Developing a Model to Rapidly Assess the Mechanism of Disease Map

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Abstract- Concept maps are graphical tools that allow students to connect ideas. Mechanism of Disease (MOD) maps are similar, and a tool used to integrate basic and clinical sciences. We used graph theory principles to create a mathematical formula to assess MOD maps. Compared to a rubric-based expert scoring, our formula demonstrated a correlation of .4.

Introduction- Concept maps are graphical tools that utilize hierarchical structure and labels to connect various ideas (1). Mechanism of Disease maps are similar, yet do not contain a hierarchical structure or require labels between ideas. Students participate in a weekly small-group learning session during which they are asked to create MOD maps based on the disease process(es) that they are studying. In doing so, they link an inciting pathophysiological event to relevant clinical features through a cascade of basic science principles.

Network analysis looks at the frequency of certain concepts being used as a proxy for how important they are (2). Schwendimann described an increase in the prominence score (the sum of ingoing and outgoing connections at a point) of predetermined 'indicator' concepts in knowledge maps as a measure of increased understanding (3).

We analyzed the number of connections to the highest three degree nodes in MOD maps, as opposed to a pre-determined indicator concept. We believe that by sampling the three highest-degree nodes, we obtained an accurate representation of rigor of the map. The degree refers to the number of connections at a particular concept (4). The formula we derived was:

- ***Score (G) = ∑(Degree A, Degree B, Degree C), where A, B, and C are the highest-degree nodes in graph (G).***

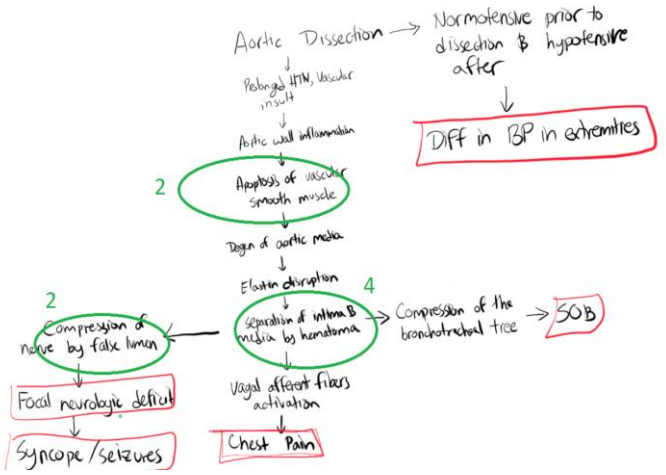

Figure 1- example MOD map showing highest-degree nodes in green

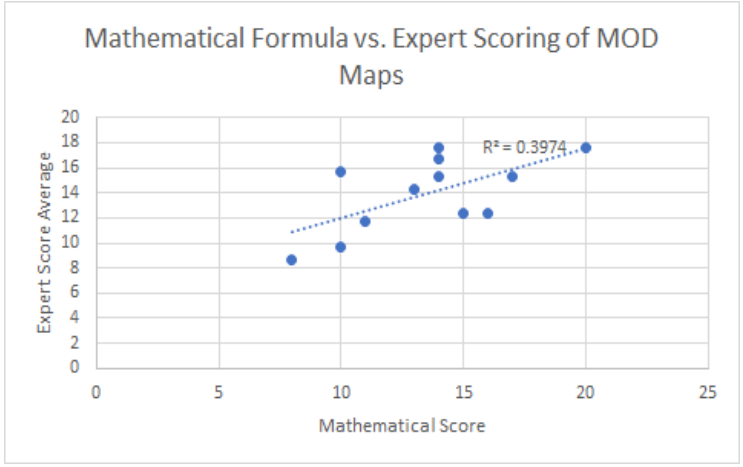

Figure 2- correlation of mathematical formula score and average of expert scores

Methods- 12 student-generated maps (six from two different disease processes) were scored using our mathematical formula and by three expert graders using a rubric. The rubric scored maps based on legibility, accuracy, completeness, and sophistication (Rubric adapted from 5,6)

Results- Using the mathematical formula, scores obtained ranged from 8-20, with a mean of 13.5 and a median of 14. The average of the three expert grader's rating using the rubric for each map ranged from 8.67-17.67, with a mean of 13.94, and a median of 14.83. A correlation of 0.4 was found between the mathematical scores and rubric-based scores. Calculations were performed with Microsoft Excel (Microsoft- Redmond WA).

Discussion- Our mathematical formula showed promise when compared to rubric-based expert scoring of MOD maps. Further, it is easy to use, as the highest degree nodes can be determined by non-experts, and a rapid assessment of a MOD map can be obtained. While the correlation of 0.4 isn't very strong, it is a promising start. Perhaps more accurate mathematical formulas can be derived using the same principles.

Conclusion- Assessment of Mechanism of Disease Maps by using the sum of the three highest degree nodes may prove to be a way to rapidly assess these maps.

References-
1- Hay, D. Kinchin, I. Using Concept Mapping to Measure Learning Quality. Education + Training. 50(2); 167-182. 2008.
2-Schwendimann, B. Multi-Level Analysis Strategy to Make Sense of Concept Maps. Concept Mapping to Learn and Innovate. Proc. Of Sixth Int. Conference on Concept Mapping. Santos, Brazil, 2014.
3-Schwendimann, B. Digital Knowledge Maps in Education: Technology-Enhanced Support for Teachers and Learners. Chapter 2, Making Sense of Knowledge Integration Maps. Springer 2014.
4-Bondy, J. Murty, USR. Graph Theory With Applications. 5th edition. New York, Elsevier Sciences. 1982.
5-Concept Map Rubrics [Internet]. University of Iowa Center for Teaching. Accessed between October 2019-February 2020. Available from: https://teach.its.uiowa.edu/sites/teach.its.uiowa.edu/files/docs/docs/Concept_Map_Rubrics_ed.pdf
6-Mueller, J. Concept Map Rubric [Internet]. North Central College. Accessed Feb 13th 2020. Available from: http://jfmueller.faculty.noctrl.edu/240/conceptmaprubric.htm