. According to Cestone, Levine and Lane (2008) some students believe in the practice while others are skeptical. Some students believe that the process interfered with their relationship with their fellow learners while other students believe that their quality of work has improved due to this feedback. It is important that the guidelines for the feedback that students will give be set forth early and have clear expectations. Students need to be prepared for the process and learn how to grow from the feedback. There are many different ways that students can give and receive feedback including the form that the students use; however, the feedback needs to be given one way or another. The use of TBL in medical schools has had a positive result due to student preparation and collaborative real-world application problems. Students who have used the TBL method demonstrated higher performances on exams, academically "at-risk" students achieved greater performance on assessments, and students have greater mastery and retention of course content (Koles et al, 2010). TBL can shift students to knowledge application and critical thinking, create a positive classroom learning environment, and increase active learning (Parmelee & Michaelsen, 2010).

According to the literature, there are many benefits to using Team-Based Learning in medical education compared to lecture based learning classes. Team-Based learning enhances the academics of students with a deeper knowledge of course concepts, higher cognitive skills, and retention of academically weaker students (Nieder, Parmelee, Stolfi and Hudes, 2005). TBL increases the active learning of students through collaborative teams using problem solving skills

and discussion (Parmelee & Michaelsen, 2010). Interprofessional communication is rarely taught in traditional healthcare settings and is learned through the hidden curriculum, but TBL allows this communication to become more visible throughout the activities (Rider & Brashers, 2006). TBL also has positive outcomes when instructors and faculty members move around the room during the gRAT activity, faculty are able to quickly identify misconceptions for students and are able to set the students on a better track to the correct answer (Sibley & Parmelee, 2008). In addition, TBL benefits the faculty since one instructor can manage a larger group of students but also allows them to interact with students and aid them in their learning (Michaelsen & Sweet, 2008). TBL also allows students to achieve similar outcomes while conserving precious resources, since it is scalable to a larger student-to-faculty ratio of two-hundred to one and above (Sibley & Parmelee, 2008).

In addition to faculty benefits, students gain many benefits from using TBL as well. According to Nieder et al. (2005) students believe that TBL aided them in grasping more course concepts, studying more consistently and that TBL was more helpful to them than traditional lecture method by a large margin of difference. Koles et al. (2010) also indicate TBL aids in retention of course material and mastery of content. In addition to retention and mastery, students who learned through TBL demonstrated higher performance on National Board of Medical Examiners exam than students from previous years as well as achieving higher course grades in classes that replaced traditional lecture with TBL classes. Exercises used in TBL improve the students' clinical reasoning skills necessary in medical education as well as prepare them more thoroughly for exams (Grady, 2011).

Challenging students to think critically, a focus of TBL has benefits for all students. Academically weaker students benefit from TBL and are much more likely to succeed

in TBL formatted classes compared to their successes in other science classes that are lecture based (Chung, Rhee, Baik & A, 2009). Students' overall performance improved; however, students in the lowest-quartile showed the greatest improvement (Koles et al, 2010). Results from Nieder et al. (2005) show in 2002 when TBL was implemented all but seven students passed the class with above 70% on the course final. The seven students who did not pass the class fell into the range for remediation (60%-70%). All but one did well enough to pass the class through the remediation. In comparison to the previous three years (1998-2001), the number of remediated students ranged from 5-11 compared to the 7 students from the TBL class and the number of failing students in the Gross Anatomy course was from 2-7 compared to one during TBL. The average number of students failing the course in the previous years (1998-2001) was an average of six compared to 2002 with a single failure. The overall average of exam scores was not significantly different over the four year time span; however, the scores were less varied in 2002.

In a comparison between two sections of an Introductory Biology class, Carmichael (2009) found the final exam scores were almost identical. Students in one section of the biology class were taught by the lecture method compared to the section of biology that was taught using lectures and TBL. Scores indicate that there may be no long-term effect from TBL on exam performances. Carmichael (2009) notes that the similar scores of the two sections may be due to both sections having a good understanding of the material due to prior knowledge. However, Carmichael (2009) does note that students taught using TBL were more capable of drawing conclusions and understanding results compared to the traditional lecture classes. In addition, higher performing students tend to perceive TBL more favorably than lower performing students overall according to Vasan, DeFouw, and Compton, (2009).

According to the literature many resources indicated TBL promotes active learning and engagement of students with course material (Nieder, Parmelee, Stolfi and Hudes, 2005, Parmelee & Michaelsen, 2010, Sibley & Parmelee, 2008). Michaelsen & Sweet (2008) suggest that "TBL enables at-risk students to successfully complete and stay on track with their course work, probably because of the increased social support or peer tutoring" (p. 25). TBL requires students to be accountable by reading material ahead of time and being prepared to come to class to take the iRAT, gRAT and participate as a member of a team in group discussion (Grady, 2011). Carmichael (2009) and Nieder et al. (2005) both indicate TBL encourages students within the groups to ask more thought provoking questions and maintain engagement within their group discussion. Grady and Parmelee (2008) suggest that the TBL process ensures mastery of core content, engages students in solving complex problems, helps students to develop important communication skills that are essential for the workplace and enables students to use critical thinking skills as an individual and within a team.

In addition, Neider et al. (2005) and Thompson et al. (2007) indicate that students came prepared for the sessions, quality discussion with debate and critical thinking skills were apparent as well as improved attendance due to the use of TBL. Grady (2011) states TBL engages students through active real-life cases and teaches them life-long learning skills in addition to clinical reasoning skills.

Based on the literature, there are many benefits for the faculty using TBL. Michaelsen and Sweet (2008) find that students engage in their learning process and have an enthusiasm for learning. The enthusiasm results in students coming to class prepared and instructors can be certain students have done the work necessary to participate in the class activity. Faculty also find working with prepared students who are knowledgeable is more like working with

colleagues instead of standing in front of students giving a lecture. Nieder et al. (2005) found that faculty became more engaged with the students than in other small group classes.

Thompson et al. (2007) also found faculty to be more in favor of TBL due to students' preparation, in-class discussion and critical thinking skills. In addition faculty found great academic student performance as well as increased collaboration among their colleagues. In addition to collaboration, many faculty members were not required to conduct TBL because one instructor can manage several small groups in one classroom. Michaelsen & Sweet (2008) determined instructors can make more personal connections with students during the discussion activities.

TBL has many positive attributes; however, Grady (2011) discusses a transition to Team-Based learning from traditional lecture method can be difficult for students and faculty members. Chung et al. (2009) also describes student attitudes may be difficult to change when they are used to lecture based learning rather than Team-Based learning. It also requires a considerable amount of faculty development and investment of time for the faculty who develop the TBL modules as well as faculty buy in for it to be successful (Parmelee, 2010). TBL requires students to become active participants who are accountable and responsible for their learning. Also, TBL works best when everyone works together to build trust, support and cooperation (Lane, 2008). These above situations could be potential problems for faculty and students during the adoption of the TBL method.

In addition to the previously mentioned problems, Lane (2008) adds that resistance from students is much greater when faculty use the TBL method to conduct classes because they have strength in numbers by working in groups and the student groups could then challenge the instructor. Also, students can also view this method as "teaching themselves" since they are

doing the pre-reading and having to come to class prepared; students may become frustrated with the TBL process. The TBL process may also frustrate students if the instructor frequently leaves the classroom or is unavailable to them when they have questions, thus making them less invested in the TBL process. Also, if instructors are over-involved in the Application Process of TBL and turn student work time into a mini-lecture it defeats the process of the students working together in their groups. Having a mini-lecture can hinder the group development and student learning. Faculty who do not circulate around the room while the students work appear to be uncaring by the students about their learning. Therefore, it is important for the faculty member to constantly circulate and provide feedback for the student groups.

Grady (2011) continues that some faculty members may resist change. Faculty members may only meet a few times a year to discuss quality assurance issues, case development and examinations; therefore, it can be difficult to make the change over to TBL. Faculty have to be well trained and comfortable to make the transition to TBL. It can also be difficult for student groups to stay on topic, if not managed well. In addition, students may become frustrated when changing to the TBL method. During a traditional discussion, students are accustomed to having one correct answer and in a TBL session during the Application Process some students may become frustrated when more than one answer can be correct. Students also feel that they are not being taught since they are constructing their own learning.

Faculty must have multiple exposures to TBL for it to be successful. Once a faculty member understands the method it will work effectively. Thus, repeated exposure and quality training is important. Faculty must also become comfortable with the procedures and accept small failures in the first attempts of the process. Faculty buy-in and attitude toward the method also limit the effectiveness of the method (Thompson et al, 2007). Weiner & Plass (2009)

indicate that some students found TBL was incompatible with their learning style and did not find it to be successful. Students also were unsure of the effectiveness of gaining knowledge through TBL.

Gaps in the literature were apparent since research regarding the optimal factors to conduct the TBL method is minimal (Thompson et al, 2007). In addition, the research about the method is fairly new thus no long-term effects of the TBL method on medical education exist. Koles et al. (2010) indicated that few studies have been implemented to show the correlation between objective examinations and the use of TBL. Lastly, research does not indicate the effects and differences between Problem-Based Learning (PBL), Team-Based Learning (TBL), and the lecture method.

In conclusion, the literature review indicates that TBL has a positive effect on learning in medical education. Students who have used the TBL method have greater mastery and retention of course content, demonstrated higher performances on the National Board Exam, and academically "at-risk" students have greater achievement levels (Koles et al, 2010). TBL can enhance active learning, produce a positive effect on classroom learning, and shift students to knowledge application and critical thinking (Parmelee & Michaelsen, 2010).

Another benefit of TBL is an increase in student attendance and participation in class discussion, as well as students coming to class prepared. The use of TBL method has had fewer failures and maintains academically weak students (Nieder et al, 2005). Using TBL can enhance student learning, cause fewer students to drop a class and promote learning (Carmichael, 2009).

A majority of students need to be taught how to perform in a group setting to make TBL successful (Wiener et al, 2009). Many students and faculty are not willing to change to an unknown format of teaching and learning (Grady, 2011) but with support and adequate training

TBL can be successful (Thompson, et al, 2007). Overall, TBL benefits students in medical school classes from the positive learning environment to developing students' critical thinking skills and cooperation in small groups.

CHAPTER 3

Methodology

Introduction

This research study was designed to determine if the use of Team-Based Learning sessions during the Structure and Development Course yield higher achievement as measured by the average of four exam scores compared to using only the traditional lecture method.

Research Question

Is there a difference between the achievement of medical students who are taught using lecture method and those taught using Team-Based Learning method?

Hypothesis

The use of Team-Based Learning will increase the student exam scores because of the prescribed method of instruction and interactions between students will deepen the learning.

Sampling Information

The first year students of the Medical School at the University of North Carolina take the Structure and Development course as the second course in the fall semester. Students learn through lectures, cadaver dissections, radiology sessions, case conferences and Team-Based Learning exercises. The nine-week course consists of five units of study starting with the Back and Upper Limb, followed by the Thorax and Abdomen, Pelvis, Head and Neck, and finally the Lower Limb. During each section of the course, students look at the support and movement of the section in regards to the skeletal and muscular systems, coordination with the nervous and endocrine systems, maintenance of the body with the circulatory, respiratory, digestive, immune and urinary systems and finally reproduction.

Students meet in large lecture halls for most of the didactic information with small group sessions in the 2011-2012 academic year and in the 2012-2013 academic year Team-Based Learning sessions were used as the second most prominent way of gaining medical knowledge.

In the 2011-2012 class, there were one-hundred seventy students who ranged from twenty to forty-two years of age. Forty-nine percent of the class was female and fifty-one percent were male. In the 2012-2013 class, there were one-hundred eighty students who were used in the study ranged from twenty-one to thirty-seven years of age. Forty-five percent of the class was female and fifty-five percent were male.

Instrumentation

Students were tested using the course assessment instruments. These assessment instruments were four exams constructed by the course directors for the current academic year. For the 2011-2012 academic year, four exams were constructed by the course directors, and delivered as in-class exams using the secure server. The first exam consisted of sixty-five multiple choice questions covering the Back and Upper Limb, followed by the Thorax and Abdomen with sixty-six multiple choice items, the third exam covering the Pelvis had thirty-six multiple choice items, and the last exam covering the Head and Neck had sixty-nine multiple choice items. In the 2012-2013 academic year the first exam consists of sixty-four multiple choice items and covers the Back and Upper Limb, followed by the Thorax and Abdomen with sixty-nine multiple choice items, Pelvis covering thirty-nine items, Head and Neck exam had seventy-seven items, and finally the Lower Limb exam had thirty-eight multiple choice items.

For the 2011-2012 academic year all of the exams were given in the Medical Biomolecular Research building for standardization the same proctors monitored all exams in the large hall. In the 2012-2013 academic year all of the exams were given in six Berryhill lab

rooms. For standardization, each exam room was monitored by the same proctor throughout the course for all four of the secure exams. Both years exams were given on the secure MedStars exam system, a proprietary exam system at the University Of North Carolina School Of Medicine.

Procedures

To obtain the information needed for the study, the Applications Technologist in the Office of Medical Education at the University of North Carolina School of Medicine was contacted for the raw data. Student information was de-identified. Information extracted from the database included final incoming MCAT score, age at matriculation, gender and scores on exams for the Structure and Development course for the year the student took the course. For a baseline comparison the student groups were based on the final incoming MCAT score for each student.

After obtaining the exam scores for each student were averaged and then the mean for each group calculated, an independent samples t-test analysis was conducted to compare the two groups of students. Since the objective of this study is to compare the means on two independent groups, in this case the 2011-2012 academic year of student achievement in the Structure and Development course to the 2012-2013 academic year that were altered by the manipulation of using Team-Based Learning as the independent variable thus an independent samples t-test was completed (Fraenkel, Wallen & Hyun, 2012). Independent-samples t-test evaluates the difference between two independent groups and evaluates whether the means values of the test variable differs significantly from the mean value from the second group (Green & Salkind, 2005).

The study used a Casual-Comparative Research Design. The method of study uses a categorical variable which is the independent variable and the dependent variable is the student achievement which is a quantitative measure. A Casual-Comparative study was used to try to determine the consequences of differences in exam scores that already exist between two groups of students (Fraenkel, Wallen & Hyun, 2012). The manipulated variable is the method of instruction. To match students a multi-layer sort of the de-identified was sorted by academic year, followed by gender then age and finally MCAT Score. The data was then matched on gender, age and final score received on the MCAT. To better control for variables that might influence students' scores the match of gender, age, and final incoming MCAT score enabled a closer baseline to compare student performance.

Threats of maturation will be controlled due to the fact that the information will be given out equally to students so all have the same chance to learn the information over the given period. Instrumentation will be controlled because students for both academic years will take similar exams over the course constructed by the same course directors. Subject characteristics were controlled as much as possible due to the matching of gender and age of subjects; however, other characteristics are not accounted for and cannot be accounted for because the selection of students was not randomly selected. Location can be controlled to some extent because the exam procedures are the same for both locations of the exams however the physical location of the exams is different.

Analysis

Data obtained was sorted by year, then by gender and then by MCAT score. Individuals were matched based upon gender, age and MCAT score. If more entries matched in one year

than the other a random match was selected. Scored for each entry were averaged and analyzed using an independent samples t-test.

Limitations

Since the sample groups are two class years at the University of North Carolina School of Medicine there is a lack of randomization because the groups were previously selected. The subject characteristics may pose a threat because the researcher did not have a say in the selection and formation of the groups (Fraenkel, Wallen & Hyun, 2012). Due to the nature of education, educational research must rely on preexisting groups because students are not randomly assigned to treatments. Therefore, groups may not be exactly equivalent so matching subjects based off of MCAT score, gender, and age as often as possible to make group comparisons as similar as possible. Even though establishing a match of students between academic years does not guarantee that the match of students are equivalent. Other factors such as students completing the course in different years and the makeup of the student group may influence test scores.

CHAPTER 4

Results

In this chapter, the results of the data analysis are presented. The data was collected and then processed to answer if the use of Team-Based Learning as a method of delivering instruction was more effective in regards to student achievement than the traditional didactic lecturing method.

Description of Sample

For the sample used in this study 66 pairs of students were analyzed. The pairs of students that were compared were comprised of a student from the 2011-2012 academic year and one student from the 2012-2013 academic year. These students were matched and paired for comparison based on their age at matriculation, the final MCAT score when entering and the gender of the student. Not all students from each of the two academic years are represented in the sample due to the inability to match all students to a corresponding student in the other academic year.

Of the 66 pairs of students, 32 pairs were females ranging from 21 years of age to 30 years of age and MCAT scores ranging from 29-38. The remaining 34 pairs were males ranging from 22 years of age to 31 years of age at matriculation. The male MCAT scores ranged from 29-39. The full table of the sample of students used and paired can be found in Appendix A.

Table 1

Description of Data

Gender	Number of Pairs	Age Range	MCAT Range
Female	32	21-30	29-38
Male	34	22-31	29-39

An independent samples t-test was conducted to analyze the data. In order to complete the t-test, information was collected from the Applications Technologist at the University of North Carolina School of Medicine from the School of Medicine's database of student information. This information was de-identified, sorted and matched. The data was then put into SPSS to complete the t-test.

Findings from Data

No significant difference was found between the 2011-2012 academic year of lecture method of instruction (M=86.07, SD=6.6) compared to the 2012-2013 academic year of instruction with Team-Based Learning (M=85.57, SD=4.6); t(116)=.504, p = .615. Results are shown in Table 2 below.

Table 2

Independent Samples T-Test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Avg	Equal variances assumed	9.678	.002	.504	130	.615	.501856060606153	.995165555821416	-1.466959975206310	2.470672096418416
	Equal variances not assumed			.504	115.714	.615	.501856060606153	.995165555821416	-1.469246085590396	2.472958206802502

These results suggest that Team-Based Learning method of instruction did not significantly improve student achievement on exams compared to the lecture method of instruction. The results suggest that no differences exist and did not detect any difference between the groups of students and a null hypothesis is confirmed.

Table 3

Group Statistics

Academic Year	N	Mean	Std. Deviation	Std. Error Mean
2011-2012	66	86.067575757575850	6.645679943937323	.818026652870781
2012-2013	66	85.565719696969810	4.604164852967287	.566733516466471

According to Table 3 the mean on the exam scores from the 2012-2013 academic year did decrease by 0.502 the difference in the standard deviation did also decrease by 2.04 points. The range of students' scores decreased significantly from the 2011-2012 academic year to the 2012-2013 academic year where the Team-Based Learning method of instruction was used. However, the decrease in the standard deviation suggests that the students who are academically challenged are closer to the mean of students when using the Team-Based Learning method of instruction.

Summary

Due to the results showing no statistical difference in the exam scores from the students from the 2011-2012 academic year and the 2012-2013 academic year it can be determined that the use of Team-Based Learning as an instructional method does not provide a greater achievement level for students.

CHAPTER 5

Discussion and Future Research

This study intended to find if there was significant difference in the method of instruction and the achievement of students on exams based on the method of instruction received. This study's findings would help to determine if the use of Team-Based Learning, a flipped classroom method, resulted in higher achievement for students in the Medical School. The results for this study do not indicate a different in achievement. From the 66 pairs of students that were analyzed in this study it is clear that no matter the method of instruction either lecture method or Team-Based Learning method students will still achieve approximately the same results on exams. The results of this study are similar to the results of the Introductory Biology course studied by Carmichael in 2009 where the exam scores did not drastically differ from year to year. Carmichael notes that the scores may not differ do to prior knowledge of the subject. However, this study does differ from Koles et al. in 2010 who found that TBL helped medical student to achieve higher scores on the National Board exams.

The findings from the study indicate that there is no statistical significance in the differences in average exam scores of students from the 2011-2012 academic year to the 2012-2013 academic year in the Structure and Development course at the University of North Carolina School of Medicine. Therefore the hypothesis the use of Team-Based Learning will increase the student exam scores because of the prescribed method of instruction and interactions between students will deepen the learning is rejected.

Even though this study did not find that the Team-Based Learning method of instruction had significant impact on student achievement it could be due to instructor preparedness or execution of the lesson. Faculty must also become comfortable with the procedures and accept

small failures in the first attempts of the process. Faculty buy-in and attitude toward the method also limit the effectiveness of the method (Thompson et al, 2007) Although the results do not support the hypothesis of overall higher achievement on exam scores, some students may have benefited from the use of Team-Based Learning as a method of instruction.

Referring to table 2 supports the findings of Koles et al in 2010 who found that students who have used the Team-Based learning method have greater mastery and retention of course content, and academically "at-risk" students have greater achievement levels.

Recommendations

Since the prescribed method of Team-Based Learning is new to the instructors and not a familiar method of instruction, it would be beneficial to have the instructors reflect on their practice and determine where they could improve their delivery of the material to be more effective. Once a faculty member understands the method it will work effectively. Thus, repeated exposure and quality training is important. Faculty must also become comfortable with the procedures and accept small failures in the first attempts of the process (Thompson et al, 2007). Since this was the first attempt at the use of Team-Based Learning, it would be recommended to continue to use the method for additional years or in additional classes for instructors to become more comfortable using the method.

The steps involved in Team-Based Learning may not have been followed completely in every small group classroom that instructors could use a refresher course in how to complete the method effectively. Differences between rooms of instructors could have existed even though Team-Based Learning does have a very prescribed method of instruction. Instructors could gather to discuss what practices were completed in each room and how these could become more similar and more effective.

Further Research

Due to the small sample size of the study comparing one year of results it would be useful to compare the data for more than one year. For example, if an expansion of the sample size to wider range of similar students would yield similar results.

Since the instructors are still learning the best way to conduct a session using the Team-Based Learning method it would imply that more practice with the method the instructors would become more comfortable with the steps and thus more effective teachers. To continue to look at the method and the student examination scores for multiple years would see if the effectiveness of the instructors increased student achievement.

There is still not a lot of information about the effectiveness of Team-Based Learning on Medical Education, so continuing to research the method in the field would be useful in regard to whether this method should be used instead of the lecture method. A study that looked at the information that students from these two academic years remembered 5 years after taking the course to determine the long term retention of information would be beneficial. The long term effects of Team-Based Learning have not been researched in-depth because the method of instruction for Medical Education realms is still a new concept.

To further the study done by Grady (2011) on student feelings about the method of instruction would be another area to explore. Student's feelings on the advantages and disadvantages of the Team-Based Learning method of instruction in addition to the qualitative study would provide the researcher information about student perceptions compared to their achievement. Grady (2011) suggested that students do not feel as if they are being taught and are learning the material on their own.

Summary

This quantitative study explored the use of Team-Based Learning method of instruction compared to the traditional lecture method. Due to the small sample size and only one year of instructors having experience with Team-Based Learning the results did not show an increase in student achievement on exam scores. Further investigation into the use of Team-Based Learning as a method of instruction is needed to determine if it is an effective method for use in a state university medical education anatomy class.

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Appendix A

Student Sample Data

ID	Gender	Age @ matriculation	Total MCAT	Academic Year	e1	e2	e3	e4
216	F	21	31	2011-12	90.77	84.62	88.89	92.75
148	F	21	31	2012-13	84.38	85.51	87.18	89.47
254	F	22	29	2011-12	83.08	66.15	91.67	79.71
69	F	22	29	2012-13	93.75	78.26	84.62	82.89
322	F	22	30	2011-12	92.31	89.23	94.44	91.3
169	F	22	30	2012-13	90.63	84.06	82.05	90.79
304	F	22	31	2011-12	81.54	52.31	94.44	76.81
330	F	22	31	2011-12	83.08	80	88.89	88.41
19	F	22	31	2012-13	78.13	73.91	87.18	75
22	F	22	31	2012-13	82.81	66.67	97.44	76.32
348	F	22	32	2011-12	96.92	95.38	100	97.1
219	F	22	32	2012-13	85.94	89.86	87.18	93.42
321	F	22	33	2011-12	93.85	87.69	94.44	89.86
326	F	22	33	2011-12	87.69	86.15	94.44	82.61
50	F	22	33	2012-13	93.75	88.41	94.87	80.26
84	F	22	33	2012-13	84.38	69.57	89.74	84.21
318	F	22	34	2011-12	93.85	83.08	91.67	91.3
319	F	22	34	2011-12	86.15	83.08	80.56	81.16
129	F	22	34	2012-13	89.06	66.67	82.05	88.16
186	F	22	34	2012-13	98.44	89.86	87.18	92.11
161	F	22	35	2011-12	78.46	70.77	75	79.71
334	F	22	35	2011-12	95.38	90.77	100	86.96
119	F	22	35	2012-13	96.88	82.61	84.62	86.84
150	F	22	35	2012-13	93.75	86.96	79.49	89.47
339	F	22	38	2011-12	93.85	95.38	88.89	89.86
195	F	22	38	2012-13	90.63	91.3	94.87	92.11
210	F	23	31	2011-12	96.92	89.23	80.56	91.3
244	F	23	31	2011-12	86.15	93.85	97.22	88.41
250	F	23	31	2011-12	83.08	69.23	83.33	82.61
305	F	23	31	2011-12	92.31	90.77	94.44	89.86
9	F	23	31	2012-13	82.81	73.91	69.23	72.37
30	F	23	31	2012-13	82.81	84.06	79.49	77.63
35	F	23	31	2012-13	81.25	82.61	82.05	78.95
112	F	23	31	2012-13	92.19	75.36	76.92	86.84

ID	Gender	Age @ matriculation	Total MCAT	Academic Year	e1	e2	e3	e4
240	F	23	32	2011-12	81.54	72.31	83.33	81.16
277	F	23	32	2011-12	98.46	95.38	100	86.96
128	F	23	32	2012-13	89.06	85.51	92.31	88.16
165	F	23	32	2012-13	95.31	85.51	89.74	90.79
238	F	23	33	2011-12	86.15	81.54	91.67	85.51
271	F	23	33	2011-12	95.38	96.92	88.89	89.86
342	F	23	33	2011-12	87.69	87.69	77.78	84.06
36	F	23	33	2012-13	90.63	82.61	84.62	78.95
151	F	23	33	2012-13	90.63	86.96	92.31	89.47
171	F	23	33	2012-13	90.63	86.96	82.05	90.79
251	F	23	34	2011-12	81.54	76.92	88.89	82.61
81	F	23	34	2012-13	92.19	72.46	89.74	84.21
350	F	24	29	2011-12	80	80	86.11	84.06
58	F	24	29	2012-13	82.81	82.61	79.49	81.58
214	F	24	31	2011-12	90.77	90.77	94.44	91.3
166	F	24	31	2012-13	84.38	62.32	84.62	90.79
268	F	24	32	2011-12	87.69	93.85	97.22	82.61
44	F	24	32	2012-13	89.06	78.26	87.18	80.26
335	F	24	33	2011-12	96.92	93.85	97.22	94.2
80	F	24	33	2012-13	96.88	85.51	87.18	84.21
295	F	25	29	2011-12	78.46	84.62	91.67	75.36
11	F	25	29	2012-13	84.38	71.01	87.18	72.37
293	F	25	30	2011-12	84.62	89.23	77.78	85.51
76	F	25	30	2012-13	81.25	81.16	92.31	84.21
263	F	26	25	2011-12	83.08	83.08	72.22	82.61
74	F	26	25	2012-13	85.94	82.61	87.18	84.21
264	F	26	34	2011-12	93.85	86.15	100	89.86
82	F	26	34	2012-13	68.75	81.16	92.31	84.21
198	F	30	27	2011-12	93.85	84.62	80.56	78.26
121	F	30	27	2012-13	92.19	82.61	89.74	86.84
285	M	21	35	2011-12	81.54	81.54	83.33	71.01
100	M	21	35	2012-13	78.13	91.3	69.23	85.53
42	M	22	27	2011-12	58.46	72.31	69.44	72.46
201	M	22	27	2011-12	93.85	90.77	91.67	94.2
92	M	22	27	2012-13	82.81	76.81	94.87	85.53
103	M	22	27	2012-13	89.06	78.26	76.92	85.53
176	M	22	31	2011-12	83.08	69.23	77.78	73.91
79	M	22	31	2012-13	92.19	71.01	89.74	84.21

ID	Gender	Age @ matriculation	Total MCAT	Academic Year	e1	e2	e3	e4
203	M	22	32	2011-12	89.23	83.08	86.11	94.2
303	M	22	32	2011-12	89.23	93.85	97.22	86.96
147	M	22	32	2012-13	87.5	85.51	89.74	89.47
257	M	22	32	2012-13	100	94.2	92.31	96.05
239	M	22	33	2011-12	90.77	76.92	88.89	75.36
317	M	22	33	2011-12	96.92	95.38	88.89	88.41
164	M	22	33	2012-13	90.63	85.51	94.87	90.79
168	M	22	33	2012-13	87.5	84.06	89.74	90.79
208	M	22	34	2011-12	93.85	84.62	88.89	85.51
138	M	22	34	2012-13	82.81	85.51	79.49	88.16
215	M	22	35	2011-12	73.85	81.54	88.89	81.16
237	M	22	35	2011-12	92.31	73.85	97.22	85.51
281	M	22	35	2011-12	90.77	86.15	88.89	85.51
29	M	22	35	2012-13	87.5	79.71	87.18	77.63
61	M	22	35	2012-13	81.25	76.81	89.74	81.58
115	M	22	35	2012-13	68.75	78.26	79.49	86.84
213	M	22	39	2011-12	84.62	64.62	83.33	76.81
111	M	22	39	2012-13	100	91.3	76.92	86.84
247	M	23	30	2011-12	93.85	86.15	86.11	86.96
188	M	23	30	2012-13	89.06	81.16	84.62	92.11
309	M	23	31	2011-12	89.23	83.08	75	79.71
132	M	23	31	2012-13	93.75	94.2	76.92	88.16
226	M	23	32	2011-12	61.54	64.62	66.67	78.26
248	M	23	32	2011-12	86.15	89.23	88.89	73.91
276	M	23	32	2011-12	76.92	76.92	86.11	81.16
21	M	23	32	2012-13	82.81	81.16	74.36	76.32
68	M	23	32	2012-13	93.75	85.51	82.05	82.89
130	M	23	32	2012-13	92.19	89.86	97.44	88.16
307	M	23	33	2011-12	92.31	96.92	94.44	91.3
99	M	23	33	2012-13	87.5	85.51	92.31	85.53
313	M	23	36	2011-12	86.15	76.92	91.67	82.61
78	M	23	36	2012-13	95.31	91.3	89.74	84.21
270	M	23	37	2011-12	90.77	93.85	97.22	85.51
190	M	23	37	2012-13	95.31	91.3	79.49	92.11
206	M	23	38	2011-12	87.69	61.54	66.67	75.36
85	M	23	38	2012-13	95.31	88.41	94.87	84.21
127	M	24	29	2011-12	83.08	76.92	77.78	84.06
135	M	24	29	2012-13	92.19	78.26	84.62	88.16

ID	Gender	Age @ matriculation	Total MCAT	Academic Year	e1	e2	e3	e4
175	M	24	30	2011-12	96.92	96.92	100	95.65
298	M	24	30	2011-12	95.38	92.31	88.89	86.96
10	M	24	30	2012-13	81.25	69.57	84.62	72.37
47	M	24	30	2012-13	78.13	72.46	76.92	80.26
343	M	24	32	2011-12	92.31	81.54	88.89	84.06
116	M	24	32	2012-13	90.63	85.51	84.62	86.84
200	M	24	34	2011-12	93.85	84.62	94.44	86.96
144	M	24	34	2012-13	92.19	86.96	92.31	89.47
233	M	24	35	2011-12	95.38	87.69	80.56	92.75
96	M	24	35	2012-13	95.31	88.41	79.49	85.53
125	M	24	39	2011-12	83.08	87.69	86.11	81.16
4	M	24	39	2012-13	87.5	85.51	76.92	68.42
333	M	25	29	2011-12	92.31	92.31	94.44	89.86
289	M	25	29	2012-13	100	98.55	89.74	97.37
266	M	25	32	2011-12	92.31	87.69	94.44	88.41
106	M	25	32	2012-13	92.19	89.86	89.74	86.84
242	M	25	33	2011-12	81.54	75.38	83.33	69.57
63	M	25	33	2012-13	96.88	81.16	97.44	82.89
209	M	28	32	2011-12	83.08	69.23	86.11	84.06
70	M	28	32	2012-13	87.5	73.91	82.05	82.89
290	M	31	39	2011-12	96.92	90.77	94.44	84.06
149	M	31	39	2012-13	87.5	92.75	87.18	89.47