Collaborative Learning Utilizing Case-Based Problems

Nestor T. Hilvano[1], Karen M. Mathis[1]* and Daniel P. Schauer[2]

[1]Science and Health Department, University of Cincinnati, Clermont College, 4200 Clermont College Drive, Batavia, OH 45103, [2]Internal Medicine, University of Cincinnati, College of Medicine, 231 Albert Sabin Way, Cincinnati, OH 45229

*Corresponding Author: karen.mathis@uc.edu

Abstract: Engaging students in discussion and creating high impact teaching and learning practices are a challenge in every classroom. Small group discussion and poster presentations were used to solve case-based problems to highlight issues for the learner and to allow each student to demonstrate understanding and application of theory to real life examples through open-ended, focused questions. This study consisted of students enrolled in an Anatomy and Physiology course sequence. Assessment was based on group goal and individual accountability. Rubrics for evaluation were developed for self and peer assessment of each groups' dynamics. A poster session provided our students with an opportunity to explain their work to an audience, as well as generate active discussion and peer evaluations. This study showed a significant positive effect ($p = 0.0001$-0.0025) on students' knowledge, attitude and psychomotor skills.

Key words: collaborative learning; small group discussion

INTRODUCTION

The University of Cincinnati, Clermont College (UCCC) is an open access regional campus that focuses on undergraduate students pursuing associate and technical degrees, as well as transferring to the main campus in Clifton. We have a diverse student population of which 58% are female, 42% are part-time students, 17% are minorities, and 36% are 25 years and older.

Students who enroll in Anatomy & Physiology are, in general, seeking degrees in health care fields. The Anatomy & Physiology course sequences are rigorous in both quantity and depth of material. Although courses have a laboratory component, the majority of the time is spent in traditional lecture. Moreover, in most classroom settings, not everyone is an active learner. Only a few students raise their hands and speak, ask questions, or interact in class. Due to time constraints, there is little occasion to apply what is learned to pathologic anatomy, which discusses the changes brought on by disease, or clinical anatomy that relates to manifestations of disease. Shared learning gives students an opportunity to engage in discussion, take responsibility for their own learning, and become critical thinkers (Totten, et al., 1991). Currently, work place environments and technological advancements require workers to solve problems and make team decisions. *The Essential of Baccalaureate Education for Professional Nursing Practice* outlines nine essential outcomes expected of graduates of baccalaureate nursing programs (American Association of Colleges of Nursing, 2008). Essential VI indicates that effective communication and collaboration among health professionals is imperative to providing patient-centered care. It also directs that the undergraduate baccalaureate program should prepare students to incorporate effective communication techniques, including negotiation and conflict resolution to produce positive professional working relationships (American Association of Colleges of Nursing, 2008). Feingold et al. (2008) demonstrated that students clearly connect the concept of working in a group to their future roles as members of health care teams. According to the American Physical Therapy Association, physical therapist assistants work as part of a team throughout their career (American Physical Therapy Association, 2013). As instructors we recognized that our course assignments were not helping our students to learn these skills. To respond to these challenges, we designed a small group discussion (SGD) project using case-based problems that relate to theory and practice.

The goal was to actively engage students by having them work collaboratively to solve case-based problems. By utilizing small group discussion, we hoped to enhance critical thinking skills, improve self-esteem, cultivate a positive attitude towards learning, increase motivation, and improve interpersonal skills. It is our belief that a positive impact in the aforementioned areas would result in higher achievement for our students.

Research Questions

1. Will there be a significant difference in achievement on test questions prior to participation in SGD utilizing case-based problems, when students are learning individually, compared to achievement on test questions after participating in SGD, when students are learning collaboratively in groups?
2. Will students find that participating in SGD has a positive impact on their knowledge, attitude,

Table 1. Sequence of events for SGD over the course of the quarter.

Week	SGD Event
1	Post SGD guidelines, rubrics and case studies to Blackboard. Assign students to read material prior to next class. Embed pre-SGD test questions within Quiz 1.
2	Discuss the SGD guidelines in class. This includes goals of the project, responsibilities of individuals and of each group, end products and due dates. Discuss both student and instructor rubrics for evaluation of the project. Assignment of students to groups (randomly selected by instructor prior to class). Once assembled in groups, discuss roles with in the group with the entire class. Ask students to discuss examples of "bad" behavior in group settings within their group. Discuss examples from each group with class as a whole. Perform a team building exercise. Students will begin working in their assigned groups beginning the following week.
3, 4, 5 & 6	After lab, allow 30 minutes for group to meet. Mediate any group issues.
7	After lab, allow 30 minutes for group to meet. Mediate any group issues. Invitations to the SGD poster session sent out to all faculty and staff of Clermont College.
8	SGD paper is due to instructor at the beginning of the week. SGD poster is due to instructor at the end of the week. This includes a preliminary presentation to the instructor for evaluation and feedback.
9	SGD poster session open to the entire Clermont College community. Rubrics designed to provide feedback to the students regarding their presentations are given to members of the community who attend the poster session. Students fill out rubric evaluating self and group member performance. Students fill out survey regarding SGD experience.
10	Instructor tabulates grade for each student based upon: instructor's evaluation of paper and poster/presentation; average for each student's self and peer assessment score. Instructor returns these rubrics and grade, along with feedback from Clermont College presentation.
Exam	Embed post-SGD test questions in Final Exam.

and psychomotor skills when utilizing collaborative learning to solve case-based problems?

METHODS

The Science & Health Department, specifically the Biological Sciences, at UCCC, offers courses that meet general education and program education requirements for the general student population. Beginning academic year 2012-2013, the University of Cincinnati converted from a three quarters system (ten weeks plus an exam week per quarter) to a two semester system (fifteen weeks plus an exam week per semester). All courses in this study were conducted when the university was using the quarter system. The University of Cincinnati IRB did not require a protocol due to anonymity of all data acquired.

Introductory Phase

The population for this study consisted of undergraduate students, in their first or second year of education, in Anatomy and Physiology course sequences, during the academic years 2009-2010 and 2010-2011. Each lab section had a maximum of 20 students. During the second week of classes, students were randomly assigned into small groups by drawing names out of a hat. See Table 1 for a timeline of SGD events. Each small group consisted of three to five students. Due to time constraints during lab and lecture, the students were required to meet outside of class time for a minimum of 60 minutes per week. To determine if students met for the mandatory 60 minutes per week, students were required to list the dates the group met on the form used to evaluate the performance of each member of the group (see Table 4), otherwise it was based on the honor system. The first step in the collaborative learning process was to explain the learning strategy and specify the academic task of solving case-based problems. Next, instructions were given regarding the essential elements of effective cooperative learning based on research: positive interdependence, face-to-face promotive or positive interaction, individual and group accountability, interpersonal and small-group skills, and group processing (Johnson et al., 1991, 1993, 1998). Guidelines and assessment rubrics were distributed, and were made available on Blackboard and the instructors' websites. Both the guidelines and assessment rubrics were thoroughly explained. After the project was explained, students were placed into groups and engaged initially in a team building activity. Play-Doh™ and wooden skewers were distributed to each group. They were instructed to create an object that would symbolize that group's teamwork. Each group was given seven minutes to complete the task. At the end of the time each group described to the class the object they had created, what it symbolized and how they felt it could contribute to a positive outcome for their SGD project. At the end of the session, it was pointed out to the students that although they were all given the same materials to work with, each group

came up with very different end products; their SGD projects would be analogous.

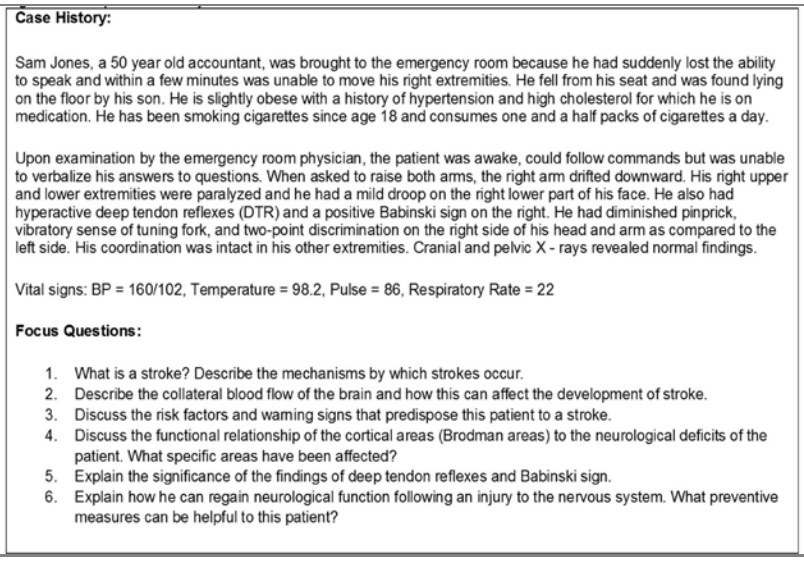
Instructional Phase

At the beginning of each term, the students were presented with identical structured case-based problems. See Figure 1 for an example of a Case Study. These were constructed based on organ systems covered during the course of the quarter. Each topic was chosen to provide an in-depth learning experience, to highlight issues for the learner, and to demonstrate application of theory to "real life" situations.

write a narrative of the clinical scenario. Explicit instruction was given regarding the use of the guided questions: they were not simply to be answered, but to be used as a starting point to initiate the creation of the narrative. They were also required to create a poster based upon the narrative and give an oral presentation highlighting the most important aspects of the case.

Production Phase

Although the students were required to meet outside of class, at least thirty minutes of each lab session was also allotted for the small groups to meet.



Case History:

Sam Jones, a 50 year old accountant, was brought to the emergency room because he had suddenly lost the ability to speak and within a few minutes was unable to move his right extremities. He fell from his seat and was found lying on the floor by his son. He is slightly obese with a history of hypertension and high cholesterol for which he is on medication. He has been smoking cigarettes since age 18 and consumes one and a half packs of cigarettes a day.

Upon examination by the emergency room physician, the patient was awake, could follow commands but was unable to verbalize his answers to questions. When asked to raise both arms, the right arm drifted downward. His right upper and lower extremities were paralyzed and he had a mild droop on the right lower part of his face. He also had hyperactive deep tendon reflexes (DTR) and a positive Babinski sign on the right. He had diminished pinprick, vibratory sense of tuning fork, and two-point discrimination on the right side of his head and arm as compared to the left side. His coordination was intact in his other extremities. Cranial and pelvic X - rays revealed normal findings.

Vital signs: BP = 160/102, Temperature = 98.2, Pulse = 86, Respiratory Rate = 22

Focus Questions:

1. What is a stroke? Describe the mechanisms by which strokes occur.
2. Describe the collateral blood flow of the brain and how this can affect the development of stroke.
3. Discuss the risk factors and warning signs that predispose this patient to a stroke.
4. Discuss the functional relationship of the cortical areas (Brodman areas) to the neurological deficits of the patient. What specific areas have been affected?
5. Explain the significance of the findings of deep tendon reflexes and Babinski sign.
6. Explain how he can regain neurological function following an injury to the nervous system. What preventive measures can be helpful to this patient?

Fig. 1. Sample Case Study

After feedback from students, additional case-based problems were developed for use in the second year of the study (2010-2011). These cases were specific to each quarter's topics, so that each group had a unique case, for a total of 4 different cases in each quarter. However, this precluded our use of pre-SGD and post-SGD test questions as the material in the cases was taught during the entire quarter instead of in a single test unit.

As a guide, the students were given a list of questions to initiate research and discussion. These included the following:

a. Discuss the structures and functions of the organ system affected.

b. Explain signs and symptoms pertinent to the chief complaint and other associated conditions.

c. Describe the causes and risk factors essential to the case.

d. What pertinent lab works will help correlate diagnosis?

e. Correlate possible complications that might arise if not given proper care and management.

f. Explore common preventive measures and suggestions to help patient's recovery or limit disability.

Additional questions were added that were specific to each case. The students were required to

The instructors were available to assist with intra-group difficulties, but the students were encouraged to rely upon each other for transformation of knowledge, clarification, elaboration, synthesis, organization of learning concepts and application of solving case-based problems.

The groups were given 4-5 weeks to complete and submit their written report. A week after the written report was submitted, each group gave a 3-4 minute oral poster presentation summarizing their case. Shortly thereafter, the students again presented their posters in an open session. This session was open to the entire UCCC community. Invitations were extended to all faculty and staff; students were encouraged to invite friends and family.

Assessment Phase

In this phase several evaluations were made by the instructor, by attendees of the poster presentation, and by the students.

Instructor Evaluation

The instructor made several types of assessment regarding performance by the students. To assess the effectiveness of this learning strategy, we developed a set of pre-SGD and post-SGD test questions to measure student understanding of a particular organ system. These were designed to assess the understanding of the material differentiating between

students learning individually (prior to the implementation of the SGD protocol) and students learning collaboratively (after completion of the SGD protocol) utilizing case-based problems in SGD. The number of students given the pre-SGD and post-SGD test questions differs from the number of students who completed the SGD project because after student feedback, in the second year of the study (2010-2011), we changed our case-based studies from being identical among all groups to assigning different case studies to each individual group. An instructor's evaluation rubric of the group's written report was formulated to set a standard for how it would be graded (Table 2); this was worth 40 of the 90 possible points of the written report. The poster with the accompanying presentation was evaluated separately, again utilizing an assessment rubric. Immediate feedback was provided to the students at the end of the poster presentation; this allowed the students a chance to improve and refine their presentation prior to the campus-wide session. The grade for the poster was determined entirely by the instructor.

participation of each member; this was worth 50 of the 90 possible points of the written report. The points awarded to each individual member by all members of the group (self-evaluation included) were tallied and averaged to determine point value. After each group submitted their written report, a 10-question survey tool was administered, using 5-point grading scale, to assess if the goals of the project were met in terms of student's knowledge, attitude, and psychomotor skills (Table 5).

Statistical Analysis

We used descriptive statistics, including means and medians, to summarize the data. Comparisons between the SGD and non-SGD groups were made using the Chi-square test and Student's t-test where appropriate. SAS version 9.2 (Cary, NC) was used for all analyses.

RESULTS

Pre-SGD and Post-SGD Questions

Of the 110 students who completed the pre-SGD and post-SGD test questions during the first year of the study (2009-2010), the pre-SGD test questions were answered correctly 56% (61 out of 110) of the time; the post-SGD test questions were answered correctly 69% (76 out of 110) (see Figure 2). This difference was significant ($p = 0.0004$), demonstrating the students had better understanding of subject matter after engaging in the collaborative learning strategy. We did not administer pre-SGD and post-SGD test questions during the second year of the study (2010-2011) because during that time, each group had unique case-based studies ($n = 189$); the material in these studies was covered during the entire quarter instead of in a single test unit as was done during the first year of the study.

Table 2: Instructor evaluation rubric of the group's written report.

Criteria	Unsatisfactory 1 – 2	Minimal 3 – 4	Effective 5 – 7	Exemplary 8 – 10	Score
Identification of the main Issues/ problems	Identifies & understands few of the issues in the case study	Identifies and understands some of the issues in the case study	Identifies and understands most of the main issues in the case study	Identifies and understands all of the main issues in case study	
Analysis of the Issues	Incomplete analysis of the issues	Superficial analysis of some of the issues in the case	Thorough analysis of most of the issues	Insightful and thorough analysis of all the issues	
Comments on effective solutions/ strategies	Little or no action suggested, and/or inappropriate solutions to all of the issues in the case study	Superficial and/or inappropriate solutions to some of the issues in the case study	Appropriate, well thought out comments about solutions, or proposals for solutions, to most of the issues in the case study	Well documented, reasoned and pedagogically appropriate comments on solutions, or proposals for solutions, to all issues in the case study	
Encourages participation	Incomplete research and links to any readings	Limited research and documented links to any readings	Good research and documented links to the material read	Excellent research into the issues with clearly documented links to class (and/or outside) readings	

Poster Presentation Attendees Evaluation

After the oral presentation, involved students, faculty members, and college staff members evaluated presentations using a session evaluation form. The feedback was given to each group. The rubric for evaluating the poster presentation can be found in Table 3.

Student Evaluation

We developed rubrics for both self- and peer-assessment of the groups' dynamics to ensure participation of each member (Table 4). Each student was asked to evaluate his or her own performance within the group, as well as asked to evaluate the

Table 3: Poster presentation grading rubric.

Criteria	Unsatisfactory 1	Minimal 2	Effective 3	Exemplary 4-5	Score
Creativity					
Visuals	No graphics; inappropriate graphics	Some graphics; appropriate to case; no additional info compared to text	Many graphics; relevant to case; added some additional info to text	Interesting graphics; very relevant to case; added significantly to info in text	
Criteria	**Unsatisfactory 1-5**	**Minimal 6-10**	**Effective 11-15**	**Exemplary 16-20**	**Score**
Content	Incomplete: Introduction, discussion, recommendations, conclusion, literature cited	Superficial: Introduction, discussion, recommendations, conclusion, literature cited	Thorough: Introduction, discussion, recommendations, conclusion, literature cited	Insightful & thorough: Introduction, discussion, recommendations, conclusion, literature cited	
Oral presentation	Literature not referenced; read directly from poster; could not answer questions; disorganized presentation; no eye contact	Mentioned some literature sources; little additional info; spoke hesitantly-only from cue cards/poster; answered some questions; little eye contact	Mentioned most literature sources; gave adequate additional info; spoke very well; answered most questions; some eye contact	Presented in a logical and clear fashion; extensive discussion of literature sources; superior additional information; spoke extremely well; answered questions thoroughly; good eye contact	

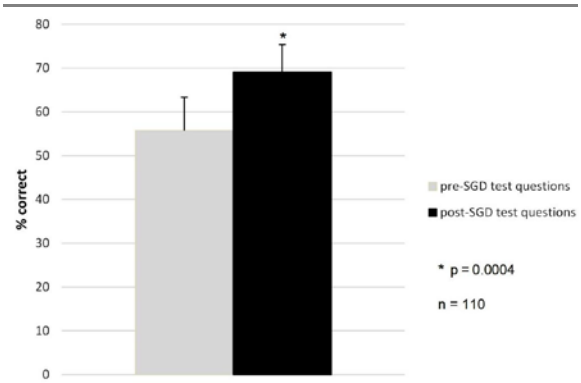


Fig. 2. The results of pre-small group discussion and post-small group discussion test questions (2009 – 2010).

Survey Responses

The 10-question survey tool (Table 5) answered by each student at the conclusion of the SGD project showed a positive significant impact ($p < 0.0001$ to $p < 0.0025$) on the students' knowledge, attitude, and psychomotor skills. In total, 299 students participated in answering the survey questionnaire during the first and second years of the study. The knowledge assessment showed that an average of 62.8% ($p < 0.0001$) of students strongly agreed that they: a) were provided with an effective learning experience using concepts presented in lecture and reading materials; b) were encouraged to use critical thinking skills to understand the subject matter; and c) had the opportunity to apply concepts learned about theory to solve problems in "real life" scenarios (see Figure 3).

The attitude assessment showed that an average of 60.4% students ($p < 0.0001$ to $p < 0.0025$) strongly agreed that they: a) were able to express their own knowledge; b) provided group motivation; c) influenced the generation of ideas; and d) had a

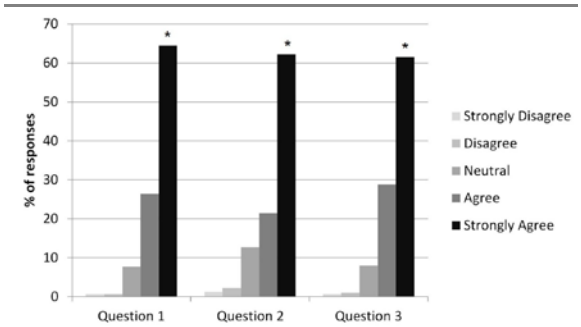


Fig. 3. Percentage of students' responses on the assessment of knowledge, n = 299, *p > 0.0001.
Question 1. Did I provide an effective learning experience using concepts presented in lecture and reading materials?
Question 2. Did the use of small group discussion encourage me to think more deeply and understand the subject matter?
Question 3. Did I provide the opportunity for the application of the presented concepts to solve problems in real life examples?

Table 4. Self and peer assessment rubric of small group discussion.

After your work is complete, evaluate your own work and that of your group mates using this rubric.
Circle one in parenthesis. Course: A & P (1, 2, 3) Section (001/ 002) Group # (1, 2, 3, 4)
Name: _____
Group Members: _____
Topic: _____
Dates the group met: _____

Criteria	Unsatisfactory 1 – 2	Minimal 3 – 4	Effective 5 – 7	Exemplary 8 – 10	Score
Understanding of the problems	Identifies and understands few of the issues in case study	Identifies and understands some of the issues in the case study	Identifies and understands most of the main issues in the case study	Identifies & understands all of the main issues in the case study	
Analysis of the Issues	Incomplete analysis of the issues	Superficial analysis of some of the issues in the case	Thorough analysis of most of the issues	Insightful and thorough analysis of all the issues	
Preparation for the discussion	Do not collect any information relating to the topic	Collect very little information- some relates to the topic	Collect some basic information- most relates to the topic	Collect great deal of information- all relates to the topic	
Listens and cooperates with group mates	Always talking and usually argue with group mates	Usually do most of the talking and sometimes argue	Listen but sometimes talk too much and rarely argue	Listen and speak in fair amount and never argue with group mates	
Encourages participation	Never ask for input from others	Sometimes ask for input from others	Often ask for input from others	Make sure that all group members contribute to decisions about major points	

positive attitude toward learning (see Figure 4).

The psychomotor skill assessment showed that an average of 73.4% students ($p < 0.0001$), strongly agreed that: a) they actively performed the task with the group; b) the group successfully applied principles taught regarding problem solving; and c) they were personally active in application of the principles taught by offering probative ideas, suggesting interpretations, sharing their personal positions, and utilizing interpersonal skills (see Figure 5).

Upon completion of the SGD project, we collated student's reflections and comments. These demonstrated thoughtful and meaningful contemplation of what they had learned individually, what they learned as a group, how they identified potential problems arising from SGD, and what solutions were achieved while working toward the common goal. A sampling of reflections and comments can be found below:

1. **What I liked in small group discussion of case-based problems.**
   - How our group worked together and finds time to meet and put all our effort and solicit information and ideas.
   - It was interesting and familiar yet it challenged our group to brainstorm and use critical thinking skills.
   - I liked being able to discuss topics that we learned in class with my group mates and also gave us a chance to apply our learning to a situation.
   - It was nice learning something new. I really enjoyed doing this.
2. **What I would do in the next small group discussion.**
   - Utilize computer during out of class discussions to expedite answers or issues brought up, and clearer understanding of resources should also be addressed by our group.
   - I would like to see more preparations for the discussion and more verbal input from some group members.
   - Picking my own group would be nice. Perhaps can choose our case to work on.
   - I do not like group work and would actually prefer not to do another SGD.
3. **What do I think about my group participation and attainment of the goal?**
   - My group was encouraging and we all got along well together.

Table 5. Survey tool on the assessment of collaborative learning.

Fill out the following survey regarding how you interacted within your group. "I" and "me" refers to the student filling out the survey.					
Direction: Kindly answer the questions by putting a check mark on each item according to the rating scale below. 1- strongly disagree 2- disagree 3- neutral 4- agree 5- strongly agree					
ON KNOWLEDGE	1	2	3	4	5
1. Did I provide an effective learning experience using concepts presented in lecture and reading materials?					
2. Did the use of small group discussion encourage me to think more deeply and understand the subject matter?					
3. Did I provide the opportunity for the application of the presented concepts to solve problems in real life examples?					
ON ATTITUDE					
4. Did it give me an opportunity to express what I know?					
5. Did I motivate group members and encourage collaboration on focused questions or problems?					
6. Did I influence and stimulate the generation of ideas from the group?					
7. Did I develop positive attitudes toward learning and use of presented material?					
ON PSYCHOMOTOR SKILL					
8. Did I perform a task actively with the group?					
9. Did the group successfully apply the principles taught to problem solving in small group discussion?					
10. Was I personally active in the application of the principles taught? (offering probative ideas, suggesting interpretations, sharing personal positions, beliefs, communication and listening)					
Write any additional comments and suggestions about your learning experience.					

- My group had a conflict of finding time to meet, but everyone did great giving their thoughts and opinions.
- Everyone had a lot of interesting and conflicting information.
- Some people did a lot of work and some did very little.

4. General comments on group's activity

- The final paper was hard to write because of many possibilities we thought. But we did it.
- I felt comfortable and confident expressing my opinion in my group.
- Great to have small groups working together, rely on each other, and put our lectures to use in thinking outside the classroom.
- I don't usually like to work with other students, but I thought the case study was very helpful & effective.

The poster presentation of case-based problems was an important part of the small group project. It provided our students with an opportunity to explain their work to an audience, as well as generate active discussion and outside evaluations. A sampling of these reviews can be found below:

- Just wanted to say how impressed I was with the students' work. It was very clear from their presentations how well they all worked together and the wonderful knowledge and experience they gained from this exercise. The confidence with which they discussed their findings was truly inspiring - proves how important it is to give our students opportunities to go beyond the immediate classroom environment to learn and share with the wider community. So thank you to you and your students - in fact you have given me something to think about for my own teaching! (P. M., MEd, Director, UCCC, TLC)
- Thanks for your work on this project where the students learned teamwork, solving problems and effective communication skills. (G.S., Ph. D., Dean, UCCC)
- All group members presented information in an easy to understand manner and were very informative. Great speaking skills and good visuals. (A.C., HSS Faculty).
- Students knew what they are talking about. The presentation was very informative, presenters were relaxed, and answered questions comfortably, not rehearsed (L. K., Academic Advisor).
- Thank you for the great opportunity for our PTA majors-it was a nice diagnostic approach that included the clue finding in exploring the various conditions to rule out or in. (S. C., PTA Faculty)

DISCUSSION

The integration of basic sciences with patient care has been supported by various studies and has proven to be a valuable strategy in the reinforcement of basic science courses (Percac and Goodenough, 1998; Stalburg and Stein, 2002). However the use of case-based problems facilitated through small group discussion needs to be explored further regarding

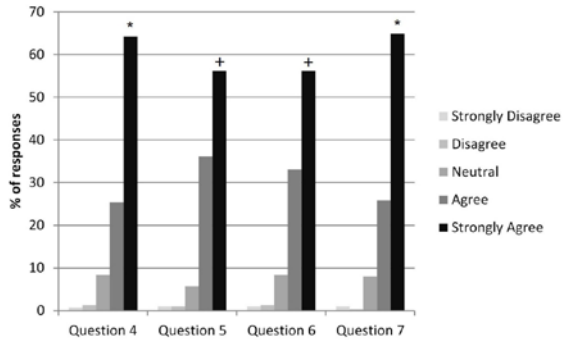


Fig. 4. Percentage of students' responses on the assessment of attitude, n = 299, *p > 0.0001, + p < 0.0025.
Question 4. Did it give me an opportunity to express what I know?
Question 5. Did I motivate group members and encourage collaboration on focused questions or problems?
Question 6. Did I influence and stimulate the generation of ideas from the group?
Question 7. Did I develop positive attitudes toward learning and use of presented material?

method of delivery of the learning strategy and its impact on student learning. We approached this study by providing a structured case, with focused questions, to serve as a guide for creating dialogue among each group's members. The case-based approach allows our students to generate a solution by engaging in independent research, analyzing data, and reflecting on their own learning experience. The ultimate objective was to present a clinical diagnosis in a written report and in an oral poster presentation that was a reflection of the entire group's work.

In addition to the cognitive process that they underwent, the students had the opportunity to enhance their confidence in problem solving because of the given chief complaint and brief clinical history. They had to investigate to discover and identify the diagnosis given the various presentations and associated findings. Utilizing the physical presentation, laboratory and radiographic results, each group had to formulate a diagnosis and present relevant information regarding statistical data, management of the presenting problem, prevention and/or rehabilitation of their patient. Thus early exposure to this is valuable in influencing our students' ability to apply and translate knowledge into a real life, clinical setting.

By utilizing collaborative learning to solve case-based problems in SGD, statistical analysis demonstrated that students who participated in the small group discussion project had a significant improvement in achievement on post-SGD test questions (after participation in the SGD project) compared to pre-SGD test questions (prior to participation in the SGD project). Furthermore, a statistically significant number of students indicated that participating in SGD had a positive impact on their assessment of their own knowledge, attitude and psychomotor skills.

Small Group Discussion fosters an effective learning experience in applying knowledge to clinical problems. In this study, a statistically significant number of students felt that participating in SGD helped them improve their critical thinking skills and academic achievement, as well as develop interpersonal skills.

Future research is needed to investigate the effect of different variables, such as the group selection process (random vs. non-random selection), group size (3-5 vs. 6-10 group members), group composition (major field of study homogeneity vs. heterogeneity), amount of teacher intervention or consultation, and student's preferences as to learning styles (individual vs. small group).

Instructors may apply this study to other disciplines to understand and analyze problem solving, learn critical thinking skills, and ensure group task of the learners. This approach is applicable to a variety of other courses.

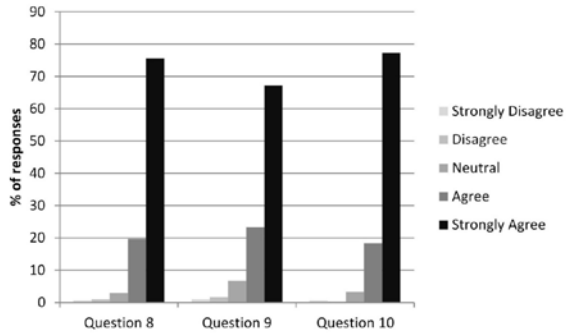


Fig. 5. Percentage of students' responses on the assessment of psychomotor skill, n = 299, *p > 0.001.
Question 8. Did I perform a task actively with the group?
Question 9. Did the group successfully apply the principles taught to problem solve in small group discussion?
Question 10. Was I personally active in the application of the principles taught?

REFERENCES

AMERICAN ASSOCIATION OF COLLEGES OF NURSING. 2008. *The Essentials of Baccalaureate Education for Professional Nursing Practice.* Accessed from http://www.aacn.nche.edu/education-resources/essential-series on 22 February 2013.

AMERICAN PHYSICAL THERAPIST ASSOCIATION. 2013. Role of a Physical Therapist Assistant. Accessed from http://www.apta.org/PTACareers/RoleofaPTA/ on 22 February 2013.

FEINGOLD C., COBB M., GIVENS R., ARNOLD J., JOSLIN S., AND J. KELLER. 2008. Student Perceptions of Team Learning in Nursing Education. *Journal of Nursing Education.* 47(5): 214-22.

JOHNSON, D. W., JOHNSON, R.T., AND K. A. SMITH. 1991. *Active Learning: Cooperation in the College Classroom*. Interaction Book Company, Edina MN. 270p.

JOHNSON, D., JOHNSON, R., AND E. JOHNSON HOLUBEC. 1993. *Circles of Learning: Cooperation in the Classroom*, 5th ed. Interaction Book Company, Edina MN. 224p.

JOHNSON, D. W., JOHNSON, R.T., AND K. A. SMITH. 1998. Cooperative learning returns to college: What evidence is there that it works? *Change: The Magazine of Higher Learning*. 30 (4): 27-35.

PERCAC S., AND D. A. GOODENOUGH. 1998. Problem based teaching and learning as a bridge from basic anatomy to clinical clerkships. *Surgical and Radiological Anatomy*. 20 (3): 203-207.

TOTTEN, S., SILLS, T., DIGBY, A., AND P. RUSS. 1991. *Cooperative Learning: A Guide to Research*. Garland, New York. 390p.