Concept Mapping as a Tool for Didactic Learning and Case Presentation in an Optometric Curriculum

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Abstract

This pilot project aimed to explore the use of a concept mapping tool to support learning and integration in an optometry curriculum. Results suggest that faculty believe concept mapping can help students demonstrate their processing of information and ability to synthesize basic and clinical sciences. Student acceptance of the learning tool was mixed. Better acceptance by students may result if faculty incorporate the learning tool early and consistently throughout the curriculum and provide greater support and feedback to students. Further research is needed to understand any long-term benefits to student learning and clinical care.

Key Words: *concept map, mind map, optometric education, integration, critical thinking*

Introduction

Integrating theory and practice has long been a goal and necessity of medical training. Particularly in the past two decades, medicine has experienced exponential growth in the biomedical knowledge expected of students. Thus, it has become important to develop more systematic methods to integrate acquired knowledge with the aim of better applying it to practical scenarios. A “concept map” or “mind map” is a graphical tool for organizing and presenting knowledge. David Ausubel is widely credited as being the creator of the concept map.[1] His assimilation theory of learning, as presented in his 1968 work *Educational Psychology: A Cognitive View* forms the basis upon which the concept map is built.

The effectiveness of concept maps as a teaching tool in healthcare education is equivocal. Maneval et al.[2] showed that nursing students taught skills using their traditional care-planning method scored significantly better on examinations than students taught with a concept mapping method. A review by Pudelko et al.[3] suggested that there was not sufficient evidence to support the hypothesis that mapping improved the acquisition of knowledge, memorization or recall. On the other hand, it has been shown that employing concept maps in problem-based learning tutorials is feasible, acceptable to both students and teachers, and can enhance learning and exam performance.[4-6] Specifically, Torre et al.[7] showed that the use of concept maps strengthened the connection between theoretical information and clinical practice, promoting a higher capacity for problem-solving and holistic thinking and improved recognition of patterns or trends in clinical care. It was thought that this facilitated the ability to form and evaluate differential diagnoses by medical students. Participants in this project indicated a sense of connection between learning styles and the perceived value of concept maps.[7] Similarly, nursing students who self-identified as visual learners reported feeling that concept maps were easier to master.[8] These findings suggest that mapping exercises may not support learning equally for all students.

In 2010 the curriculum at the State University of New York (SUNY) College of Optometry was revised. One of the goals of the revised curriculum was to improve the ability of students to integrate basic and clinical sciences. The purpose of the pilot projects presented here was to gauge the utility and acceptance of concept maps among select groups of optometry students, and to determine whether the exercise improved their ability to integrate didactic knowledge and clinical care in a clear, cohesive way.

Methods

This pilot project was approved by the SUNY Optometry Institutional Review Board as exempt under educational settings (Code of Federal Regulations 45 CFR 46.101(b)(1)). The project was performed in three arms, with each arm utilizing the concept map software Mindomo (Mindomo, Expert Software Applications, Timisoara, Romania). Each arm of the project was performed successively, incorporating lessons learned from the prior projects. In each arm, the Academic Program Coordinator (JP) and Library Director (EW) provided demonstrations of the software to the course instructors and student participants.

Mindomo is a cloud-based software presentation program that allows real-time collaboration but can also support off-line use. The software integrates with Google Drive, Microsoft PowerPoint, Blackboard and Dropbox, and maps can be saved in multiple formats. To begin constructing a map in the program, the user chooses a template and assigns a title to the map. The user can then create a main topic and subtopics with further branches to expand areas of interest. Users can add photos and links to websites, journal articles or other points of reference.

The first arm of this project was a small (n = 5) focus group with third-year students in a Contact Lens II course. The goal was to allow students time to utilize the software with a given task and to provide feedback. Students volunteered to participate in a one-hour guided concept map instruction session. Topics for the concept maps were selected from the Contact Lens II curriculum by the Course Instructor (KR) to encourage incorporation of basic knowledge (e.g., ocular anatomy, optics) and clinical application (e.g., fitting of orthokeratology or multifocal contact lenses). Students selected from the list of potential topics and, after an in-person training session, were allowed to work with the software for the entire semester. They were asked to provide feedback to the Course Instructor, Academic Program Coordinator or Library Director.

In the second arm of the project, second-year students (n = 84) were invited to complete a concept map as part of the Contact Lens I course. The project was included in the syllabus as a graded assignment. The students were assigned to groups of six with individual grade-point averages taken into consideration to ensure a balance of academically strong students in each group. The Course Instructor (DL) provided general topics based on learning objectives in the curriculum, and each group selected one topic. Topics included how to identify appropriate contact lens candidates and how to decide which lenses and care systems are best for a patient. In addition to receiving instructions on how to use the software, the third-year Contact Lens II students were asked to present their concept maps to the rest of the class, both contact lens Course Instructors, the Academic Program Coordinator and the Library Director at the end of the term. Students were also asked to answer questions about their experience with the concept mapping exercise.

For the third and final arm of the project, the concept mapping tool was introduced to first-year students in the Integrative Seminar course (n = 93). The college's Integrative Seminar course incorporates observation in the college's clinical care facility to enable case-based learning using small-group discussions of real patient cases. For this arm of the project, each student was asked to create a map around a case he or she observed in clinic. The Instructor for Integrative Seminar (SS) was available throughout the term to assist students in selecting a case and creating their concept maps. Students were asked to submit their concept maps to their small-group discussion leader at the end of the term,

and eight of the best concept maps were presented as part of a schoolwide grand rounds presentation. All students were also asked to complete a survey about their use of the concept mapping tool and to complete a Felder & Solomon Learning Style Inventory questionnaire.[9,10] This questionnaire is used to determine individual preference to “Active-Reflective, Sensing-Intuitive, Visual-Verbal and Sequential-Global Thinking” learning styles. In general terms, Felder describes active learners as those who learn best by active discussion and engagement, whereas reflective learners do better with passive or solitary methods. Sensing learners prefer facts and established methods, while intuitive learners prefer discovery and broader inquiry. Visual learners prefer diagrams or flow charts, while verbal learners tend towards written or spoken explanations. Finally, sequential learners appreciate step-wise learning, while global learners grasp things better as a large picture or model. Many people can express or feel comfortable with some characteristics of each type of learning style, depending on the setting, topic or other factor.

A few volunteers from the Integrative Seminar course were asked to participate in a one-hour post-activity focus group (n = 10). Open-ended questions about their experience with the concept mapping exercise, including the impact on their learning, participation in Integrative Seminars and the relationship between learning style and the use of concept maps, were used to facilitate the discussion.

Results

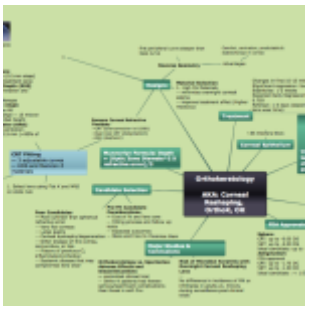


Image 1. A concept map for orthokeratology contact lenses.
Image 1: click to enlarge

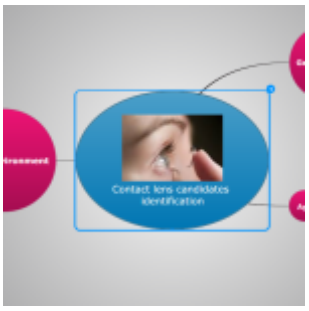


Image 2. A section of a concept map for selection of a good contact lens candidate. View the full map here.
Image 2: click to enlarge

An example of a concept map created in the Contact Lens II course by third-year students is shown in **Image 1**. The orthokeratology concept map demonstrates a student’s integration and consideration of corneal anatomy, lens parameters, fitting considerations, and major research studies, among other things. The student also incorporated images she thought important to helping her understand the fitting of orthokeratology lenses.

General feedback from third-year students was that the tool required some explanation and practice to use. Some students found it helped to organize their thoughts, but others preferred their own study

methods. The Course Instructor reported that it was a useful exercise to see which concepts the students thought to be key learning points and where there were gaps in understanding. She felt that it provided valuable insight into the breadth and depth of the students' grasp of the topic.

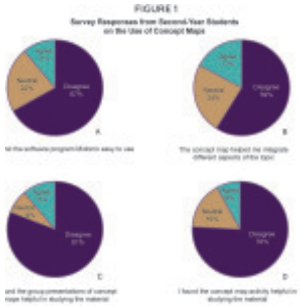


Figure 1: click to enlarge

An example concept map created in the Contact Lens I course is shown in **Image 2**. This concept map outlines potential contact lens candidates based on considerations such as systemic health, environment, age and ocular findings. The faculty members attending the concept map presentations were able to ask questions and give feedback directly to the student groups during their presentations. The faculty members felt that the concept map presentations were a good review of concepts and allowed them to clarify misinterpretations and questions prior to the final examination. They liked that it showed the students' ability to integrate and present course material in a way that is not typically done in a didactic course.

There was an 85% response rate to the second-year Contact Lens I student post-mapping survey (n = 71 of 84). Categories were collapsed into three from five categories (Agree/Strongly Agree, Neutral, and Disagree/Strongly Disagree) **(Figure 1)**. The majority of students in the class felt that Mindomo was not easy to use **(Figure 1A)** and that the concept maps did not help them integrate the material **(Figure 1B)**. They also did not find the group presentations helpful in reviewing the material **(Figure 1C)**. Only 8% said that the concept maps were helpful for studying **(Figure 1D)**. Open feedback from the students suggested that they were not open to new learning tools at this point in their education, suggesting that it might be better to introduce the tool during the first year of the curriculum. Faculty and student discussion raised questions as to whether learning style had an influence on student acceptance. This advice led to the third arm of the project and incorporation into a first-year course.



Image 3. A section of a concept map for ocular manifestation of Down Syndrome. View the full map here.
Image 3: click to enlarge

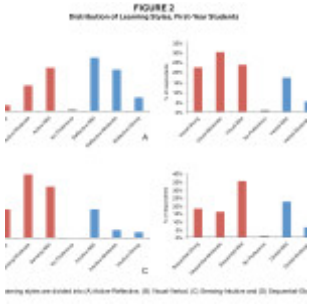


Figure 2: click to enlarge

The final arm of the project with first-year students incorporated both hands-on and written instruction in concept map building, as well as instruction on how to find and utilize didactic and clinical information to review and present a clinical case. **Image 3** shows a sample concept map that was created for the first-year Integrative Seminar course. This map is a review of ocular associations with Down Syndrome and it demonstrates a first-year student's incorporation and broad understanding of the many clinical manifestations he/she may come across during an examination. The signs and symptoms are elaborated upon with references, photo and video documentation and further explanation. The Course Instructor found the mapping exercise a good way to assess students' ability to cohesively integrate and present multiple aspects of clinical cases.

The distribution of learning styles in the first-year class as determined by the Felder & Solomon questionnaire is shown in **Figure 2**. Overall, there was a tendency toward more reflective, visual, sensing and sequential learners; however, there was a wide range of learning styles in the class.

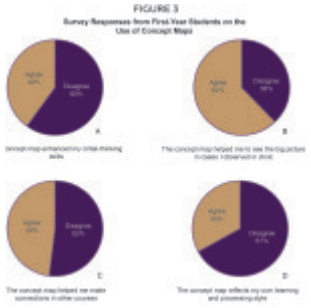


Figure 3: click to enlarge



Table 1: click to enlarge

The post-activity survey from the third arm of the project demonstrated that the majority of students preferred to visualize or outline their map in the initial design **(Table 1)**. More than half wanted to get just a brief introduction before exploring the software on their own, and 51% would be likely to create new maps similar to what they had done previously. When asked about the utility of concept mapping, about half saw no utility, but the other half found it useful for bringing together concepts or understanding clinical cases better. Approximately 40% of students felt that the concept map enhanced their critical-

thinking skills **(Figure 3A)**. In addition, 62% of the respondents indicated that the concept map helped them see the big picture in their clinical case presentations **(Figure 3B)**. About half of the students indicated that the concept map helped them make connections to other courses **(Figure 3C)**. But only one-third thought that the concept mapping exercise reflected their individual learning style **(Figure 3D)**.

The first-year focus group further demonstrated that the experience and impact on learning among participants varied. Some students indicated that the concept maps helped them to see the bigger picture and organize information and thought that it could be of benefit if the exercise were integrated as a continuous project throughout the program. Some continued to use the software in other courses in the curriculum. However, many students cited concerns over the time it took to complete the maps and questioned the utility compared to other methods of study. Many students also felt that, despite the additional training, they still needed more instruction on the technical aspects of the software. Some students reported that they felt other types of presentation software were easier to use.

Discussion

A review of the literature on concept mapping in medical education reveals that there are many factors that can influence its acceptance and viability as a learning tool. Harrison and Gibbons[8] noted that students expressed negative feelings about concept mapping when they did not fully understand the reason for creating the maps and when they felt that this new learning strategy was imposed upon them. Students at the SUNY College of Optometry echoed this sentiment when concept mapping was introduced in the second and third years of their optometric studies. Student feedback demonstrated that by this point in the curriculum, they had developed their own methods of studying and many objected to having to learn and use a new study tool. This was even the case for some first-year optometry students who likely developed study methods during their undergraduate work. Many graduate level students simply may not be open to trying new study methods without solid proof of efficacy.

Contradicting many students' lack of enthusiasm for the learning tool, faculty reported that it was a useful tool to demonstrate student knowledge, ability to organize and present thoughts, and to integrate key concepts of a course or clinical case. That there is a discrepancy between student and faculty experiences with concept maps is not entirely surprising. From the first to the third arm of this pilot project, the authors learned that making the exercise part of the course was important, as was thorough and continued support for use of the software. It is likely that continued use across multiple courses would improve students' comfort and efficiency with the tool. This would likely also influence their thoughts on the utility of the learning tool. It is important that instructors utilizing non-traditional learning and assessment methods clearly share with students how the exercise can benefit their learning above and beyond typical written examinations or case presentations. These kinds of tools can serve as a future reference beyond any single course, for example, to review for board exams or as a quick reference in clinic. Another example is that a glaucoma map could be created as a single point of reference for diagnostic criteria, pharmaceutical dosing information, corneal thickness and intraocular pressure lookup tables, etc.

Previous literature suggested that learning style may have an effect on the utility and adoption of concept maps.[4] The SUNY first-year students tended to be more visual, sequential, sensing and reflective learners. The skew toward reflective and sensing learners may also partially explain why many of the students didn't embrace the active, broader, more global view of concept mapping.

There are many different platforms for creating concept maps including Inspiration, MindMap, Creately, Prezi, and others. Some are free and others, like Mindomo, require a license for expanded features. The costs generally vary with the number of users. Mindomo was selected for this pilot project population based on a personal recommendation and the software's sharing, storing and collaboration features. The cost for the SUNY student class size was reasonable ($90 for a six month license plus $250 for six

months for 100 users). Some advantages of these concept mapping systems include features that allow a user to zoom in and “drill down” for more information and make presentations more dynamic and interactive with animation. These systems readily allow the addition of links to external photos, videos or other reference materials.

There are some limitations to this pilot project. The sample sizes of the focus groups were small and may not fully represent all students. This project was done in three iterations using learning from each arm to modify the next project. While this allowed us to improve the implementation each time, the same data points were not collected for all classes and thus the data cannot be compared across classes. Finally, these were all cross-sectional projects with only one map done per student/group, and there is no information about the acceptance and utility of continued implementation of concept maps throughout the curriculum or over time. In the future, a study could randomize half of a first-year optometry class to use a new learning tool throughout their four years of study and compare performance in the courses, in clinic or on National Board Exams. There is limited information on the ability of learning tools to improve short- or long-term knowledge in a clinical setting. In an undergraduate setting, Burdo and O’Dwyer[11] compared concept mapping to retrieval (self or small-group repeated recall testing) and showed that retrieval practice did improve performance on standardized exams. The idea behind retrieval practice is that the more learners actively practice using (retrieving) information, the better they retain the information. Clinical practice involves broader thinking and integration across multiple courses and longer retention of material than any single standardized course exam, thus larger, longitudinal studies would be required to fully assess the impact of any new learning method on clinical training.

Despite these limitations, the pilot projects presented here provide useful baseline information on how concept mapping might be utilized in an optometry curriculum. Based on the pilot projects and student feedback, we recommend the following to schools or instructors interested in incorporating concept maps into their curricula:

- introduce concept mapping early in the curriculum before students have formalized their study habits and methods
- weave the concept mapping exercise throughout the learning experience and across multiple courses in the didactic and clinical curriculum to increase student comfort with the tool
- ensure that students have sufficient training to utilize the software via tutorials, written reference materials and continued technical support
- provide direct feedback to students and emphasize the benefits of concept mapping exercises in their ability to allow students to demonstrate their depth and breadth of knowledge, ability to highlight key concepts, etc.

Conclusions

The success of incorporating new learning tools into any curriculum depends on many factors, but especially instructor support and student engagement. While it is clear that faculty see learning benefits of concept mapping exercises, such benefits must be translated back to students for them to embrace the tool. Further research is needed to fully assess the utility of concept mapping in healthcare education.

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