Evidence-Based Concept Mapping for the Athletic Training Student

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Context: A concept map is a graphical and cognitive tool that enables learners to link together interrelated concepts using propositions or statements that answer a posed problem. As an assessment tool, concept mapping reveals a learner's research skill proficiency and cognitive processing.

Background: The identification and organization of the relationships between concepts are the hallmark of concept mapping that build knowledge acquisition and clinical reasoning skill. Concept mapping does not emphasize linear relationships but the complexity of reciprocal relationships, linking new knowledge to prior knowledge. The brain works by making analogical links between past and current information and utilizes these links to create new mental models to solve a current or future problem. Students engage in a search of the literature and synthesize and critique the findings for integration into an approach to address a clinical question or problem.

Objectives: Provide health profession educators with an understanding of how concept mapping can be utilized to assess and build students' clinical reasoning as well as promote transfer of learning from the classroom to the clinical setting.

Description: An overview of the concept mapping process as well as rationale for its use to build clinical reasoning and decision-making skill is provided. Suggestions are also provided for its use as a competency instruction and assessment tool.

Clinical Advantages: Concept mapping reveals the gaps in a student's clinical reasoning and decision-making process, assists in filling these gaps and builds student understanding and application of evidence-based medicine to inform appropriate clinical decisions.

Conclusions: Through examination of concepts, their associated problems and how best to solve them based on evidence, concept mapping complements the instruction and assessment of educational competencies. The concept mapping process facilitates a student-centered learning approach, which can be peer or instructor evaluated.

Key Words: Clinical reasoning, transfer, competency, analogical reasoning

A concept map is a graphical and cognitive tool that enables learners to link together new and previously learned concepts using propositions or statements to analyze, answer, or define a posed problem.¹ Concept mapping can be utilized for student engagement and as a method to evaluate an individual or group's grasp of a clinical proficiency, complex topic, or problem.² Additionally, the mapping process can be utilized to build skill and understanding of evidence-based practice by requiring students to search, organize, synthesize, and evaluate the literature that supports their concepts and the propositions used to address a clinical problem or topic. Learning about how to approach a complex topic or problem is not only enhanced through the creation of a concept map but also by comparing 1 map against another that is attempting to address the same topic or problem.³ Comparison of maps between students allows the learner to see the differences and similarities in their clinical decision-making process.⁴ The process of analogical reasoning (contrasting and comparing) allows the learner to connect structural similarities (patterns) or relationships between maps engendering creation of a model of practice that can be used for future diagnosis of clinical cases or problems.⁵ Concept mapping

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assists learners to visualize patterns in black and white in order to identify gaps,⁶ while helping to imprint the learning process for future recall. The end result of the mapping process is a representation of the learner's thinking process of how to solve a clinical problem or topic, ideally, grounded in evidence-based medicine.

SALIENT CONCEPTS

- The identification and organization of the relationships between concepts are the hallmark of concept mapping.
- Concept mapping does not emphasize linear relationships, but complexity of reciprocal relationships.
- Concept maps link new knowledge to prior knowledge.
- The brain works by making analogical links between information or events and utilizes these links to create new mental models for future application.
- The brain needs a cue to recruit important information for application to a problem—concept mapping can serve as the cue.
- Proficient concept mapping takes deliberate practice and feedback over time.

USING CONCEPT MAPS IN HEALTH PROFESSION EDUCATION

Concept mapping was originally created to provide a graphical representation of how to dissect and approach difficult ideas.¹ However, since its inception, it has been used successfully in a multitude of subject matter, professional fields, and across all educational levels. Professional ethics, patient assessment, diagnosis, and treatment can be complex, especially for the novice health profession student. Health profession education has historically focused on didactic teaching methods and formal learning until students reach the professional level-a time when they are faced with the challenge of applying their knowledge to clinical practice.⁷ Concept mapping can assist health profession students not only to dissect a difficult case, but more importantly how the components of a patient assessment are connected to a diagnosis and treatment plan rather than just a list of signs and symptoms.²

Experienced clinicians are often able to diagnose in moments due to their robust tacit or implicit knowledge, which gives them a "gut feel" or intuition of what is wrong.⁸ However, novice learners lack clinical experience limiting development of this gut intuition, which challenges their clinical decisionmaking process.9 Concept mapping has the potential to address this deficiency by building schema of related concepts around a domain or clinical problem to foster clinical reasoning for effective patient care.⁴ Moreover, clinical instructors and educators can use concept maps to understand and uncover the student's implicit thought process, or literally tangled knowledge, which may have been overlooked in the clinical decision making process.^{4,10} The untangling of implicit knowledge by a student themselves or the instructor fosters metacognition, thereby enabling the identification of gaps in their thinking and learning to be addressed.¹¹ Identification of these gaps will lead the learner into a self-directed learning process as they strive to improve their learning and clinical practice.²

As a representation of one's thought process and mental model of practice, these maps can neither be right nor wrong. There is no way to evaluate someone's concept map and have it fail, as it is a representation of where they are in their learning. However, it is possible to evaluate a concept map for missing links or concepts that another may or should have addressed, but concept maps are as individual as individuals themselves. Therefore, a sample concept map rubric (Figure 1) is provided to assist instructors in the assessment process and should be used judiciously.

HOW TO CREATE CONCEPT MAPS

Concept maps can take many forms and can be done in a group or individual format. Although, to engender understanding of the map construction process and to limit anxiety of students about this type of instructional strategy, the authors suggest first introducing concept mapping as a group activity. Why initiate it as a group activity? Group membership and participation has been found to ease student anxiety, improve participation, and sets the stage for multiple map comparison between groups. Whether the clinical case problem to be examined is provided by the instructor or formulated by the group or individual, it should be applicable in nature in order to enhance the transfer of learning from the classroom to the clinical environment.¹² Therefore, the first step in the concept mapping process is to determine a common clinical problem, question, or topic to examine.

Depending upon the chosen topic or question, most if not all students in the group should have been exposed to material or experiences that will enable them to address the topic or clinical problem at hand. Groups of 5 to 7 are recommended. The authors have both provided groups the same question or a question that varies among groups, but regardless of the nature of the question, the question should move students to articulate how they will address the clinical question or problem based on what they know and to engage them in the process of concept mapping. For example, 1 group may be assigned the question, how does combination ultrasound assist in the reduction of a trigger point? Another group may be assigned, how does a contract relax stretch assist in the *reduction of a trigger point?* Both questions work to elicit from the student the mechanisms involved in the reduction of a trigger point, but they also help the students to recall, affirm, and connect their knowledge, but most importantly, the process exposes the student to what they do not know. After the question(s) are established, student groups should be encouraged to identify 4 to 6 major concepts or theories and how their connections address the clinical question or problem at hand. Use of chart paper or white boards will allow students to make revisions to their maps as their group thought process develops.

Students initially will need to be cued from the instructor on how their chosen concepts are connected (eg, *how would contraction affect the stretch reflex of the affected tissue?*). Speicher & Kehrhan¹² have proposed, when working with novice learners, instructor cueing is essential for retrieval of past knowledge and its application to a current experience (task at hand) for solution of novel problems. Once the maps are completed, students should present their maps to the class so they can explicitly articulate and explain their thinking process. Whether the question is the same for all groups or

Figure 1. Concept map rubric example.

Cor	icept Map-Component	NameName	Evaluator	Grade/100 {Pee
TUL	Content	Organization	Presentation	Feedback
A	 Is very well thought out and supports fully the aspects of the topic (5) Reflects high level of critical thinking (5) Goals are related to the topic (5) A variety of sources, both data and literature are utilized (5) Is accurate (5) 	 Information is clearly focused in an organized and thoughtful manner (5) Information is constructed in a logical pattern to support the treatment/prevention approach (5) AMA citation utilized appropriately for both concepts and propositions (5) 	 Presentation captures audience attention (5) Presentation is organized and well laid out (5) Evidence is explained and connected to topic and approach (5) Implications of evidence to field of athletic training and/or other stakeholders are articulated (5) 	
В	 Is well thought out and adequately supports the topic (4) Application of critical thinking is apparent (4) Goals are related to the topic, but not clear throughout map (4) Adequate number of sources, both data and literature are utilized (4) Is mostly accurate (4) 	 Information is focused but may lack organization in areas, but not considered significant to the understanding of the map (4) Information supports the treatment/prevention approach but may not be logical in all areas (4) AMA citation utilized appropriately for most concepts and propositions (4) 	 Presentation often captures audience attention (4) Presentation lacks organization in some areas (4) Evidence is explained and connected in some areas to topic and approach (4) Implications of evidence to field of athletic training and/or other stakeholders are articulated in some areas (4) 	
С	 Supports the question (3) Has limited application of critical thinking (3) Has no clear goal (3) Is pulled from a limited number of sources, both data and literature (3) Has some gaps, factual errors or inconsistencies (3) 	 Model has a focus but might stray from it at times (3) Information appears to have a pattern, but the pattern is not consistently carried out in the model (3) Information loosely supports the treatment/prevention approach (3) AMA citation utilized appropriately, but <u>not for both</u> concepts and propositions (3) 	 Presentation does not capture audience attention (3) Presentation lacks organization in multiple areas (3) Evidence is not explained and connected in multiple areas to topic and approach (3) Implications of evidence to field of athletic training and/or other stakeholders are not articulated in multiple areas (3) 	
D	 Provides inconsistent information for the question (2) Has no apparent application of critical thinking (2) Has no clear goal (2) Is pulled from few sources, both data and literature (2) Has significant gaps, errors, misconceptions, or misinterpretations (2) 	 Content is unfocused and haphazard (2) Information does not support the treatment approach (2) Information has no apparent connection to treatment/prevention approach (2) AMA citation not utilized appropriately for either concepts or propositions (2) 	 Presentation is choppy and hard to follow (2) Presentation has no clear organization (2) Evidence is not explained and connected to topic and approach (2) Implications of evidence to field of athletic training and/or other stakeholders are not articulated (2) 	

The student who constructed and presented the concept map, will provide the instructor action steps to be taken to improve future maps and presentations in the space below after feedback is provided, via email. The action steps for improvement must be received prior to submission of the next concept map. Peer evaluators will provide the map rubric/feedback to the instructor and their peer via email on the assigned due date.

Action Steps/Goals for Next Map/Presentation:

different, the instructor should promote the group to identify how the approaches represented are similar or different from one another in order to deepen their understanding and importance of the major structural relationships or concepts they desire the student to learn. The implementation of evidence into the maps at this juncture is not needed. The focus should be on the map construction process; however, the instructor or students can and often do question other groups on whether any evidence exists to support their thinking or clinical approach, which moves the student towards the awareness of the need to produce an evidencebased approach for their clinical decision making. Once the student has been exposed to the concept mapping process in a group format, they will be better prepared to construct 1 individually.

Even after engaging in a group concept mapping process, the novice's initial thinking will still be messy, possess a plethora of ideas, and show a limited pattern of organization. Therefore, as mentioned previously in the group mapping process, a select number of concepts tied to the clinical case problem or question should be focused upon to avoid the student from becoming overwhelmed. However, to build complexity of thinking over time, a concept map can be created and recreated over the course of the semester or unit to include new evidence, material, or address additional questions. For example, as seen in Figures 2 and 3, an undergraduate modalities student has progressed his or her examination of an ACL injury through the phases of the healing process across the semester, refining, building, and organizing his or her thinking and the evidence that exists. What is notable from the first map (Figure 2) to the second (Figure 3) is the development and organization of connections between concepts, clinical applications, and the evidence that supports them. Another approach to build complexity in the student's clinical decision-making process is to scaffold current knowledge onto previous or concurrent course material, such as biomechanics, as seen in Figure 4.

The easiest way to create a map in its simplest form is to start with a select number of boxes. Each of these boxes represents 1 single concept or part of a treatment approach (eg, legal issues), as seen in Figure 2. Concepts may be added, deleted, combined, or rearranged as the understanding of the interconnections between the concepts develop. The initial process of getting the major concepts down on paper, white board, note cards, sticky notes, or on PowerPoint is not about getting them right, but more about brainstorming what primary concepts are essential to address to solve the posed clinical problem or issue. For construction, presentation, and



Figure 2. Undergraduate concept map example.





grading of individual student concept maps, the authors have found the use of PowerPoint to be a useful medium due to its ease of use; however, there are many types of software available to instructors and students, a few of which have been listed in the resource section of this article. The map will change dramatically as the case or problem is thought through or new information is discovered and reconnected, which is representative of the constructive learning process. Therefore, flexibility on the part of the student and instructor as well as the software utilized is essential. It is uncommon that students will get it right on the first go around.

Once the major concepts have been identified, the next step is to start connecting the concepts and determining their interrelationships and intrarelationships. A line shows these connections with arrows pointing in the direction of which the boxes are connected. The learner will place words or phrases near the connector arrows or lines, which are termed propositions. Propositions represent the learner's understanding of the relationships that exist and their level of critical thinking about them and are the most important aspect of the map. An example of a proposition could be "causes" or a longer statement such as "when achieved progresses to" as seen in Figure 3. As the map develops, learners will connect and reconnect more concepts while adding or grouping items together. Colors should be used to denote different sections of a map or to dictate the nature of a concept. Symbol, shapes, and pictures can also be utilized to communicate a concept. However, what is most important about the mapping process is the identification of the relationships that exist among the concepts and how they support an approach to a clinical problem or topic. Prior to submission of the concept map for grading and/or presentation, a feedback process is recommended so that the instructor and/or peer can cue the student to identify additional relationships or concepts that should be part of their map. Student understanding of the map's connections, propositions, and their comprehension of the evidence which supports their approach to the problem can be assessed through presentation of the map, through verbal or written means, or a combination of both. Adding a written paper that further explains the evidence and clinical approach may also help to deepen the student's understanding of the material examined, topic, and evidence that supports the clinical approach presented.

KEY ELEMENTS OF A CONCEPT MAP

- A clinical question, clinical experience, or topic should be utilized, which guides concept map development.
- Labeled lines or arrows which indicate relationships and/ or directionality.

According to recent literature, anterior chronic exertional compartment syndrome (CECS) in long distance runners may be treated by converting from a rearfoot strike (RFS) running technique to a forefoot strike (FFS) running technique¹⁻⁵. The FFS technique significantly decreases anterior intracompartmental pressure (ICP), whereas the RFS technique significantly increases anterior ICP.



1. Diebal et al. 2012; 2. Diebal et al. 2011;3. Goss DL, Gross MT 2012; 4. Tsintzas et al. 2009; 5. Wilder RP, Sethi S 2004

- Shapes and colors to emphasize concepts.
- Citations of literature to indicate new knowledge construction.
- A short narrative or overview of the map should be included.
- There should be a start and end to the map.

CONCLUSION

Through examination of concepts, their associated problems, and how best to solve them based on evidence, concept mapping complements the instruction and assessment of educational competencies. The concept mapping process facilitates a student-centered learning approach to foster the development of appropriate clinical reasoning and decision making as well as transfer of learning. Students are promoted to explicitly identify interconnections that exist between concepts (eg, cognitive rest for treatment of mild brain injury and impact on intracranial pressure), if they are supported by evidence, and how they can be integrated into an overall prevention and treatment approach. Moreover, the analogical reasoning process of concept mapping assists in the construction of domain-specific knowledge around a competency, clinical problem, or topic to further enhance the clinical decision-making process to ultimately improve patient care.

Resources

Web-Based

http://cmap.ihmc.us/Publications/ResearchPapers/ TheoryCmaps/TheoryUnderlyingConceptMaps.htm

http://www.social $researchmethods.net/mapping/mapping. \\ htm$

http://uts.cc.utexas.edu/~best/html/learning/concept.htm

 $http://pages.cpsc.ucalgary.ca/{\sim}kremer/papers/ICCS94.html$

Software

http://cmap.ihmc.us (Free for educators)

http://compendium.open.ac.uk/institute/

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