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ACCEPTANCE

This thesis, PROBLEM-BASED LEARNING AS A TEACHING METHOD VERSUS LECTURE-BASED TEACHING IN RESPIRATORY THERAPY EDUCATION, by Bandar Almasoudi was prepared under the direction of the Master's Thesis Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Master's of Science in the Byrdine F. Lewis School of Nursing and Health Professions, Georgia State University.

The Master's Thesis Committee, as representative of the faculty, certifies that this thesis has met all standards of excellence and scholarship as determined by the faculty.

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ABSTRACT

PROBLEM-BASED LEARNING AS A TEACHING METHOD VERSUS LECTURE-BASED TEACHING IN RESPIRATORY THERAPY EDUCATION

By

Bandar M. Almasoudi

BACKGROUND: Although Problem-based learning (PBL) approach is a common teaching technique in medical education, its use in the field of respiratory therapy is somewhat controversial. With so many programs adopting PBL strategies, it is important to examine whether there are differences between PBL and traditional teaching approaches in regards to learning outcomes. Therefore, the purpose of this study was to investigate if there are any significant differences between PBL and lecture-based program students in their cognitive abilities in mechanical ventilation.

METHODS: Two universities with BS programs in respiratory therapy were chosen—one uses PBL (15 participants) and on uses lecture-based method (24 participants). All 39 participants were given10 multiple-choice questions related to mechanical ventilation derived from the NBRC RRT written exam forms (C & D) as a pre and a post test.

RESULTS: The dependent *t*-test showed a significant difference between the pre and post test of the lecture-based and the PBL groups, resulting in a p value of 0.006 and 0.025 respectively. The independent *t*-test showed a significant difference in the pre-test favoring the lecture-based group ($p = 0.039$). However, the independent *t*-test showed no significant difference in the post-test ($p=0.085$)

CONCLUSIONS: PBL is increasing in popularity despite the fact that studies of its efficacy have been thus far inconclusive. This study has shown PBL to be effective, but not significantly more effective than traditional lecture-based methods in regards to objective test scores.

PROBLEM-BASED LEARNING AS A TEACHING METHOD VERSUS LECTURE-BASED TEACHING IN RESPIRATORY THERAPY EDUCATION

By

Bandar M. Almasoudi

A Thesis

Presented in Partial Fulfillment of the Requirement for the

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2012

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ABBREVIATIONS

CPR	Cardiopulmonary Resuscitation
CSE	Clinical Simulation Examination
DM	Decision-Making
GSU	Georgia State University
GPA	Grade Point Average
MCAT	Medical College Admission Test
MU	University of Missouri–Columbia
NBRC	National Board for Respiratory Care
PASW	Predictive Analytics Software
PBL	Problem-based Learning
RRT	Registered Respiratory Therapist
R-SPQ-2F	Revised Two-Factor Study Process Questionnaire
USA	University of South Alabama
USMLE	United States Medical Licensing Examination
SDLI	Self-Directed Learning Instrument
SDLRS	Self-Directed Learner Readiness Scale

CHAPTER I

INTRODUCTION

Health care professionals, including respiratory therapists, are increasingly in demand in the United States due to the steady growth in the number of patients presenting themselves to the healthcare system (Andrews, Byington, Masini, Keene, & Burker, 2008). Respiratory therapy schools are trying to meet these demands through various instructional methodologies. Projections of the continuing need for healthcare professionals in the coming decades makes an examination of these teaching and learning methods used in respiratory therapy education programs necessary (Op't Holt, 2000). Because this increasing demand for healthcare professionals is not currently being met through traditional educational means, an exploration of alternative teaching techniques is needed (Murphy, Hartigan, Walshe, Flynn, & O'Brien, 2011). In a series of conferences, professionals and practitioners have discussed the challenges and changes that need to be made to the current curricula to produce competent respiratory therapists for the future (Barnes, Gale, Kacmarek, & Kagler, 2010). Respiratory therapists have become increasingly responsible for assessing their patients' conditions, making judgments about the appropriate courses of treatment, evaluating the effectiveness of treatments, and modifying the treatment plan where necessary. Hence, these therapists must have a higher level of critical thinking and problem-solving skills than ever before (Hill, 2002).

Respiratory Therapy Education

Respiratory therapists are professionals who assess, cure, and take care of patients who present with breathing and other cardiopulmonary problems. Respiratory therapists work under the supervision of physicians, but they take chief responsibility for all treatments and procedures related to respiratory care. They work hand-in-hand with doctors and other healthcare personnel

to create specialized treatment regimens for their patients. They also offer multifaceted therapies that require independent judgment and reasoning, for instance, caring for patients in intensive care units. Because of their critical role, respiratory therapists require effective education and training programs, and all respiratory therapists must have at least an associate's or bachelor's degree. The aim of this paper is to compare and contrast the problem-based learning (PBL) approach with the traditional lecture-based teaching approach, with a special focus on respiratory therapy education.

In the beginning, the early training programs for respiratory therapists took place in hospital settings where the educators were practitioners and physicians. These programs typically lasted less than a year. Over time, respiratory therapy programs were transitioned to accredited colleges as undergraduate programs, and they are now taught by practitioners who are well-trained educators. These programs must teach respiratory therapists to think critically and make decisions rather than simply following a physician's orders (Hill, 2002). This need for respiratory therapy students to develop critical-thinking skills has been linked to the potential enhancement of clinical decision-making under the premise that there is a connection between universal critical thinking and decision-making in respiratory therapy (Ceconi, Op't Holt, Zip, Olson, & Beckett, 2008; Hill, 2002; Mishoe, 2002).

Background

PBL emerged as a common teaching technique for use in medical education in the late 1960s at McMaster University Medical School in Canada. PBL is an instructional strategy that uses small groups that attend a series of sessions. PBL is defined as "…an instructional method characterized by the use of patient problems as a context for students to learn problem-solving skills and acquire knowledge about the basic and clinical sciences" (Albanese & Mitchell, 1993,

p. 53). According to Evensen and Hmelo (2000), PBL came out of constructivist theory of education, which states that learning is active knowledge development rather than the passive absorption of information. Authors who have studied constructivist theory suggest that the interactive nature of PBL fosters a greater incorporation of new information into existing knowledge in order to create new ideas and concepts (Beachey, 2007).

Traditional classroom curricula emphasize the presentation of content information through a lecture format whereas the PBL method relies on the introduction of real-life problems as a means to facilitate self-directed learning (Beachey, 2007). PBL shifts the learning environment from a faculty-centered approach to a student-centered process (Mishoe, 2007). In a PBL classroom, the student becomes a partner in the learning process by utilizing real-life scenarios to recognize what they know and what they need to know to understand the situation, thus creating their own knowledge. This approach gives the student the responsibility for analyzing information and communicating it to other students in class (Beers, 2005).

Advocates believe that PBL enhances critical-thinking and decision-making skills, and thus that it should be part of respiratory therapy education programs (Ceconi et al., 2008; Mishoe, 2002). PBL has also been incorporated into the curricula for nursing (Benner, 1984) and other allied health professions such as occupational therapy (Royeen, 1995) and physiotherapy (Solomon, 1994). Literature suggests that the goal of this integration is to develop illustrative models and learning cues that can be utilized for rapid recall in clinical contexts by practicing professionals (White et al., 2004).

While a PBL approach is common in medical education, its use in the field of respiratory therapy is somewhat controversial (Mishoe, 2002). The PBL approach was introduced to respiratory therapy education as an alternative teaching method to the traditional lecture-based

teaching approach in 1993 (Mishoe, 2007). Since that time, literature regarding the efficacy of PBL for teaching respiratory therapy has been mixed. Proponents claim there are significant benefits (Ceconi et al., 2008; Mishoe, 2007; Op't Holt, 2005), while others claim that it is no better than traditional approaches to learning (Beachey, 2007).

Statement of the Problem

In respiratory therapy, educational programs must prepare students to pass the National Board for Respiratory Care (NBRC) Clinical Stimulation examination and other standardized tests to demonstrate competence in the field. With so many programs adopting PBL strategies, it is important to examine whether there are differences between PBL and traditional teaching approaches in regards to learning outcomes. In addition, if these differences exist, the question remains whether or not they are significant enough to justify changes in the curricula.

The research question of this study was:

> Are there any significant differences between PBL and traditional program students in their cognitive abilities in mechanical ventilation? Specifically, are there any differences in a pre- and post-test between students in a BS program with PBL and students in a BS program that uses traditional educational methods?

This study is the first to specifically compare the teaching methods of two different respiratory therapy programs in regards to mechanical ventilation. This study will add to the limited number of studies that have focused on respiratory therapy education.

Limitations of the Study

This study was limited by the lack of prior comprehensive research in respiratory therapy education that has focused on the PBL versus the traditional lecture-based learning approach. As a result, relevant literature sources for the study were limited, making it difficult to conduct a more extensive study of the topic.

In summary, this chapter describes the need to investigate the effectiveness of PBL as an alternative method to teaching respiratory therapy.

CHAPTER II

LITERATURE REVIEW

This literature review provides a summary of what is known to date regarding PBL when compared to traditional teaching. This chapter is organized as follows: introduction, PBL in medical education, PBL in nursing education, PBL in respiratory therapy education, and conclusion. A computerized search of the CINAHL, CINAHL Plus with Full Text, Academic Search Complete, MEDLINE, MEDLINE with Full Text, Cochrane Library, Nursing & Allied Health Source, PubMed, and ScienceDirect databases was conducted using the following key words: problem based learning, problem-based learning and medicine, problem based learning and nursing, and problem based learning and respiratory therapy. The Georgia State University (GSU) computerized library catalog was searched using the following key words: problem based learning, problem based learning and medical education, problem based learning and nursing, problem based learning and respiratory therapy. References in current scholarly journals and research articles were pursued as well.

Introduction

A number of studies have shown the importance of education and the role that instructional design and pedagogy play in skills and knowledge acquisition. Schneeberger (1999) determined that “the transition from school to working life has acquired a new dimension for education policy and research” (p. 612). This may be especially true in the medical field, since it is projected to be a field that will continue to grow over the next few decades.

Several medical schools have implemented changes to their curricula in order to facilitate the teaching necessary for students to bridge the gap between classroom learning and real-world problem-solving. It is now estimated that in the United States alone, more than 80% of medical

schools have included some type of problem-based learning (PBL) in their curricula (Hoffman, Hosokawa, Blake, Headrick, & Johnson, 2006). For example, one of the first schools that switched from traditional teaching methods to the problem-based method was the medical school at the University of Missouri–Columbia (MU). According to Hoffman et al., MU's pioneering curriculum teaches medicine by using clinical cases, which has shortened by nearly 60% the amount of time spent in lectures as well as decreasing the amount of rote memorization.

PBL was first introduced as a student-centered instructional theory in the MD program at McMaster University in Canada in the late 1960s. At that time, "it heralded a major change in medical school pedagogy that has influenced the education of medical students around the world" (Neville & Norman, 2007, p. 370). The McMaster PBL curriculum emphasized small-group tutorials, self-directed learning, a minimal number of didactic presentations, and student evaluations based on how the students perform in the tutorial (Neville & Norman, 2007). The PBL approach at that time (and even currently) was a dramatic change from the traditional teaching methodology, especially in the field of medical studies.

For more than 50 years, scholars have been debating whether PBL is more effective than a traditional educational model (Colliver, 2000). So far, this question remains unresolved. PBL started in medical settings but has since been adopted by other disciplines as well (Baker, 2000). Even so, its efficacy remains questionable (Colliver, 2000). This literature review examines the effectiveness of this learning approach when used to teach physicians, nurses, and respiratory therapists.

PBL in Medicine

Predicated on the notion that change was needed specifically in medical education, PBL was designed to enhance self-directed learning and continuing education skills to allow for professional growth (Barrows, 1996).

In a 1993 meta-analysis, Albanese and Mitchell concluded that PBL fosters a deep approach to learning, especially in medical education. The authors reviewed the English-language international literature from 1972 to 1992 to evaluate the effectiveness of PBL in medical education. Most of the studies they found that compared PBL to conventional instruction focused on the change in knowledge and performance levels that occur with PBL. However, no significant differences between the knowledge that PBL students and traditional students acquired through science courses were found. In general, across this review, PBL graduates performed as well as their traditional lecture-based counterparts, and students taught through PBL sometimes did better on clinical examinations and clerkship performance measures (Albanese & Mitchell, 1993).

Albanese and Mitchell (1993) also found that in a few studies, PBL students scored *lower* on basic science and PBL students felt that they were less prepared than the traditional students in basic science. In two studies, PBL students scored lower on tests of medical knowledge (de Vries, Schmidt, & de Graaf, 1989; Schmidt, Dauphinee, & Patel, 1987). In one study, PBL graduates' engagement in reasoning seemed to be backwards, and gaps in their cognitive knowledgebase that might affect the outcomes of practice were reported (Albanese & Mitchell, 1993). On the other hand, PBL students reported greater satisfaction and motivation in their educational experience and rated their programs higher than their traditional lecture-based counterparts (Albanese & Mitchell, 1993; de Vries et al., 1989; Schmidt et al., 1987).

Other studies similarly have found PBL to be more nurturing and enjoyable for both students and faculty (Albanese & Mitchell, 1993; Colliver, 2000). In addition, some studies have found that PBL student attitudes toward learning changed. PBL students at Harvard University Medical School, for instance, reported their studies to be more engaging, difficult, and useful than non-PBL students (Albanese & Mitchell, 1993). Unlike students who were taught through a lecture-based format, Bransford, Franks, Vye, and Sherwood (1989) reported that learning in a problem-solving context, such as the PBL format, allowed graduates to spontaneously use this approach to solve new problems that they might face in their future career. A different study found that clinical competencies among students in a PBL environment were stronger than those in traditional settings, although the differences were small and non significant (de Vries et al., 1989).

A meta-analysis by Colliver (2000) on the effectiveness of PBL on knowledge acquisition and clinical performance focused on "(1) the credibility of claims (both empirical and theoretical) about the ties between PBL and educational outcomes and (2) the magnitude of the effects." (p, 259). Colliver reviewed medical education literature published between 1992 and 1998 and identified those publications that dealt with PBL versus traditional curricula in medical education. For each study that compared PBL to traditional teaching, Colliver summarized the study design, outcome measures, effect sizes, and any other information relevant to the research conclusion. In addition to being concerned with the small sample sizes used in the studies reviewed, Colliver concluded that no convincing evidence supports the superiority of PBL over a traditional teaching approach in regards to improving the students' knowledge base and clinical performance. Colliver expected that PBL students would have a significant advantage over their traditional peers due to the clinical application in the classroom and the extensive resources used

in the PBL format; yet these advantages were not found. Other studies, however, have found the opposite (Distlehorst et al., 2005; Hoffman et al., 2006).

After 10 years of administering PBL at the University of Missouri's School of Medicine, Hoffman et al. (2006) sought to examine the overall efficacy of PBL in their program curriculum. Hoffman and her research team believed that the PBL curriculum emphasized learning in tandem with practical problem solving. Hoffman's team also believed that PBL helps students access their own knowledge as well as grasp relevant information they will use in real practice. To discern the effects of PBL on medical students, the researchers divided the medical students into two categories: students learning via traditional teaching methods and students reliant on PBL. Hoffman's team used five indices to determine the potential outcomes: students' MCAT scores, their undergraduate GPA, students' performances on the USMLE (Step 1 and 2) exams, faculty contact hours, and the residency program director's evaluation of each student. Hoffman and her team concluded that traditionally trained students differed from PBL students and that PBL-trained graduates acquired skills needed for professional practice. This outcome, the team felt, was especially important given the complexities inherent in today's healthcare system. This finding is further supported by another study in which Distlehorst et al. (2005) compared the characteristics and outcome data of students from a single institution with a two-track—PBL and a conventional lecture-based—curriculum. The study's methodology involved two groups of students: a PBL group and a lecture-based group from nine graduating classes at the Southern Illinois University School of Medicine. The two groups were compared using common medical school performance outcomes (USMLE Step 1, USMLE Step 2, clerkship mean ratings, number of clerkship honors and remediation designations, and the senior clinical competency exam), as well as common admission and demographic variables. The authors

concluded that educational outcomes for the PBL and conventional lecture-based students were very positive. In addition, they found that PBL students performed significantly better in several clerkship performance measures. PBL students did not perform worse than their conventional lecture-based counterpart students in any of the study measures.

White et al. (2004), in comparison, found no significant differences between PBL and traditional teaching methods. In a randomized-controlled trial, White et al. investigated learning effectiveness of small-group PBL exercises compared to traditional didactic lectures. Both investigated groups used an evidence-based guideline on asthma management as the content to determine differences in continuing medical education learning by physicians. PBL or didactic educational models were randomly selected for sites. The same learning materials were given to both participating groups and were taught by the same physician. The authors found no evidence that PBL was superior to other learning styles in assisting family physicians in acquiring or retaining knowledge regarding asthma management. PBL participants rated their learning experience higher than non-PBL participants. Despite the study's small sample size (*N*= 53), this finding is consistent with the majority of studies that similarly have not found greater knowledge acquisition or retention amongst PBL students versus those taught via traditional methods (Colliver, 2000).

PBL in Nursing

The McMaster University School of Nursing also pioneered PBL curricula in nursing education. Subsequently, several nursing schools in the United States and in other countries (i.e., Australia, Japan, the U.K., China, South Africa, Thailand, and the Middle East) have adopted this approach to teaching to some degree (Baker, 2000). Studies of the efficacy of PBL in nursing education also have had mixed results. PBL advocates support its superiority, while

proponents of other methods claim that PBL shows no differences in student learning than traditional teaching methods.

Hwang and Kim (2006) conducted one of these studies that has shown a significant relationship between PBL and the clinical knowledge scores of students compared to their counterparts who received traditional lecture-based methods. These advantages included the acquisition and retention of information regarding basic clinical reasoning, clinical knowledge, and independent learning. These findings have been further supported by other recent studies.

In 2010, Szogedi, Zrinyi, Betlhem, Ujvarine, and Toth compared PBL's effectiveness to that of traditional learning when training nurses. The study involved 1,775 nurses who had received cardiopulmonary resuscitation training (CPR) at three major universities in Hungary. A retrospective and a comparative analysis were used. The researchers collected CPR final exam grades of PBL students and traditional students between 2000 and 2007 and compared outcomes between the two groups of students. The researchers relied on *t*-tests and exam grades. The *t*-tests yielded significant differences ($t = 3.569$; $p < 0.001$) between conventionally trained and PBL students. The students who received PBL training had higher final CPR exam grades than their counterparts and appeared to acquire more theoretical knowledge and skills. Thus, the researchers concluded that PBL is superior to the traditional method of learning for CPR training.

In another study with similar results, Gabr and Mohamed (2011) assessed the effect of PBL on undergraduate nursing students enrolled in a nursing administration course at Mansoura University in Egypt. Using an experimental comparative research design, the researchers divided a total of 260 nursing students into two equal groups: a control group and an experimental group. Data were collected using four indices: the Self-Directed Learner Readiness Scale (SDLRS), five

problem-solving scenarios related to managerial skills, a students' problem-solving evaluation sheet, and a students' opinion questionnaire sheet. Gabr and Mohamed found a significant difference in knowledge, problem-solving grades, and self-directed learning, with the PBL group scoring higher than the non-PBL group ($p < 0.05$). The study concluded that the PBL learning strategy had a positive effect on knowledge and skills acquisition. The study reported that the PBL students gain more knowledge and were more motivated to learn than their non-PBL counterparts. Gabr and Mohamed concluded that PBL is a powerful approach to learning for nursing students seeking practical problem-solving experience and self-directed learning.

In Saudi Arabia, Mohamed Ali and El Sebai (2010) investigated the effect of PBL on 30 female nursing students' learning approaches and self-directed learning abilities. Their quasi-experimental design was based on before-and-after effects using the Revised Two-Factor Study Process Questionnaire (R-SPQ-2F) and the Self Directed Learning Instrument (SDLI) to compare students' approaches to learning and self-directed learning abilities before and after PBL. Not only did the results indicate that the post-test mean score was significantly higher than the pre-test ($p = 0.001$), but the results of self-directed learning abilities also increased after the PBL course ($p = 0.003$). The researchers concluded that the successful introduction of PBL to nursing education improves professional performance.

Not all studies have found a positive link between PBL and improved skills or knowledge acquisition. For example, when investigating the effect of teaching method on objective test scores in a school of nursing, Beers (2005) found that PBL is no different than traditional teaching. Using a pre- and post-test, Beers (2005) examined the test scores of two groups of students enrolled in an Adult Health I nursing course. One group was taught content on diabetes using a PBL format ($n = 36$), and the other group was taught the same content using a traditional

lecture method (n = 18). The pre- and post-test were compared using an independent t-test. The study found no statistically significant differences between the two groups. Beers concluded that PBL is equally as effective as traditional teaching for student learning. Further, Applin, Williams, Day, and Buro (2011) sought to determine if PBL training versus a traditional model had any effect on students' self-perceptions about their own competencies. Applin's team employed a qualitative, comparative descriptive research design. Using a survey that included both forced-choice and open-ended questions, the team collected self-reports from 121 nurses in Canada who each had six months of practical experience. The researchers found no empirical differences between PBL students and their traditionally trained counterparts. However, PBL students rated their programs higher in preparing them for entry-to-practice competencies.

As these various research findings show, the efficacy of PBL as a teaching approach is unclear. As Beers (2005) pointed out, to justify the extensive resources that are required to implement a PBL curriculum, one would expect significant improvement in clinical knowledge and performance. Empirical studies, however, are mixed in this regard.

PBL in Respiratory Therapy Education

The PBL approach is relatively new to respiratory therapy education (Op't Holt, 2005). This approach was introduced to the field in 1993 with the rationale that it would improve the critical-thinking and decision-making skills of practitioners through the direct application of theory to practice (Mishoe, 2007). Advocates felt that PBL students were more likely to continue learning through a self-directed process and to advance in their field further and more quickly than their traditional counterparts (Mishoe, 2007). Promoters of PBL also feel it helps students pass the National Board for Respiratory Care examination (NBRC) Clinical Simulation Examination (CSE) (Op't Holt, 2000). For example, Op't Holt (2005) found that the passing rate

on the CSE of University of South Alabama (USA) students was above the national average after implementing this approach. Furthermore, program evaluation at USA showed that not only did students take pleasure in the PBL process, they also believed that they had the capacity to outperform their peers from traditional curricula in clinical settings (Op't Holt, 2005). However, these assertions have not been supported by the literature (Beachey, 2007; Colliver, 2000; Smits, Verbeek, & de Buisonje, 2002).

Beachey (2007) was the first to publish a study investigating the efficacy of PBL versus traditional curricula in respiratory therapy education across institutions. Beachey's retrospective mixed-methodology study relied on multiple indices to test its outcomes: graduates' self-assessment and employers' assessments of student competencies. Beachey also rated students' competencies in cognitive abilities, psychomotor skills, and emotional competencies via standardized surveys as well as students' scores in the NBRC (entry-level and written Registered Respiratory Therapist) examinations. The researcher collected surveys and examination scores for the 1999–2002 graduates of four BS programs, two of which used PBL (n = 92) and two that used traditional curricula (n = 120). These data were analyzed using multivariate analyses of variance and 2-tailed t-tests for independent samples. The study found no significant differences in the survey ratings (Wilks's lambda = 0.815, p = 0.207). Beachey also found that graduates of PBL respiratory therapy education programs reported higher levels of satisfaction with their training than their peers who had been enrolled in traditional lecture-based educational programs (p=0.012). The study further showed no significant differences in the mean scores between the two groups on the NBRC entry-level examination or the NBRC written Registered Respiratory Therapist examinations (p = 0.866 and p = 0.971, respectively). These findings are consistent with the results of prior studies that examined the effectiveness of PBL in medical and nursing

education (Albanese & Mitchell, 1993; Colliver, 2000; Smits, Verbeek, & de Buisonje, 2002; Applin et al., 2011; Beers, 2005). Furthermore, the study found no differences between PBL and traditional graduates with regard to membership in state and national respiratory therapy professional associations or participation in continuing education ($p = 0.129$, $p = 0.284$, and $p = 0.604$, respectively). This is not a surprise because credentialing is a necessity for state licensure and practice, and a big proportion of continuing education takes place through state and national professional conventions in which members receive discounted services (Beachey, 2007). On the other hand, Beachey (2007) found that graduates of traditional respiratory therapy educational programs received higher ratings from employers than the PBL graduates in four major areas: the ability of the graduates to use diagnostic data to propose therapy and procedures ($p = 0.021$), their abilities to carry out diagnostic procedures and make inferences from the diagnostic data ($p = 0.046$), their abilities to communicate effectively with others ($p = 0.028$), and their ethical and professional behaviors ($p = 0.010$). These results contradict those of other studies conducted on PBL in medical education programs (Thammasitboon, Sukotjo, Howell, & Karimbux, 2007). Conversely, Beachey (2007) found that the employers' rating of general graduate quality was similar between the PBL and the traditional graduates.

Currently, there are only one published investigation (Ceconi et al., 2008) and one preliminary report (Op't Holt, 2000) that have compared the NBRC examination scores for consecutive graduating classes before and after conversion from a traditional lecture-based to a PBL curriculum. Ceconi et al.'s retrospective study focused on the effect of PBL on respiratory therapists' decision-making (DM) skills. The researchers used a correlational research design to analyze the records of 100 respiratory therapy students who graduated between the years 1996 and 2003 from a baccalaureate program at USA. They used two instruments to measure students'

capabilities on DM: the NBRC Clinical Simulation Self-Assessment Exam and the graduates' actual exam scores. The study compared and correlated DM scores for students between the years 1996 and 1999, when a conventional lecture-based curriculum was used, and the years 2000–2003, when a PBL curricula was used. The study suggested that PBL had a positive impact on DM skills of respiratory therapy students ($r = 0.58$, $p = 0.010$). The study further showed an increase in students' DM mean scores after shifting to a PBL curriculum at USA ($r = 0.34$, $p = 0.010$). Ceconi et al. concluded that their findings support the hypothesis that PBL will improve DM in respiratory therapy students; however, they acknowledged that further investigation on the effect of PBL in respiratory therapy education is needed.

In conclusion, because of the mixed findings about PBL's correlation with higher levels of knowledge attainment or application, it is unclear if there are significant differences between traditional learning environments and PBL settings (Colliver, 2000). In addition, if these differences exist, the question remains whether or not they are significant enough to justify the continuation of such a teaching strategy. Some authors question whether changes made at a curriculum level truly have an impact on the outcome of the educational experience (Albanese, 2000). Additionally, because few studies have focused on the efficacy of PBL in respiratory care education specifically, further research is warranted.

CHAPTER III

METHODOLOGY

This study investigated whether there are any significant differences between PBL and traditional program students in their cognitive abilities in mechanical ventilation. Specifically, are there any differences in pre- and post-test scores between students in a BS program that uses PBL and students in a BS program that employs traditional educational methods?

Methods

Two universities—Georgia State University (GSU) and the University of South Alabama (USA)—were the research sites for this study. GSU uses traditional lecture-based teaching methods to teach respiratory therapy, and USA uses PBL to teach respiratory therapy. These two universities were chosen due to their accessibility to the researcher.

Instrument

Two secured forms (C and D) of the NBRC Registered Respiratory Therapy (RRT) written exams were purchased for use in this study. These forms were chosen to strengthen the face validity of the instrument. Forty questions related to mechanical ventilation were identified in these forms. Out of these 40 questions, 10 questions that covered different areas of mechanical ventilation were chosen by the primary investigator, student investigator, and the mechanical ventilation course instructors for both BS programs (Appendix A). All tests used a 10-question multiple-choice format. The questions were the independent variable in the study, as the same 10 questions were used in all four tests: the pre- and post-tests at each of the two schools. The main dependent variable, then, was the teaching method, either traditional lecture-based (in the GSU group) or PBL (in the USA group). The chosen questions centered on the practice of mechanical

ventilation in respiratory therapy, thus making this the first study to analyze the value of PBL in this specific area of respiratory therapy education.

Participants

After obtaining IRB approval from GSU, the researchers invited students from both programs via e-mail to voluntarily participate in the study (Appendix B). USA did not require its own IRB because of the IRB approval from GSU. No incentives were given to participants.

Inclusion Criteria

Students who were 19 years old or older, who were enrolled in a mechanical ventilation course, and who agreed to participate were included.

Exclusion Criteria

Students who had a degree in respiratory therapy or who had had prior experience in mechanical ventilation as on-the-job-training were excluded.

Recruitment

The USA mechanical ventilation course started in the spring of 2011, and the student investigator traveled to Mobile, AL and introduced himself to the faculty and students. After providing informed consent, USA participants were given the 10-question instrument to answer on mechanical ventilation at the beginning of their mechanical ventilation course (pre-test). The student investigator explained to the USA course instructor how to administer the post-test and left him a sealed package that contained the post-test questions. Towards the end of their mechanical ventilation course, the USA course instructor administered the post-test, giving students the same 10-question instrument. The post-test was then mailed to the student investigator.

At GSU, the mechanical ventilation course started in the summer of 2011. The student investigator introduced himself to the course instructor and the students at the end of spring 2011 and asked them to participate in the study. The pre- and post-test administration was explained to the course instructor and two packages that contained the informed consent forms, the pre-test, and the post-test were left at his office. At the beginning of mechanical ventilation course, an e-mail that contained an invitation letter was sent to the course instructor to send to students. The course instructor obtained informed consent from students and administered the 10-question instrument on mechanical ventilation (pre-test). Towards the end of the mechanical ventilation course, the course instructor administered the same 10-question instrument (post-test). The pre- and post-test were then left sealed in the course instructor's office. The investigator collected both at the end of August 2011.

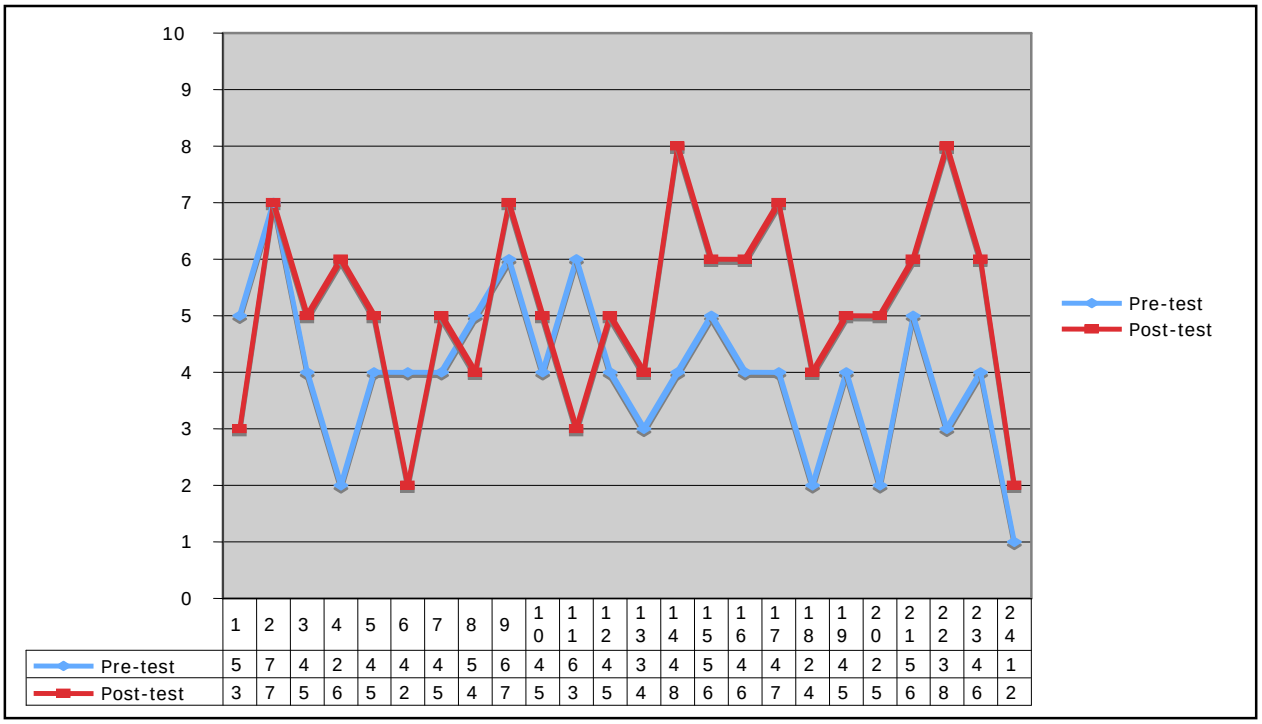
Using Predictive Analytics Software (PASW), results were analyzed using a dependent *t*-tests among each group and independent *t*-tests between the two groups. PASW was used to analyze the differences between the pre- and post-tests within each program, the differences between the pre-tests of both programs, and the differences between the post-tests of both programs.

CHAPTER IV

RESULTS

This chapter discusses the results of this experimental study, which investigates whether there are any significant differences in a pre- and post-test between students in a BS program with PBL and students in a BS program with traditional lecture-based educational methods.

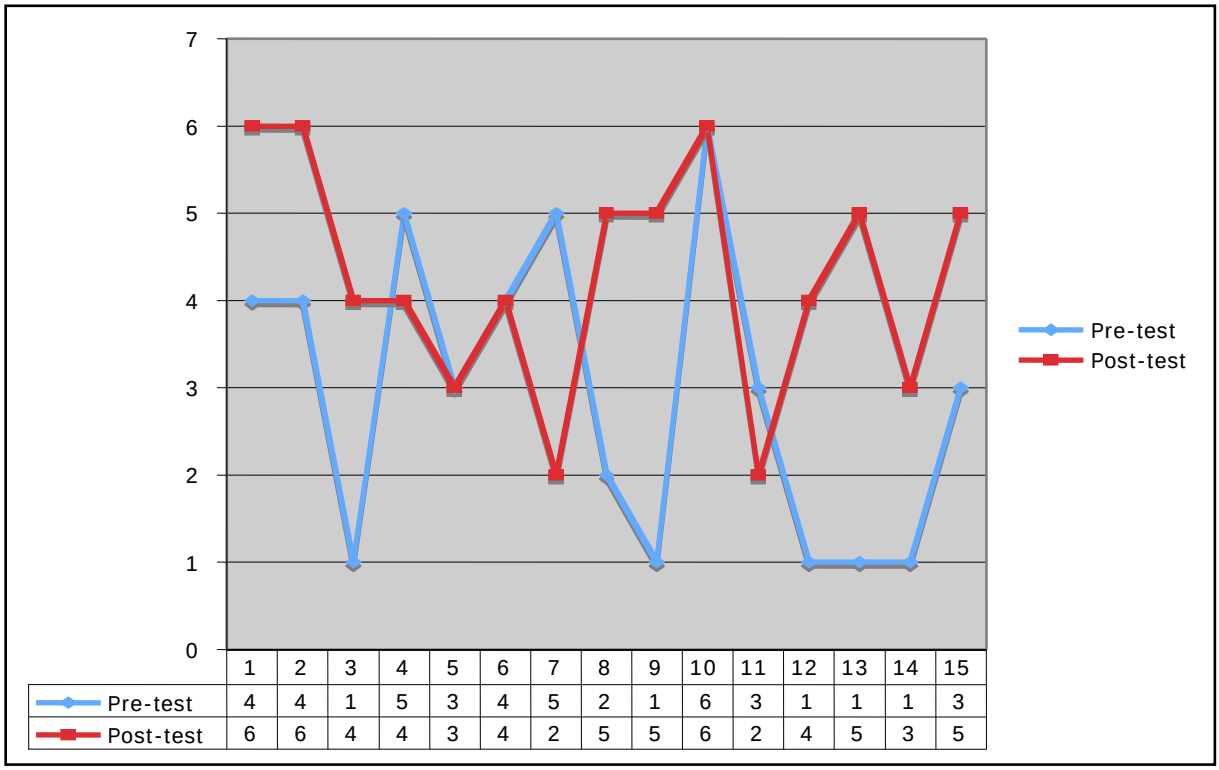
Two universities were chosen for the pre- and post-tests: Georgia State University (GSU), which uses traditional teaching methods, and the University of South Alabama (USA), which uses PBL. The GSU course comprised 25 students, and all agreed to participate (100% participation). One student, however, was absent on the day the pre-test was administered; thus his post-test result is not included in the analysis. Therefore, the total sample size was 24: 19 females and five males between the ages of 22 and 38. Figure 1 displays the GSU students' pre- and post-test results.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Pre-test	5	7	4	2	4	4	4	5	6	4	6	4	3	4	5	4	4	2	4	2	5	3	4	1
Post-test	3	7	5	6	5	2	5	4	7	5	3	5	4	8	6	6	7	4	5	5	6	8	6	2

Figure 1. GSU (traditional lecture-based) test results.

The USA program included 20 students, all of whom agreed to participate (100% participation rate). However, two students dropped out of the program and three students were eliminated from the study because they had an associate's degree in respiratory therapy. Therefore, the total sample size was 15: seven females and eight males between the ages of 21 and 40. Figure 2 shows their pre- and post-test results.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Pre-test	4	4	1	5	3	4	5	2	1	6	3	1	1	1	3
Post-test	6	6	4	4	3	4	2	5	5	6	2	4	5	3	5

Figure 2. USA (PBL) test results.

Using PASW, the researcher analyzed the differences between the pre- and post-tests among each program, the differences between the pre-tests of both programs, and the differences between the post-tests of both programs. In addition to looking at differences in pre- and post-test scores, it is important to know whether the differences are great enough to form the basis of scientific conclusions.

Pre-test Analysis

Table 1 provides the pre-test results of both schools.

Pre-test GSU

The highest possible score on the pre-test was 10. The mean score on the GSU pre-test was 4.00 with a standard deviation of 1.38 and a standard error mean of 0.28. This means that GSU students scored an average of 4 correct answers on the pre-test. The highest score on the GSU pre-test was 7, and the lowest score was 1.

Pre-test USA

Consistent with the GSU test, the highest possible score on the USA test was 10. The mean score on the USA pre-test was 2.93 with a standard deviation of 1.71 and a standard error mean of 0.44. This means that USA students scored an average of 3 correct answers on the pre-test. The highest score on the USA pre-test was 6, and the lowest score was 1.

Table 1. *Pre-test Results*

Test	**STATISTICAL MEANS and STDEV**		
	Mean	**SD**	**Std. Error**
GSU pre	4.00	1.38	0.28
USA pre	2.93	1.71	0.44

Post-test Analysis

Table 2 provides the results of both schools on the post-test.

Post-test GSU

As with the pre-test, the highest possible score on this test was 10. The mean score for the GSU post-test was 5.17 with a standard deviation of 1.66 and a standard error mean of 0.34. Thus, on the post-test the GSU participants scored an average of 5, which is an improvement of

one correct answer over the results of the GSU pre-test. The highest score on the GSU post-test was 8, and the lowest score was 2. No students scored a 1 on the post-test.

Post-test USA

The highest possible score on the post-test, again, was 10. The mean score on the USA post-test was 4.27 with a standard deviation of 1.33 and a standard error mean of 0.34. Thus, in the post-test the USA participants scored an average of 4, an improvement of one correct answer over the results of the USA pre-test. The highest score on the USA post-test was 7, and the lowest score was 2. No students scored a 1 on the post-test.

Table 2. *Post-test Results*

STATISTICAL MEANS and STDEV			
Test	**Mean**	**SD**	**Std Error**
GSU post	5.17	1.66	0.34
USA post	4.27	1.33	0.34

Correlations

Table 3 provides the correlations of both schools.

Table 3. *Paired Samples Correlation of GSU and USA*

Paired Samples Correlations	**N**	**Correlation**	**Sig.**
USA pre-post	15	.10	.72
GSU pre-post	24	.23	.29

Paired Samples Correlations GSU

GSU had the most participants, 24, which provided a larger field of participation upon which to base the assessment. The group had a correlation of 0.23 with a significance value of 0.29. This means that there was a positive relationship between the pre and the post-tests.

Paired Samples Correlations USA

With an *n* value of 15, the paired samples between the USA pre-test and USA post-test was the smaller of the two test groups, but still provided a sufficient number of participants to conduct an accurate study. The group produced a correlation of 0.10 with a significance value of 0.72. This also means that there was a positive relationship between the pre and the post-tests.

Paired Samples Test GSU

Analysis of the paired differences between the GSU pre-test and the GSU post-test produced a mean of -1.67 with a standard deviation of 1.90 and standard error mean of .39. The 95% Confidence Interval of Difference produced a lower range of -1.97 and an upper range of -0.36. The paired samples test also included a *t*-value of -3.00 with a *df* of 23.

Paired Samples Test USA

Analysis of the paired differences between the USA pre-test and the USA post-test produced a mean of -1.33 with a standard deviation of 2.06 and a standard error mean of 0.53. The 95% Confidence Interval of Difference produced a lower range of -2.47 and an upper range of -0.19. The paired samples test also included a *t*-value of -2.51, with a *df* of 14.

As Table 4 shows, the unpaired *t*-test results in the traditional group sample (GSU) was 0.006, which means there is a significant difference between the pre- and post-test results. Likewise, the PBL sample (USA) shows a value of 0.025, which also indicates a significant difference between the pre- and post-test. The independent *t*-test for the pre-test showed a significant difference favoring the traditional method group ($p = 0.039$). However, the post-test analysis showed no significant difference between the two groups ($p = 0.085$).

Table 4. *Dependent and Independent T-Test Results*

STATISTICAL SIGNIFICANCE	
Test	**Significance (P-value)**
Paired	
USApre-USApost	0.025
GSUpre-GSUpost	0.006
Independent	Equal Variances Assumed
GSUpre-USApre	0.039
GSUpost- USApost	0.085

Demographics

In addition to answering questions on mechanical ventilation, participants were asked a number of demographic questions (Appendix A). Means were assessed to see if there was a difference in results for males and females or across different age groups. The hypothesis here is that perhaps different age groups have a tendency towards different learning styles and teaching methods. Table 5 provides the breakdown of results for the traditional teaching method used at GSU and for PBL used at USA.

Table 5. *GSU and USA Demographics*

	Pre Mean		**Post Mean**	
	GSU	**USA**	**GSU**	**USA**
Female	n=19 4.26	n=7 3.71	5.11	4.14
Male	n=5 3	n=8 2.25	5.4	4.38
Age 18-23	n=9 4.25	n=9 2.88	6.25	4.38
Age 24-29	n=8 3.75	n=3 4	4.25	4
Age 30 +	n=7 4	n=3 2.67	5	4

For GSU students, who were taught using traditional methods, improvement in test scores occurred across all demographic groups. GSU female students showed the least improvement; however, this demographic group started with the highest test score mean of all the demographic sections in either test group.

For USA students, who were taught using PBL techniques, again improvement was shown across most demographic groups. On the USA test, there was a more significant rise in test scores for the male demographic, but just as in the GSU sample, the female participants started with a higher mean score on the pre-test. Among both GSU and USA students, the youngest group showed the greatest improvement in scores.

CHAPTER V

DISCUSSION

This study examined whether there is a significant difference between the PBL and the traditional lecture-based teaching method in regards to respiratory care education. When discussing the results, determination whether there is statistical significance between the pre- and post-test results is needed; thus the *p* value was set at $p = <0.05$. The study does show a difference in results slightly favoring the use of PBL. However, the results do not fall within the realm of statistical significance, and thus they do not provide enough evidence to draw a conclusion that PBL is more effective than the traditional method. In other words, the results are helpful, but not conclusive. Given the small sample size, the margin of error on this study is quite high but not out of the range of validity for a study such as this.

Pre-test and Post-test Results Analysis

Pre-test scores among the GSU and USA samples were not particularly high. The traditional method group scored a mean of 4.00 on the pre-test. This group began the test with a higher test scores than the PBL group, which scored a mean of 2.93. A number of suppositions can be made regarding this result. One possibility is that the higher initial test scores indicate a higher aptitude for learning in the traditional method group. Thus, the entry scores and ability levels of the students may need to be taken into consideration in determining whether the results are valid. A higher initial test score may indicate a greater ability to learn at a quicker pace, and so any improvement in test scores may be due to student aptitude rather than to the method of teaching. Although this was not analyzed in this study, it should be considered before making conclusions.

On the post-test**,** the students taught via the traditional method improved their scores, with a mean of 5.17. The standard deviation, however, is higher in the second test, and a number

of students did, in fact, get a lower test result. On average, however, the students improved their scores by 1.17 answers.

The PBL group also improved their scores, to an average of 4.27. The standard deviation in this case is the lowest of all four test groups, indicating the most accurate result. The improvement in the PBL group was 1.34, whereas the improvement in score within the GSU group, which used the traditional method, was 1.17. The higher pre-test scores in the traditional method group could lead one to hypothesize that the group would see greater improvement. This group started with higher scores, perhaps indicating that they entered the testing with a higher aptitude, thus it would be likely that their scores would increase. Conversely, the PBL group's lower pre-test scores suggest that these students had more room for improvement. Results are inconclusive but do seem to indicate that the PBL method was somewhat effective, even overcoming a possible disadvantage in the pre-test knowledge of the students.

It is important to note that the difference between the two results, however, falls within the margin of error, so care should be taken before drawing conclusions from these results. A greater difference in improvement would lend more strength to any conclusions drawn about the effectiveness of PBL. Still, the test does give us a sense of what further tests might indicate. In general, these results give future researchers reason to hypothesize that PBL may be a more effective method of instruction in respiratory therapy education, but this study by itself cannot make such a claim.

Demographic Differences

Age, gender, educational background, and other demographic factors could affect the success and efficacy of one teaching method over the other. Though the participants tended to be quite homogenous in terms of level of education, each having earned one degree, there were

differences in age and gender that might contribute to the success of one method of teaching versus the other. Males, for example, improved more with PBL than did females. Though the study indicates that PBL is as effective as the traditional method for both men and women, the numbers show that it is more effective for men, as the male participants in the study showed greater improvement, raising their test scores from 2.25 to 4.38. This was the most dramatic improvement in any of the demographic groups that were analyzed. Because the GSU sample included only five males, caution should be taken in interpreting this result. PBL also seems to be effective among all the age groups studied, as each group improved their mastery of learning outcomes. However, the youngest group showed the greatest rise in scores. Some caution needs to be made here as there are a variety of external factors, such as the responsibility and maturity of the students, that may also play a role in these results. Moreover, students' backgrounds, socioeconomic differences, and teacher's competency need to be considered as well. Study results seem to indicate that PBL is as effective as a traditional teaching approach for all groups but may be more beneficial for males and for the younger demographic group. Perhaps this is because the younger students are more familiar with nontraditional methods of learning than the older groups, who may have been taught via traditional lecture-based methods in most other courses and throughout their educational careers. Because of the study's small sample sizes, it is difficult to run a regression analysis to test the significance of these subgroups.

The review of syllabi and curricula of both programs showed that students participating in the traditional curriculum had 35 faculty contact hours in their mechanical ventilation course: 21 hours spent in lectures and 14 hours spent in lab practice. The PBL group on the other hand, spent 72 hours as group discussions in a PBL format and 46 hours as enrichment lectures as well as 13 hours in lab practice in their mechanical ventilation course. PBL students thus had more

faculty contact hours than students who are in the traditional curriculum. However, it is important to mention that there is a difference between the two curricula. The traditional group had two courses to cover mechanical ventilation—one during the summer and the second is during the fall semester whereas the PBL group had only one course to cover the mechanical ventilation during the spring semester.

Comparison of Test Results to the Literature

This study seems to match the fledgling consensus that there are no significant differences in students outcome in regards to the objective test scores between PBL and traditional. Also, this study seems to contradict the trend in medical school programs and other fields of promoting PBL over traditional teaching methods.

Several studies have consistently shown that PBL is not heavily associated with knowledge attainment in medical education (Albanese & Mitchell, 1993; Colliver, 2000; Smits, Verbeek, & de Buisonje, 2002; White et al., 2004) and nursing education (Beers, 2005; Applin et al., 2011). This is also true in the field of respiratory therapy, where Beahey (2007) found no significant differences in the mean scores between the PBL and the lecture-based method on students' NBRC entry-level or written Registered Respiratory Therapist examinations. Though Ceconi et al. (2008) showed some support for PBL, further study was suggested.

This study similarly shows a slight difference in results between the two groups, though it is not statistically significant. This difference may be limited to certain demographics and age groups, as indicated in the previous sections. This study is in line with other literature in finding no statistically significant difference between the two teaching methods in regards to objective test scores.

Limitations

The results of this study are limited because of the small and unequal sample sizes: there were 24 participants in the lecture-based group whereas there were 15 participants in the PBL group. The admission GPAs of both groups were also different, although this was not investigated here, it is important to consider. It was also hard to compare these results to the results of previous studies due to the limited research that has been conducted in this area. It is also important to note that the PBL group started their mechanical ventilation course in the second semester of the program and the traditional method group began their course in the third semester of the program and they were introduced to some form of mechanical ventilation towards the end of the second semester. Thus, this might have given an advantage to the lecture-based group over the PBL and may explain the higher pre-test scores. Finally, the lecture-based program reported that they use some form of PBL in their mechanical ventilation lab to some extent.

Conclusions

Since its inception as a post-secondary teaching method in the late 1960s at McMaster University in Ontario, Canada, PBL has become an increasingly popular method of instruction. PBL use has spread, and the teaching method is now common in medical and nursing schools, as well as in social sciences. However, PBL's use in respiratory therapy education is fairly new. Studies have shown that the design of instructional practices and pedagogy have great importance and correlation to the learning of students, particularly in the medical field. This had led to changes in the curricula of medical schools, to the extent that the majority of American medical schools have implemented some form of PBL. Schools such as the University of Missouri–Columbia School of Medicine have switched from traditional lecture-based learning to

PBL, and studies have praised the benefits of the switch. However, the critical consensus seems to lean toward no statistical difference between PBL and traditional learning in medicine, nursing, and respiratory therapy. In fact, some studies have noted a decline in performance. However, to date, this question has not been adequately investigated. The study at hand asked whether there are any significant differences between PBL and traditional program students in their cognitive abilities in mechanical ventilation. Specifically, this study investigated whether there are any differences in the mean score results of a pre- and post-test between students in a BS program with PBL and students in a BS program with traditional educational methods. This was the first study to compare the teaching method of two different respiratory therapy programs in regards to mechanical ventilation, and the findings will contribute to the sparse number of studies that have been performed in respiratory therapy education thus far.

The study demonstrated that though there is a slight difference in results, it is not, in fact, statistically significant. Although there is a noticeable difference in some demographic areas, namely the youngest group and males, it is important to note that this study will likely need to be supplemented by further research in these demographic areas. Thus, it cannot yet conclude that PBL has a significant effect on the teaching of respiratory therapy in regard to mechanical ventilation.

Future Considerations

One way to further compare the efficacy of PBL versus traditional lecture-based teaching methods would be to assess these same students again with the roles reversed. The USA students would be taught in the traditional method, while the GSU students would be taught using PBL. However, because the students would have pre-knowledge on the topic of mechanical ventilation in respiratory therapy, the study design would need to be revised. Another study might also

assess whether PBL is more or less effective in improving the test scores of higher aptitude students or students with higher pre-test scores. Does the pre-test score have any bearing on the effectiveness of PBL? It is possible that a particular teaching method varies in effectiveness based on the aptitude of the tested students, and this would be an interesting area for further study.

Further study to test whether or not PBL increases or decreases the test scores of respiratory therapy students studying mechanical ventilation will be needed to supplement this research. However, further studies may focus on specific demographic areas and demonstrate an increase or decrease with certain types of students. If a particular demographic group benefits from PBL more than other groups, programs might consider gearing PBL courses specifically toward these students.

In addition to demographic considerations, the quality and competence of the lecturer may play a role in test results. Learning in a traditional environment is dependent on the interaction between the lecturer and student. PBL emphasizes a more social constructivist model and therefore a single factor such as the lecturer cannot be isolated in the same way. Therefore, future researchers may wish to study whether PBL is more or less effective versus a number of different lecturers.

Although PBL was not proven in this study to be superior to traditional teaching in a mechanical ventilation course in respiratory therapy education, neither can it be said to be inferior. Nor does the study demonstrate it to be an inadequate form of teaching. The conclusion to be made here is that PBL is effective, especially among younger students and among males, but it does not appear to be dramatically more effective than traditional teaching methods. Faculties considering the implementation of PBL in this field may wish to consider whether the

financial costs of switching are worth it, especially when it does not seem, at this point, to produce significantly different results. The chance of PBL producing superior results does exist, but further study is needed.

Respiratory therapists are increasingly in demand in the healthcare system and respiratory therapy schools are attempting to fill these needs through varied pedagogical methods. Reviewing these practices is essential to future growth in the field and to improving the quality of education in this demanding area. Problem-based learning is increasing in popularity despite the fact that studies of its efficacy have been thus far inconclusive. This study has shown it to be effective, but not significantly more effective than traditional lecture-based methods.

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Appendixes

Appendix A

Problem-Based vs. Traditional Teaching Methods

PBL _____ Trad _____ Participant Number _____

1. A 60-kg (132-lb) patient is receiving volume-controlled ventilation. The respiratory therapist is asked to increase the tidal volume from 500 to 700 mL. Which of the following ventilator alarm settings should be changed?

I. low exhaled tidal volume
II. high pressure limit
III. high minute volume
IV. low respiratory rate

A. I, II, and III only
B. I, II, and IV only
C. I, III, and IV only
D. II, III, and IV only

2. A respiratory therapist is using a test lung to conduct a pre-operational test of a ventilator at the following settings:

Mode	Assist/control
F_IO_2	0.40
Respiratory rate	12
Flow	60 L/min
V_T	700 mL

The exhaled tidal volume measurement is 500 mL. Which of the following actions should the therapist take?

A. Complete the remaining elements of the pre-operational test.
B. Increase the tidal volume setting to 900 mL.
C. Assess the ventilator circuit for leaks.
D. Set the low tidal volume alarm to 400 mL.

3. A 50-kg (110-lb) patient is receiving volume-controlled ventilation with the following settings:

Mode	SIMV
Pressure support	10 cm H_2O
F_IO_2	1.0
Mandatory rate	12
Total rate	15
V_T	650 mL
PEEP	10 cm H_2O
Peak airway pressure	50 cm H_2O
SpO_2	85%

A chest radiograph shows diffuse bilateral infiltrates. Which of the following should the respiratory therapist recommend?

I. Increase the mandatory rate.
II. Change to pressure-controlled ventilation.
III. Change to assist/control mode.
IV. Increase the PEEP to 15 cm H_2O.

A. III only
B. I and III only
C. I and IV only
D. II and IV only

4. A patient weighing 70 kg (154 lb) and 173 cm (5 ft 8 in) tall is recently sedated and pharmacologically paralyzed. A chest radiograph shows bilateral basilar atelectasis but is otherwise clear. Ventilator settings are:

Mode	SIMV
F_IO_2	0.50
Mandatory rate	10
V_T	450 mL

Arterial blood gas results are as follows:

pH	7.43
$PaCO_2$	36 torr
PaO_2	79 torr
HCO_3^-	23 mEq/L
BE	0 mEq/L
SaO_2	96%

Which of the following modifications should the therapist recommend to the physician?

	Tidal Volume	Mandatory Rate	Mechanical Dead Space
A.	650 mL	12	0 mL
B.	450 mL	14	50 mL
C.	550 mL	8	100 mL
D.	700 mL	10	200 mL

5. A patient who weighs 60 kg (132 lb) is sedated and receiving volume-controlled ventilation. The following information is available:

F_IO_2	0.35
Mandatory rate	12
V_T	900 mL
PEEP	5 cm H_2O
Peak flow	50 L/min

pH	7.50
$PaCO_2$	30 torr
PaO_2	100 torr
HCO_3^-	23 mEq/L
BE	0 mEq/L

Which of the following should the respiratory therapist decrease to normalize the patient's arterial blood gases?

A. tidal volume
B. peak flow
C. F_IO_2
D. PEEP

6. An adult patient has some spontaneous respiratory efforts and is receiving volume-controlled ventilation with an F_IO_2 of 0.40 using a microprocessor ventilator. The source gases to the ventilator fail. According to the ventilator's capabilities, which of the following would the respiratory therapist expect to occur?

I. The high airway pressure alarm will sound.
II. The low oxygen alarm will sound.
III. The ventilator powers off.
IV. The safety valve will open.

A. I and III only
B. I and IV only

C. II and III only

D. II and IV only

7. A 58-year-old male patient is 165 cm (5 ft 5 in) tall and weighs 110 kg (242 lb) and is 1 day postoperative open cholecystectomy. The patient is receiving volume-controlled ventilation guided by a patient-driven protocol. The therapist notes the following:

Mode	SIMV
F_IO_2	0.25
Mandatory rate	10
Total rate	10
V_T	1100 mL
PEEP	5 cm H_2O
Pressure support	5 cm H_2O

pH	7.59
$PaCO_2$	27 torr
PaO_2	105 torr
HCO_3^-	21 mEq/L
SaO_2	98%
BE	2 mEq/L

Which of the following changes in the protocol should the therapist recommend?

A. Reduce the mandatory rate until spontaneous breaths occur.

B. Discontinue use of pressure support with the SIMV mode.

C. Use ideal body weight to calculate the tidal volume setting.

D. Increase the PEEP setting to 10 cm H_2O.

8. In reviewing the ventilator flow sheet for a patient who is receiving mechanical ventilation, the following data are noted:

Peak pressure	35 cm H_2O
Plateau pressure	28 cm H_2O
PEEP	5 cm H_2O
Dynamic compliance	38 mL/cm H_2O
Static compliance	33 mL/cm H_2O

Which of the following should the respiratory therapist conclude?

A. These data are erroneous.

B. Airway resistance is 5 cm H_2O/L/sec.

C. A bronchopleural fistula has developed.

D. The patient has significant airway obstruction.

9. A patient receiving volume-controlled ventilation has the following series of airway pressures:

Time	PIP (cm H_2O)	P_{plat} (cm H_2O)
0800	35	21
1200	30	22
1600	27	23
2000	25	24

Which of the following is true of pulmonary compliance and resistance changes during this period?

	Compliance	Resistance
A.	increased	increased
B.	increased	decreased
C.	decreased	increased
D.	decreased	decreased

10. A 32-year-old female is 167.6 cm (5 ft 6 in) tall and weighs 56.8 kg (125 lb). She has a diagnosis of heroin overdose and is receiving volume-controlled ventilation. Chest radiograph reveals bilateral infiltrates consistent with pulmonary edema. An arterial blood gas is obtained 30 minutes later. Ventilatory data and blood gas results are:

Mode	SIMV	pH	7.38
F_IO_2	0.60	$PaCO_2$	42 torr
Mandatory rate	12	PaO_2	48 torr
V_T	600 mL	HCO_3^-	23 mEq/L
PEEP	5 cm H_2O	SaO_2	84%
PIP	55 cm H_2O	BE	0 mEq/L
Plateau pressure	37 cm H_2O		

Which of the following changes should the respiratory therapist recommend?

A. increasing the F_IO_2 to 0.80
B. pressure-controlled ventilation at 35 cm H_2O
C. increasing the tidal volume to 700 mL
D. increasing the mandatory rate to 20

Tel us about yourself: (This is strictly confidential)

Gender: Male_____ Female _____

Age: _____

Total number of years of college education: _____

Is this your first college degree? Yes_____ No _____

Appendix B

Invitation Letter

Dear Respiratory Therapy Students.

I am inviting you to participate in my research study "Problem Based Learning as a Teaching Method versus the Lecture=Based Teaching in Respiratory Therapypp Education"

The purpose of this study is to investigate the effectiveness of Problem Based Learning (PBL) approach and the Traditional Teaching approach in Respiratory Care Education and to determine if there is any difference between these two approaches.

If you volunteer to participate, you will be asked to answer 10 questions on mechanical ventilation on the first and the last day of having the mechanical ventilation course at your program. These questions should take approximately 10-15 minutes of your time to answer. These questions shall be given to you by your mechanical ventilation course instructor at your program in your classroom. The answers will then be sent to the principal investigator Dr Lynda Goodfellow and the student investigator Bandar Almasoudi at Georgia State University to evaluate them.

Your answers will be confidential. We will use a study number rather than your name on the study records. The information you provide will be stored in password- and firewall-protected computers. Your name and other facts that might point to you will not appear when we present this study or publish its results. The findings will be summarized and reported in a group form. You will not be identified personally.

Although your participation in this study may not benefit you personally, we hope to gain information about the effectiveness of these two approaches and advance our knowledge about Respiratory Therapy Education.

Thank you.

Bandar Almasoudi
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