

TEACHERS' TOPICS

The Utility of Concept Maps to Facilitate Higher-Level Learning in a Large Classroom Setting

Sian M. Carr-Lopez, PharmD, Suzanne M. Galal, PharmD, Deepti Vyas, PharmD, Rajul A. Patel, PharmD, PhD, Eric H. Gnesa, MS

University of the Pacific, Thomas J. Long School of Pharmacy and Health Sciences, Stockton, CA

Submitted January 31, 2014; accepted April 21, 2014; published November 15, 2014.

Objective. To describe the utility of concept mapping in a cardiovascular therapeutics course within a large classroom setting.

Design. Students enrolled in a cardiovascular care therapeutics course completed concept maps for each major chronic cardiovascular condition. A grading rubric was used to facilitate peer-assessment of the concept map.

Assessment. Students were administered a survey at the end of the course assessing their perceptions on the usefulness of the concept maps during the course and also during APPEs to assess utility beyond the course. Question item analyses were conducted on cumulative final examinations comparing student performance on concept-mapped topics compared to nonconcept-mapped topics.

Conclusion. Concept maps help to facilitate meaningful learning within the course and the majority of students utilized them beyond the course.

Keywords: concept mapping, critical thinking, active learning

INTRODUCTION

Therapeutics courses in pharmacy curriculum build upon foundational science, introduce new evidence and approaches to patient care, and require critical analysis to make decisions about drug therapy for individuals. In order to grasp the vast amount of information in such a course, students may have a tendency to memorize facts rather than learn the material. To avoid this, the Accreditation Council for Pharmacy Education requires the use of active-learning techniques to promote critical thinking among students, facilitating the integration of new materials with existing knowledge.¹ Providing active-learning opportunities, particularly in a large classroom, is difficult and requires the use of approaches such as concept mapping, which are relatively easy to implement and promote meaningful learning.

Concept mapping refers to a visual representation of key ideas or thoughts in a graphic or pictorial form. Concept mapping allows the learner to identify relationships between seemingly isolated concepts while developing a cohesive knowledge structure. This conceptualization promotes in-depth learning rather than rote memorization and allows the learner to understand the global concept rather than isolated facts.² In addition, constructing a

concept map requires students to collect relevant information and sequence it in a hierarchical fashion. To successfully develop a concept map, students must understand the relative importance of each idea within the overall context. Ultimately, concept mapping should result in improved long-term retention of the course material. In pharmacy education, this technique is useful in identifying links between knowledge structures learned in other courses and new concepts currently being explored.³⁻⁴ In therapeutics courses, the use of concept mapping can be integral to linking theory, facts, and concepts to pharmacy practice and patient care. Concepts such as drug indications, drug-drug interactions, contraindications, adverse drug reactions, etc, can be integrated into a concept map depicting relationships of first-line therapy options, alternatives, and monitoring requirements. Development of such a map requires students to compile information acquired in previous courses, such as pathophysiology, pharmacokinetics, and pharmacology, and link it within a therapeutic framework. This requires the application of functional knowledge. As such, a concept map can more closely resemble thinking patterns than the linear approach of most course assignments.⁵

Concept maps are a useful educational tool in both teaching new principles and assessing student knowledge.³⁻¹² Heinze-Fry and colleagues compared a group of students who developed concept maps in a biology

Corresponding author: Dr. Suzanne Galal, University of the Pacific, 3601 Pacific Avenue, Stockton, CA 95211. Tel: 209-946-3918. Fax: 209-946-2390. E-mail: sgalal@pacific.edu

tutorial course to a control group in the course. The mapping group achieved slightly higher mean scores on both a multiple-choice exam and an oral examination.⁶ Hill described the use of a concept mapping assignment in a pharmacy communications course and found that, with practice, students working in small groups were able to develop sophisticated maps depicting pharmacy communications.³ In similar findings, Hsu and colleagues used concept map assignments in a nursing course and found that iterations of the maps were more complex as the semester progressed and showed a greater understanding among learners of the relationships between concepts.⁷ Gonzalez found that students who used concept maps in a human physiology course performed better on problem-solving examinations than those who attended traditional discussion sessions and concluded that concept mapping facilitated meaningful learning and resulted in improved problem-solving abilities.⁸

In a study to determine the impact of concept mapping on critical thinking abilities, Atay compared California Critical Thinking Disposition Inventory (CCTDI) scores of an experimental group, who used concept maps, to a control group, who did not. Based on their significantly better scores on the CCTDI, Atay argued that the experimental group had developed better critical thinking skills than the control group.⁹ In the clinical field, Cutrer and colleagues found that resident physicians who used concept maps as an advanced means of organizing performed better on an assessment measure than the control group and concluded that concept maps improve knowledge organization.¹⁰

Thus, the literature strongly suggests that concept maps are useful in helping learners identify links between new information and existing knowledge. Since therapeutics courses are designed to integrate foundational theory with new information, concept map assignments are a natural fit in these courses. Active-learning strategies are critical, yet pose challenges for course coordinators, especially for those who must integrate such strategies and appropriate assessment activities into large classroom settings. Concept maps can resolve both issues as they can be a tool enabling learners to construct meaningful knowledge while providing faculty members with an assessment of student learning.

Evidence for the use of concept mapping in therapeutics courses, and in pharmacy education in general, is lacking. In this paper, we describe the utility of concept mapping assignments in a cardiovascular therapeutics course, particularly regarding student attitudes toward concept mapping by the end of the course and during practice experiences, along with the potential use of mapping in developing questions on a cumulative final examination that require higher-level thinking by students.

DESIGN

Concept mapping activities were implemented into a cardiovascular care therapeutics course taught in the fifth semester of the doctor of pharmacy curriculum. The typical class size was approximately 200 students. The course description stated the course would enable students to design and implement evidence-based pharmaceutical care plans for patients with cardiovascular disease, or for those at high risk for cardiovascular disease. Patient care plans emphasize appropriate use and monitoring of drug therapy in the management or prevention of disease.

The teaching methodologies used include didactic lectures, individual and team assignments, case-based activities, activities based on reading assignments, treatment guidelines, primary literature on landmark clinical trials, student presentations, and concept mapping. The course concluded with a cumulative final examination. At completion of the course, students were expected to achieve the learning objectives outlined in Table 1, with items 2-4 expected to be most impacted by integration of concept mapping.

Concept maps were used for 5 chronic conditions covered in the course. They included hypertension, systolic heart failure, coronary heart disease, atrial fibrillation, and venous thromboembolism. After completing the lecture series for each of the 5 conditions, students were given instructions on the core elements to include in the creation of a concept map (Appendix 1). Originally designed as an in-class assignment with a 2-hour discussion session, students were unable to complete the assignment within the time-frame. Subsequently, concept maps were administered as take-home assignments. Students were expected to work independently and develop their own concept map addressing items from the assignment, such as nonpharmacologic interventions indicated for the condition, pharmacologic interventions including first-line therapy and alternatives, contraindications, and monitoring requirements. Students were given the option to create the concept map on paper, or as a computer-generated document.

A portion of a completed concept map is provided as Figure 1. A grading rubric was developed by the course coordinator to facilitate peer-assessment of the concept map. Concept maps comprised an eighth (50 out of 400 points) of the possible points for the course. Each concept map was worth 10 points.

The impact of instituting concept mapping was assessed in 3 ways. First, during the pilot year, students were surveyed at the end of the course to assess usefulness of concept maps in organizing material and focusing on clinically relevant material. Students were also asked if

Table 1. Cardiovascular Care Course Learning Objectives

- (1) Determine which diagnostic criteria is present in an individual for each of the cardiovascular conditions; appreciate the differences in patient presentation between chronic/stable conditions from acute deterioration of the condition.
- (2) Critique the treatment guidelines for each condition from national organizations (eg, American Heart Association/American College of Cardiology); incorporate findings from landmark clinical trials into the development of patient care plans.
- (3) For an individual, choose the goals of treatment for each condition.
- (4) Develop individualized treatment and monitoring plans that improve health-related outcomes (morbidity and mortality) and quality of life; recognize that factors such as gender or ethnicity may impact patient presentation and/or the risks/benefits of treatment.
- (5) Create persuasive consultations for patients that encourage effective lifestyle changes including nutrition, exercise, and adherence to medication.
- (6) Create persuasive consultations for prescribers that advocate for optimal drug therapy for patients including evidence-based drugs of choice and cost effective therapy.

concept maps should continue to be utilized in the course in subsequent years. The second year concept maps were used, rather than surveying students immediately following the course, students were surveyed during their advanced pharmacy practice experiences (APPEs), approximately 8 months after the completion of the

cardiovascular care course. The purpose of the survey was to determine the utility of concept maps beyond the course, particularly during the on-campus practicum courses and during APPEs. Third, the impact of concept maps on student performance on cumulative final examinations for the 2 consecutive years was assessed. Final examination

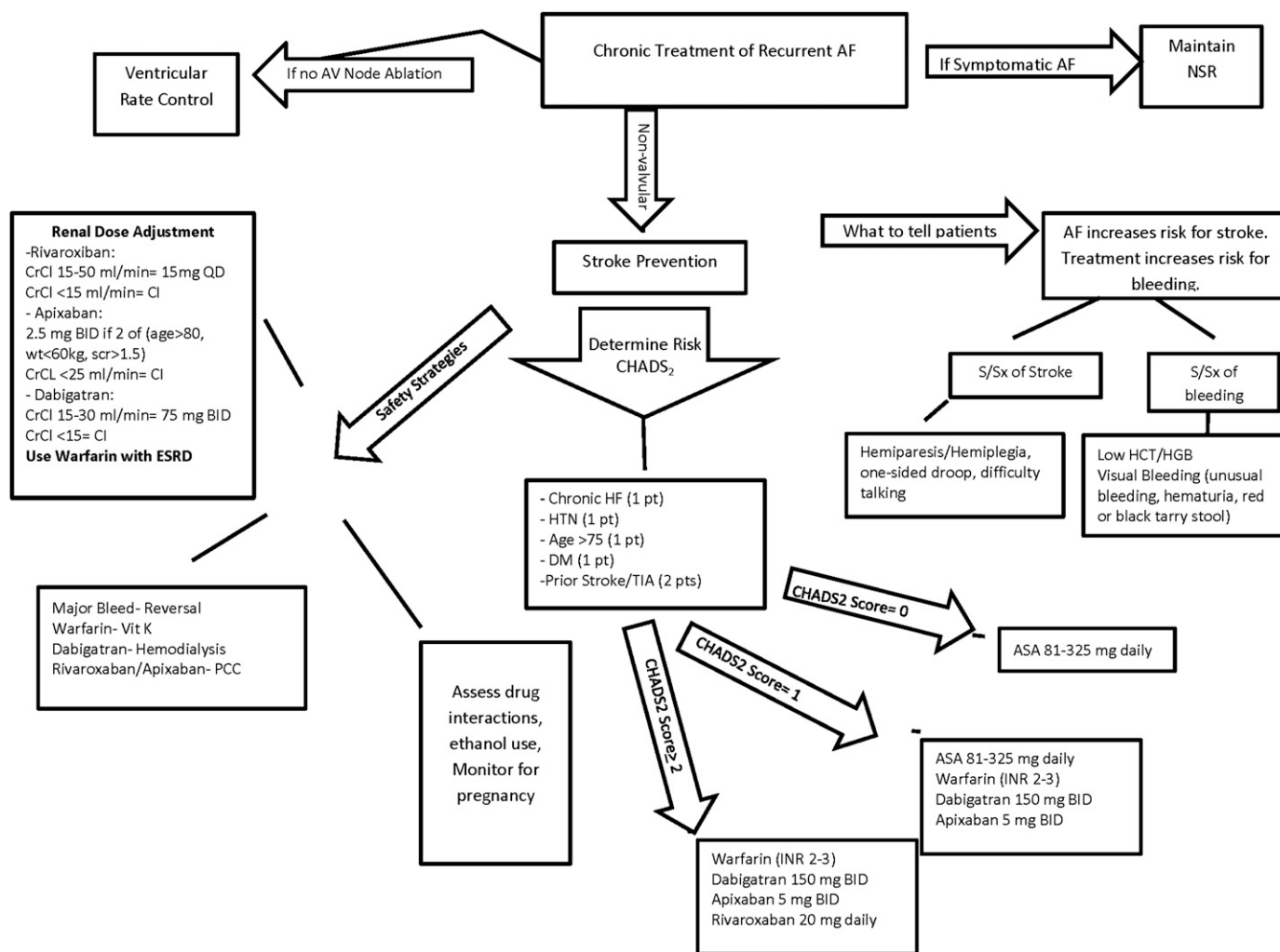


Figure 1. Example of a portion of an atrial fibrillation concept map

questions were separated into 2 categories: questions written about topics that students mapped, and questions written about topics students did not map. Bloom's Taxonomy was used to classify examination questions as either a lower cognitive level question (knowledge or comprehension), or a higher cognitive level question (application, analysis, synthesis, or evaluation). The final examination questions were categorized into one of the 2 cognitive levels independently by 2 faculty members. Question item analysis was performed for each question, specifically the item difficulty index (DI) and point biserial (PB). The DI refers to the proportion of students who answer a question correctly, with a higher value indicating that a question is relatively easy. The PB is the correlation between student performance on a particular question and the student's overall performance on an assessment. A large PB would indicate that higher performing students answered the question correctly and lower performing students answered the question incorrectly. A DI of less than 0.63 for a 4-choice question is considered ideal and a PB of >0.3 is considered within the acceptable range,¹³ so both were recorded accordingly for each final examination question. Questions about concept-mapped topics were compared to questions about topics that were not concept mapped.

Students were asked to evaluate the utility of concept maps to their learning by indicating their level of agreement with different statements on a 5-point Likert scale (1=Strongly Agree to 5=Strongly Disagree). Descriptive statistics (eg, frequency counts) were reported on such data. Inferential statistics (independent sample *t* tests) were performed to identify if the DI or PB varied as a function of whether the question was concept mapped. The chi-square test was used to test whether the categorization of an item according to Bloom's Taxonomy was dependent on whether it had been mapped. All inferential statistics were performed at a priori alpha level of 0.05. Data analyses were performed using SPSS, version 21.0 (IBM, Armonk, NY). The project was approved as an exempt protocol by the University of the Pacific's Institutional Review Board.

EVALUATION AND ASSESSMENT

Surveys were conducted to assess student perspectives regarding the utility of concept maps. For the pilot year, 141 of 186 students (76%) completed the survey at the end of the course. Of the 141 respondents, 123 (87%) agreed or strongly agreed with the statement "The concept map assignments were useful to organize the material relating to a disease state or condition." One hundred seven (76%) agreed or strongly agreed that "The concept map assignments enabled me to focus on clinically relevant material used to make decisions about patients' drug

therapy." One hundred nine (77%) agreed or strongly agreed that "The concept map assignments should continue to be included in the course for future students."

A second survey assessed the utility of concept maps beyond the cardiovascular care course. Of the 166 (75%) survey responses from 220 students during APPEs, approximately 60% reported using concept maps on APPE rotations and nearly all responded that they agreed that concept maps helped to organize and synthesize treatment strategies and goals and to conceptualize the broad picture of drug and nondrug treatment for common cardiac conditions (Table 2). Final examination questions for the 2 consecutive years were compiled, separated into 2 categories, one for questions about concept-mapped topics ($n=72$) and the other for questions on topics that were not concept-mapped ($n=45$). Two faculty members independently classified questions using Bloom's Taxonomy and there were no discrepancies in their classifications for any question.

Question item analysis on 117 final examination questions revealed no significant differences in DI or PB between questions that were concept-mapped and nonconcept-mapped. However, a greater number of higher-level Bloom's Taxonomy questions were written for the concept-mapped topics ($n=59/72$, 82%) than were written for the nonconcept-mapped topics ($N=18/45$, 40%). Questions about concept-mapped topics were significantly ($p<0.01$) associated with a higher Bloom's category. Even though more higher-level cognitive questions were written for concept-mapped topics, the percent of students who answered the questions correctly (DI) was not different for questions about concept-mapped topics compared to nonconcept-mapped topics.

Implementing concept mapping into the therapeutics course required minimal technological resources. Although some students chose to develop their maps using a computer, others used paper. The most significant resource needed was faculty member time. An introduction to concept mapping was presented to students each year prior to the first concept map assignment. Each concept map assignment was developed by the course coordinator. For the large class size, individual grading by faculty members was not feasible, but for smaller programs, that option would be possible. A grading rubric was developed so that peer-assessment could be conducted. The rubric was developed to determine the accuracy of the concepts, not the creativity, utility, or the sequence of ideas. Office hours dedicated to regrading the peer-assessed maps was required.

DISCUSSION

In our study, concept maps were used as an active-learning activity for each of 5 chronic conditions and as

Table 2. Responses to a Survey Administered to Students During Advanced Pharmacy Practice Experiences (N=166)

| Please rate your level of agreement with the following statement: | Strongly agree n (%) | Agree n (%) | Disagree n (%) | Strongly Disagree n (%) | Not Applicable n (%) |
|--|-----------------------------|--------------------|-----------------------|--------------------------------|-----------------------------|
| Concept maps helped me conceptualize the broad picture of drug and nondrug treatment for a given cardiovascular condition. | 96 (58) | 68 (41) | 2 (1) | 0 (0) | 0 (0) |
| Concept maps helped me organize and synthesize treatment strategies and goals for common cardiac conditions. | 101 (61) | 61 (37) | 4 (2) | 0 (0) | 0 (0) |
| I used my concept maps during Practicum to help with evaluating and designing patient care plans. | 77 (46) | 59 (36) | 20 (12) | 8 (5) | 1 (1) |
| I used my concept maps during my ambulatory care advanced pharmacy practice experience. | 41 (25) | 60 (36) | 43 (26) | 14 (8) | 8 (5) |
| I used my concept maps during my internal medicine advanced pharmacy practice experience. | 48 (29) | 55 (33) | 41 (25) | 18 (11) | 4 (2) |
| I used my concept maps during other advanced pharmacy practice experiences. | 46 (28) | 51 (31) | 49 (30) | 17 (10) | 3 (2) |

a summative assessment tool at the completion of each of the 5 chronic condition sections of the course. We found that concept mapping assisted students with organizing and focusing on clinically relevant materials used to make patient-care decisions. Among the advantages of using concept maps is the potential for students to learn material more deeply. Students in our study reported that concept maps helped them synthesize treatment strategies and conceptualize broad approaches to pharmacologic and nonpharmacologic management of chronic conditions. It also had utility beyond the course, as approximately 60% of students reported using their maps during ambulatory care and internal medicine APPEs, and more than 80% reported using them in a practicum course during therapeutics discussion sessions.

Concept maps have a range of utility. While some active-learning strategies involve teams of learners, concept mapping can give students the opportunity to design maps individually. Concept mapping provides faculty members with the flexibility of having students work independently, or in small groups. They may also be used as a summative assessment at the completion of a given chronic condition module. The use of a grading rubric enables utility of concept maps as a summative assessment in a large classroom setting.

Gardner and Monaghan used knowledge maps in gastrointestinal and cardiovascular modules within a pharmacy therapeutics course, and students experienced improved examination scores and overall comprehension of materials.¹⁴ Knowledge maps differ from concept maps in that knowledge maps do not require hierarchical organization of concepts, and the relationships or links are

standardized, whereas with concept maps, individuals must define the relationships. Although our study did not demonstrate improvement in examination scores, students were able to perform as well on concept-mapped questions associated with a higher Bloom's cognitive category as they did on questions about nonconcept-mapped topics.

Concept mapping did present faculty members with various challenges. For example, faculty members had to develop instructions for each chronic condition in order for students to use the maps as active-learning tools. Instructions assisted students in 'filling in' their concept maps, guiding students to include the most relevant information, but allowing them to develop their own graphic representation, including how they chose to relate items to each other and how they described those relationships. Additionally, feedback for students regarding their concept maps required faculty member-assessment or peer-assessment. Due to the large class size, faculty members could not provide feedback to each student for each mapping assignment. A peer grading rubric was developed which primarily assessed if the content was accurate. The relationships and description of those relationships was not assessed. Thus, assessment of the impact of concept mapping in this study relied on student perception and student performance on cumulative final examinations.

One significant challenge for faculty members, besides the resources required to create the instructions and the grading rubrics, was that students were generally resistant to this process. Students are familiar, and thus more comfortable with multiple-choice exams, journal clubs, patient case assignments, and group activities. They are not familiar with concept mapping. Our program

uses a course liaison system for formative assessment, and feedback from the liaisons following the first 2 assignments was that the majority of students did not like concept maps. Perhaps one explanation for their dislike was that concept maps took a long time to develop. Initially, students were given time during the discussion section to develop maps. However, this process was modified so that students could complete the assignments as homework. Moreover, students did not like having peers use the grading rubric to determine points earned for the assignment. Students preferred to have a faculty member grade their map. Offering the opportunity for a faculty member to re-grade the assignment mitigated student frustrations, but created additional work for the faculty member.

The impact of concept mapping on student performance in the practice setting was not assessed. Our design compared student performance on concept-mapped topics to nonconcept-mapped topics on a final examination. Our design did not include a control group for comparison. Lastly, incorporation into other therapeutics courses within our curriculum will be dependent on faculty interest and acceptance of the additional workload associated with concept mapping assignments.

SUMMARY

Overall, concept maps facilitated meaningful learning in a large classroom setting of a therapeutics course. Students reported that concept maps helped them synthesize and conceptualize treatment strategies and goals for 5 chronic cardiac conditions. Students were able to perform as well on examination questions about concept-mapped topics as they did on questions about nonconcept-mapped topics even though the former were written at a higher Bloom's Taxonomy cognitive classification. Concept maps also showed potential utility beyond the course, as students reported using them in other settings such as practice experiences and practicum discussion sections.

ACKNOWLEDGMENTS

Drs. Carr-Lopez and Galal wish to acknowledge Dr. Jace Hargis for his mentorship while he served as Director

of the Center for Teaching and Learning at the University of the Pacific, and for his profound influence on our development as faculty members.

REFERENCES

1. Accreditation Council on Pharmacy Education. Accreditation standards and guidelines for the professional program in pharmacy leading to the doctor of pharmacy degree. <https://www.acpe-accredit.org/pdf/FinalS2007Guidelines2.0.pdf>. Accessed January 2, 2014.
2. Novak JD. Meaningful learning: the essential factor for conceptual change in limited or inappropriate propositional hierarchies leading to empowerment of learners. *Sci Educ*. 2002;86(4):548-571.
3. Hill LH. Concept mapping in a pharmacy communications course to encourage meaningful student learning. *Am J Pharm Educ*. 2004;68(5):Article 9.
4. Abate MA, Meyer-Stout PJ, Stamatakis MK, Gannett PM, Dunsworth TS, Nardi AH. Development and evaluation of computerized problem-based learning cases emphasizing basic sciences concepts. *Am J Pharm Educ*. 2000;64(1):74-82.
5. Baugh NG, Mellott KG. Clinical concept mapping as preparation for student nurses' clinical experiences. *J Nurs Educ*. 1998;37(6):253-256.
6. Heinze-Fry JA, Novak JD. Concept mapping brings long term movement towards meaningful learning. *Sci Educ*. 1990;74(4):461-472.
7. Hsu L, Hsieh S. Concept Maps as an assessment tool in a nursing course. *J Prof Nurs*. 2005;21(3):141-149.
8. González HL, Palencia AP, Umaña LA, Galindo L, Villafrade M LA. Mediated learning experience and concept maps: a pedagogical tool for achieving meaningful learning in medical physiology students. *Adv Physiol Educ*. 2008;32(4):312-316.
9. Atay S, Karabacak U. Care plans using concept maps and their effects on the critical thinking dispositions of nursing students. *Int J Nurs Pract*. 2012;18(3):233-239.
10. Cutrer WB, Castro D, Roy KM, Turner TL. Use of an expert concept map as an advance organizer to improve understanding of respiratory failure. *Med Teach*. 2011;33(12):1018-1026.
11. Pinto AJ, Zeitz H. Concept mapping: a strategy for promoting meaningful learning in medical education. *Med Teach*. 1997;19(2):114-121.
12. Qadir F, Zehra T, Khan I. Use of concept mapping as a facilitative tool to promote learning in pharmacology. *J Coll of Physicians Surg Pak*. 2011;21(8):476-481.
13. Shakil M. Assessing student performance using test item analysis and its relevance to the state exit final exams of MAT0024 Classes-An Action Research Project. *Polygon*. 2008;2 (II).<http://www.mdc.edu/hialeah/Polygon2008/articles/shakil3.pdf>. Accessed February 15, 2013.
14. Gardner SF, Monaghan MS, Peel J. Knowledge maps improve comprehension in therapeutics. *Am J Pharm Educ*. 1996;60(Spring):56-59.

Appendix 1. Sample of Instructions Given to Students to Create a Concept Map

Instructions for the Atrial Fibrillation Concept Map

Label your concept map “Chronic Treatment of Recurrent Atrial Fibrillation.”

Develop 3 areas (if you like, extend 3 lines from the title box and label them) “Rate Control,” “Stroke Prevention in Non-valvular AF” and “Maintain Sinus Rhythm in Non-Permanent, Symptomatic AF.”

- For rate control
 - Indicate HR targets and drug options for rate control.
 - Specify when specific drugs should be avoided.
 - Specify when specific drugs are preferred.

 - For stroke prevention
 - List the conditions in CHADS₂ and indicate when specific agents (aspirin, warfarin, dabigatran, apixaban, and rivaroxaban) are indicated based on the CHADS₂ score.
 - List the INR goal for warfarin and the acceptable INR range, contraindications to warfarin, along with signs/symptoms of bleeding (supra-therapeutic INR) AND stroke (sub-therapeutic INR) and warfarin antidote.
 - Specify appropriate stroke prevention in patients with AF and mitral mechanical valve replacements.
 - For the alternative to warfarin, list dosing considerations with normal and with renal impairments (specify CrCl), contraindications, and reversal strategies.

 - For rhythm control in symptomatic patients
 - List the agents that are indicated first-line for each of the following: no or minimal cardiac disease, HTN with LVH, CHD, and HF.
 - List the contraindications and black box warning for dronedarone.
 - For amiodarone, list the monitoring parameters.
 - Identify oral agents also effective for cardioversion.
-