

# Evaluating the Implementation of a Concept Mapping Tutoring Program in Undergraduate Medical Education at a Single Institution

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## Abstract

**Objective:** Concept mapping as a learning tool for medical students has been studied in single courses but has been studied less when applied more broadly to all medical students in a course agnostic manner. This study evaluated a course agnostic concept mapping tutoring program for medical students at a single institution.

**Materials & Methods:** This concept mapping tutoring program was based on a published program for using concept mapping as a learning tool in medical school. The concept mapping tutoring program utilized medical students who had success using the concept mapping method and had been trained to provide concept mapping tutoring. The program began at the start of the 2013-2014 academic year and was evaluated during the 2014-2015 academic year. The evaluation consisted of a survey sent to medical students and academic performance metrics (medical school grades) retrieved for survey respondents.

**Results:** The survey response rate was 37%, and approximately 39% of medical students reported using the concept mapping method. Medical students who used the concept mapping method reported high satisfaction and that concept mapping helped improve their grades. It was also discovered that students who never attempted to use the concept mapping method had higher Medical College Admission Test scores, higher medical school grades, and less time spent studying than other respondents.

**Conclusion:** The concept mapping program provided benefit to

a subset of medical students. Students who used the concept mapping method reported high satisfaction and the development of integrative thinking skills. Several areas for future research were identified, including investigating study techniques used by students who never used concept mapping but were demonstrating significant academic success.

**Keywords:** Concept mapping; Undergraduate medical education; Program evaluation; Visual learning

## Abbreviations

EVMS: Eastern Virginia Medical School; EVMS AD: Eastern Virginia Medical School Office of Academic Development; MCAT: Medical College Admission Test; GPA: grade point average; NeverCM1 group: first-year medical students who never attempted to use concept mapping; TriedCM1 group: first-year medical students who attempted to use concept mapping but no longer using concept mapping; UsingCM1 group: first-year medical students using concept mapping at least once a week; NeverCM2 group: second-year medical students who never attempted to use concept mapping; TriedCM2 group: second-year medical students who attempted to use concept mapping but no longer using concept mapping; UsingCM2 group: second-year medical students using concept mapping at least once a week

## Introduction

A concept map is a visual knowledge representation tool that helps the learner understand the material by creating a hierarchical organization and “crosslinks” that show relationships between ideas in different segments of the map (Figure 1) [1]. Concept maps are based on Ausubel's assimilation theory of learning: new ideas/concepts are built upon prior knowledge, ideas/concepts are structured in a hierarchy, and when students have improved understanding, the connections between ideas/concepts become more explicit and integrated [2]. Concept maps were developed initially to understand how children learn about science concepts, but now concept maps are used in a wide variety of disciplines [2-9].

Multiple studies have examined concept mapping as a learning tool for medical students in a single course/discipline [10-13]. However, there has been less study of medical students using concept mapping as a learning tool outside of a specific course setting. Only one group described a program (the SuccessTypes program) that taught medical students how to use concept mapping in this broader, course agnostic setting [7]. The SuccessTypes program operationalizes concept mapping into daily and weekly study cycles for efficient encoding and retrieval of medical school lecture content. In this study, an adapted version of the SuccessTypes program was implemented to provide a course agnostic concept mapping tutoring program at a single medical school. The primary objective of this study was to evaluate the efficacy of this course agnostic concept mapping tutoring program. The exploratory objectives included identifying the academic characteristics of medical students stratified by their concept mapping usage and describing why medical students benefited from concept mapping.

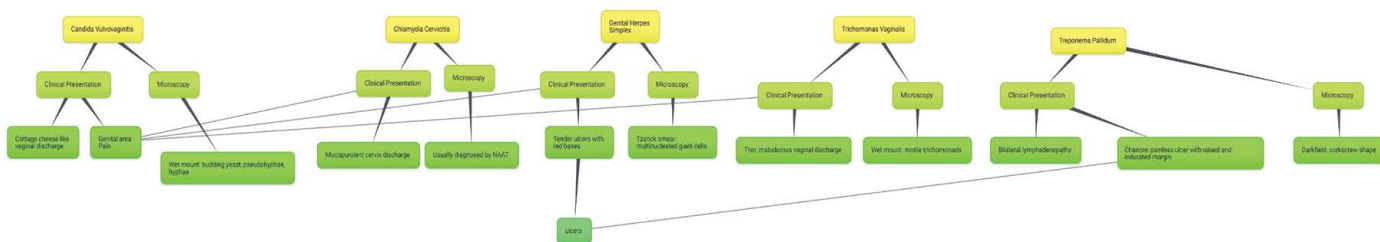


Figure 1: Concept map comparing and contrasting Candida Vulvovaginitis, Chlamydia Cervicitis, Genital Herpes Simplex, Trichomonas Vaginalis, and Treponema Pallidum.

## Materials & Methods

### Description of the concept mapping tutoring program

The Eastern Virginia Medical School Office of Academic Development (EVMS AD) started a concept mapping tutoring program at the beginning of the 2013-2014 academic year.

In the Spring of 2013, while a fourth-year medical student at EVMS, author MT trained seven medical students to be the first concept mapping tutors for this program. The training lasted about one hour and is described in Supplemental Appendix A. These seven medical students had previously received concept mapping tutoring using a variation of the Success Types program [7], appeared to have success using the concept mapping method based on feedback provided to the EVMS AD, were in good academic standing, and expressed interest in providing this concept mapping tutoring service.

At the start of the 2013-2014 academic year, the EVMS AD gave all incoming medical students a mandatory session on concept mapping. Several concept mapping tutors described their mapping approaches in this session and provided visual examples of their concept maps. The EVMS AD also offered a second optional session on concept mapping to all medical students. Concept mapping tutors showed more examples of their concept maps and demonstrated some live concept mapping. These mandatory and optional sessions were part of first-year medical student orientation in all subsequent years.

Any medical student who desired concept mapping tutoring would contact the EVMS AD who arranged this one-on-one tutoring. These sessions lasted approximately one hour and were voluntary. There was no limit to the number of sessions a student could have with a tutor. The sessions generally followed the outline in Supplemental Appendix A.

### Evaluation of the concept mapping tutoring program

**Collection of academic performance metrics:** The following information was extracted for each student who participated in this study: Medical College Admission Test (MCAT) score, overall grade point average (GPA) from college/university before starting medical school, medical school grades for the 2014-2015 academic year. The "Introduction to the Patient" course was excluded from these medical school grades, given that this course did not cover basic science topics, and any courses graded on a pass/fail scale were also excluded from the data collection. First and second-year medical school courses at EVMS were graded on an Honors, High Pass, Pass, Fail scale for the 2014-2015 academic year. To calculate the students' medical school GPA for data analysis, numerical values were assigned: Honors = 3, High Pass = 2, Pass = 1, and Fail = 0.

**Development of survey tool:** The complete surveys can be found in Supplemental Appendices B and C. Authors MT and AK developed the novel survey through an iterative process based on their experience providing academic support to medical students. The iterative process was deemed complete when authors MT and AK determined the survey would collect sufficient data for a meaningful evaluation of the concept mapping tutoring program.

**Survey procedures:** The surveys were sent via email to all first and second-year medical students on 5/7/2015, and the survey closed on 6/10/2015. A reminder email was sent to students one week prior to the survey closing. The online survey was created with SurveyMonkey Inc (Palo Alto, CA; www.surveymonkey.com).

**Data Analysis:** The normality of the quantitative data sets was assessed using the D'Agostino & Pearson test. For data sets that were found to have a normal distribution, their means were compared using a two-tailed, unpaired t-test with Welch's correction to account for any lack of homogeneity of variances given the differences in sample size among data sets. For data sets that did not have a normal distribution, their means were compared using the Mann-Whitney test. Categorical

data was compared using the Chi-square test of independence. Statistical analysis was performed using GraphPad Prism version 9.3.0 for Windows, GraphPad Software, San Diego, California USA, www.graphpad.com.

Data from first and second-year medical students were analyzed separately because first, and second-year medical students take different medical school courses. Within first and second-year medical student data sets, the data was further analyzed by the following subgroups: NeverCM1 group (first-year medical students who never attempted to use concept mapping), TriedCM1 group (first-year medical students who attempted to use concept mapping but no longer using concept mapping), UsingCM1 group (first-year medical students using concept mapping at least once a week), NeverCM2 group (second-year medical students who never attempted to use concept mapping), TriedCM2 group (second-year medical students who attempted to use concept mapping but no longer using concept mapping), UsingCM2 group (second-year medical students using concept mapping at least once a week). The data was analyzed using these subgroups because the authors theorized that the concept mapping status of a student might correlate with academic performance and study habits.

Respondents could also include open-ended comments to questions with the "other" answer choice. Author MT reviewed these comments to identify broad themes relevant to the evaluation of the concept mapping program.

### Resources needed for concept mapping tutoring program

The concept mapping tutoring program required two hours of lecture time per academic year: one hour for a mandatory lecture during first-year medical student orientation, and another hour of lecture for a subsequent optional session on the concept mapping method. The training of medical students to be concept mapping tutors required a one-hour training session. The payments to the concept mapping tutors cost approximately \$10-12/hour. Administrative support was needed to arrange for the payment of tutors and connecting medical students with the tutors.

### Ethical Approval

The University of California, San Francisco Institutional Review Board determined that this study qualified as exempt (IRB # 15-16228, 4/24/2015). The Eastern Virginia Medical School Institutional Review Board gave an expedited board approval for this study (IRB # 15-04-EX-0072, 5/1/2015).

## Results

### Response Rate/Demographics

The survey was sent to 292 medical students. One hundred and twenty six responses were received, but 16 were disqualified due to incomplete data. An additional entry was disqualified because the respondent reported being a third-year medical student. This left 109 evaluable responses for an overall response rate of 37%.

Forty-two (39%) of the respondents reported using concept mapping at least once per week to study course material, 47 (43%) of respondents reported trying but ultimately discontinuing concept mapping, and 20 (18%) of respondents reported never attempting to use concept mapping (Table 1). There was no significant difference in the distribution of first and second-year medical students among the different concept mapping groups (Table 1).

### First-year medical students

**Academic performance metrics:** The NeverCM1 group had significantly higher medical school GPA compared to the TriedCM1 group (Table 2,  $P = 0.033$ ). The NeverCM1 group did not significantly differ in medical school GPA compared to the UsingCM1 group (Table 2).

**Table 1:** Use of concept mapping distribution amongst survey respondents by year in medical school.

	Using concept mapping at least once a week	Attempted to use concept mapping but no longer using concept mapping	Never attempted to use concept mapping	Total
First year medical student	26 <sup>a</sup>	18 <sup>b</sup>	12 <sup>c</sup>	56
Second year medical student	16 <sup>d</sup>	29 <sup>e</sup>	8 <sup>f</sup>	53
Total	42	47	20	109

<sup>a</sup>UsingCM1 group, <sup>b</sup>TriedCM1 group, <sup>c</sup>NeverCM1 group, <sup>d</sup>UsingCM2 group, <sup>e</sup>TriedCM2 group, <sup>f</sup>NeverCM2 group

**Table 2:** Characteristics of first-year medical students.

	Mean value for UsingCM1 <sup>a</sup> (Std deviation) [N = 26]	Mean value for TriedCM1 <sup>b</sup> (Std deviation) [N = 18]	Mean value for NeverCM1 <sup>c</sup> (Std deviation) [N = 12]	P-value
Medical College Admission Test score	32 (2.8)	32 (2.8)	32 (2.7)	ns
Grade point average from all college/university courses taken before medical school	3.63 (0.278)	3.58 (0.304)	3.52 (0.299)	ns
Medical school grade point average for 2014-2015 academic year <sup>d</sup>	2.13 (0.702)	1.97 (0.585)	2.56 (0.425)	h
For the 2014 - 2015 academic year, on average, how many hours per week did you spend studying course material?	39	45	22	i
How satisfied are you with the concept mapping method? <sup>e</sup>	4.1	3.0	not applicable	<0.0001
Did the use of concept mapping IMPROVE your grades for the related courses? <sup>f</sup>	4.1	3.3	not applicable	0.0006
Did the use of concept mapping DECREASE the amount of time spent studying per week for the related courses? <sup>g</sup>	3.5	2.7	not applicable	0.0068

ns = P-value > 0.05 for all comparisons between the UsingCM, TriedCM, and NeverCm groups.

<sup>a</sup>UsingCM1: First-year medical students using concept mapping at least once a week

<sup>b</sup>TriedCM1: First-year medical students who attempted to use concept mapping but no longer using concept mapping

<sup>c</sup>NeverCM1: First-year medical students who never attempted to use concept mapping

<sup>d</sup>average medical school GPA was calculated by assigning a 3 to an honors grade, 2 to a high pass grade, 1 to a pass grade, and 0 to a fail grade for basic science courses taken. Courses graded on pass/fail scale were excluded.

<sup>e</sup>1-5 likert scale (1: very unsatisfied, concept mapping was detrimental to my academic success; 3 Neutral, concept mapping is not better and not worse than my past studying methods; 5: Very satisfied, would recommend concept mapping to a friend)

<sup>f</sup>1-5 likert scale (1: No, grades decreased quite a bit; 2: No, grades decreased somewhat; 3: Neutral, grades remained the same; 4: Yes, somewhat; 5: Yes, quite a bit)

<sup>g</sup>1-5 likert scale (1: No, study time increased quite a bit; 2: No, study time increased somewhat; 3: Neutral, study time remained the same; 4: yes, somewhat; 5: yes, quite a bit)

<sup>h</sup>P-value = 0.42 for UsingCM vs TriedCM; P-value = 0.076 for UsingCM vs NeverCM; P-value = 0.0033 for TriedCM vs NeverCM.

<sup>i</sup>P-value = 0.32 for UsingCM vs TriedCM; P-value = 0.0018 for UsingCM vs NeverCM; P-value = 0.0011 for TriedCM vs NeverCM.

The NeverCM1 group reported significantly fewer hours per week studying than both the TriedCM1 group (Table 2, P = 0.0011) and the UsingCM1 group (Table 2, P = 0.0018).

**Reported effectiveness of concept mapping:** The UsingCM1 group had significantly higher satisfaction scores for concept mapping, reported improved grades from concept mapping, and reported improvements in time spent studying than the TriedCM1 group (Table 2). Eighty-eight percent of first-year medical students using concept mapping reported that concept mapping “somewhat” or “quite a bit” improved their medical school grades (Supplemental Appendix B).

**Barriers to using concept mapping:** The most common response reported by the TriedCM1 group for why they no longer used concept mapping was that it was too time-consuming to be effective (Supplemental Appendix B). The most common response reported by the NeverCM1 group for why they never attempted to use concept mapping was they were having enough success with their current study strategy (Supplemental Appendix B).

## Second-year medical students

**Academic performance metrics:** The NeverCM2 group had higher MCAT scores than the TriedCM2 group (Table 3, P = 0.017). The NeverCM2 group also had higher MCAT scores than the UsingCM2 group (Table 3, P < 0.0001). The TriedCM2 group had higher MCAT scores than the UsingCM2 group (Table 3, P = 0.0047).

**Reported effectiveness of concept mapping:** The UsingCM2 group had significantly higher satisfaction scores for concept mapping, reported improved grades from concept mapping, and reported improvements in time spent studying than the TriedCM2 group (Table 3). Eighty-two percent of second-year medical students using concept mapping reported that concept mapping “somewhat” or “quite a bit” improved their medical school grades (Supplemental Appendix C).

**Barriers to using concept mapping:** For the TriedCM2 group, the most common response for why they stopped using concept mapping was that it was too time-consuming to be effective (Supplemental Appendix C). For the NeverCM2 group, the most common response for

**Table 3:** Characteristics of second-year medical students.

	Mean value for UsingCM2 <sup>a</sup> (Std deviation) [N = 16]	Mean value for TriedCM2 <sup>b</sup> (Std deviation) [N = 29]	Mean value for NeverCM2 <sup>c</sup> (Std deviation) [N = 8]	P-value
Medical College Admission Test score	30 (2.2)	32 (2.2)	34 (1.1)	h
Grade point average from all college/ university courses taken before medical school	3.54 (0.275)	3.57 (0.237)	3.60 (0.253)	ns
Medical school grade point average for 2014-2015 academic year <sup>d</sup>	1.53 (0.657)	1.86 (0.731)	1.68 (0.709)	ns
For the 2014 - 2015 academic year, on average, how many hours per week did you spend studying course material?	35	32	26	ns
How satisfied are you with the concept mapping method? <sup>e</sup>	4.3	2.5	not applicable	<0.0001
Did the use of concept mapping IMPROVE your grades for the related courses? <sup>f</sup>	4.3	2.8	not applicable	<0.0001
Did the use of concept mapping DECREASE the amount of time spent studying per week for the related courses? <sup>g</sup>	3.0	2.4	not applicable	0.0117

ns = P-value > 0.05 for all comparisons between the UsingCM, TriedCM, and NeverCm groups.

<sup>a</sup>UsingCM2: Second-year medical students using concept mapping at least once a week

<sup>b</sup>TriedCM2: Second-year medical students who attempted to use concept mapping but no longer using concept mapping

<sup>c</sup>NeverCM2: Second-year medical students who never attempted to use concept mapping

<sup>d</sup>average medical school GPA was calculated by assigning a 3 to an honors grade, 2 to a high pass grade, 1 to a pass grade, and 0 to a fail grade for basic science courses taken. Courses graded on pass/fail scale were excluded.

<sup>e</sup>1-5 likert scale (1: very unsatisfied, concept mapping was detrimental to my academic success; 3 Neutral, concept mapping is not better and not worse than my past studying methods; 5: Very satisfied, would recommend concept mapping to a friend)

<sup>f</sup>1-5 likert scale (1: No, grades decreased quite a bit; 2: No, grades decreased somewhat; 3: Neutral, grades remained the same; 4: Yes, somewhat; 5: Yes, quite a bit)

<sup>g</sup>1-5 likert scale (1: No, study time increased quite a bit; 2: No, study time increased somewhat; 3: Neutral, study time remained the same; 4: yes, somewhat; 5: yes, quite a bit)

<sup>h</sup>P-value = 0.0047 for UsingCM vs Tried CM; P-value <0.0001 for UsingCM vs NeverCM; P-value = 0.017 for TriedCM vs NeverCM.

why they never attempted to use concept mapping was that it appeared to be too time-intensive to be useful (Supplemental Appendix C). The second most common response from the NeverCM2 group regarding why they never attempted to use concept mapping was that they had enough success with their current study strategy.

**Qualitative comments regarding concept mapping:** Multiple medical students reported they continued to use concept mapping because concept maps allowed them to connect/integrate the material: “I’m able to better understand how the material all relates,” “It helped me see the big picture and connect ideas,” and “Instead of memorizing discrete pieces of information it allows me to see how it all fits together”(Supplemental Appendices B and C).

Multiple medical students reported that concept mapping led to improved understanding of content: “I feel like I understand the content better,” “It helps me understand the material better,” and “Concept mapping has significantly increased my depth of understanding of the material” (Supplemental Appendices B and C).

One medical student reported they continued to use concept mapping because concept maps created a visual recall tool: “I can think of countless questions where I may not remember a certain fact, but got it correct because I knew where it was located on my map” (Supplemental Appendix C).

## Discussion

### Efficacy of the concept mapping tutoring program

Given the low response rate, there is a danger of overestimating the use of concept mapping. To decrease this risk, if one assumes that all non-responders did not use concept mapping then 14% of all medical students (42 out of 292) used the concept mapping method. First and second-year medical students who used concept mapping

seemed satisfied with the study strategy. In addition to the self-reported quantitative impact on medical school grades, the qualitative comments suggest that concept mapping aids in the development of integrative thinking skills. The ability of concept mapping to help learners develop integrative thinking patterns has been described previously [7].

It is also important to note that the program did not appear to cause harm to medical students who tried concept mapping but did not continue to use it. The majority of students who attempted concept mapping but did not continue to use it reported their grades did not worsen with concept mapping. However, the first-year medical students who tried concept mapping but did not continue to use it did have lower medical school GPAs compared to the first-year medical students who never attempted to use concept mapping. Due to this study’s retrospective nature, it cannot be determined whether the attempt at concept mapping resulted in this lower medical school GPA or whether their failed attempt to adopt the concept mapping method was a symptom of existing academic difficulties.

Given the benefit to students with minimal incidental harm and the minimal resource allocation needed to run the program, this concept mapping tutoring program continues to be an important part of the academic support services offered to medical students at EVMS. From a theoretical perspective, it is plausible this program could provide benefit if implemented at other medical schools. The program uses publicly available teaching materials [7], is grounded in well studied constructivist learning theory [2], and the resources needed for implementation appear to be feasible from a financial, time, administrative, or personnel standpoint.

### Medical student academic performance

One of the exploratory objectives was to better understand the academic characteristics and study habits of medical students in relation

to their concept mapping usage. Given the low response rate, it is difficult to draw any firm conclusions about this exploratory objective, but these results can guide future research efforts.

The first-year medical students who never used concept mapping appeared to have more efficacious and efficient study techniques already in place. They had higher medical school GPAs and spent less time studying than other first-year medical students. Future research should closely examine the study techniques of these first-year medical students who never used concept mapping to identify their effective strategies and determine if such strategies can be taught to other students. One possible theory for why some high-performing medical students did not use concept mapping is that they were able to visualize the connections between material in their head without having to physically construct a concept map. Based on this possible theory, author MT often will not suggest concept mapping as a study strategy to students who report this ability to make integrative connections in their head without using a written tool and instead will explore other study strategies with the student. This ability of high-performing students to visualize relationships mentally raises the possibility that they utilize the same techniques of mapping in combination with other inherent capacities or skills (e.g., attention or memory, time management).

The first-year medical students who tried to use concept mapping but did not continue to use concept mapping were the only students who had significantly lower medical school GPAs than other groups of medical students. This finding raises concern that this group of first-year medical students who attempted but failed to use concept mapping likely needed improved study techniques, so they tried to use concept mapping. Future research should examine whether first-year medical students who attempt concept mapping but do not continue using it should receive earlier and more intensive outreach/academic support to develop effective study techniques.

The second-year medical students who continued to use concept mapping had MCAT scores significantly lower than all other second-year groups. This finding may be related to the literature describing how concept mapping can be especially helpful to improve academic performance for students with previous history of academic difficulties [10]. Future research should examine whether medical students with MCAT scores of 30 and below (the MCAT score mean for the second-year medical students who continued to use concept mapping) should receive earlier and more intensive outreach/academic support. In 2012 (when many of these second-year medical students likely took the MCAT), the mean MCAT score was 31.2, with a standard deviation of 4.0 for students accepted into medical school [14]. This possibility of medical students with MCAT scores of 30 and below requiring more academic support has been reported previously [15].

### Medical student reflections on concept mapping

Another exploratory objective was to describe why medical students benefited from concept mapping. Multiple medical students reported that concept maps allowed them to connect/integrate the material in their qualitative comments. Meaningful learning results in relationships between concepts becoming “more explicit, more precise, and better integrated with other concepts and propositions,” and meaningful learning was one of the foundational principles that led to creation of the concept mapping tool [2]. The medical student comments likely represent how concept mapping facilitates meaningful learning. Meaningful learning is instrumental in medical education, given the need to connect basic science and clinical content. The integration of content provided by concept mapping can also help develop clinical reasoning skills [16].

This description of concept maps functioning as spatially oriented visual recall tools suggests that concept maps can aid in recall similar to the method of loci. The method of loci is a visual recall tool where the learner imagines “walking through a familiar environment and

placing the to-be-remembered items along their path. To recall, they re-imagine walking through the environment, seeking items as they go [17].” The method of loci has been used in multiple contexts, including medical education [18-20]. In this study, the student appears to be using the piece of paper on which the concept map is drawn as the familiar environment and recalling the bubbles of the concept maps as the remembered items. Using the concept map in this method of loci manner allows a concept map to be useful for recall even if a concept map only shows unconnected but spatially oriented information.

It is difficult to determine precisely what learners meant when they described that concept mapping led to better understanding. Still, perhaps this could signal that concept mapping leads to deeper learning, as described elsewhere [21,22].

Medical students also reported barriers to using concept mapping. One of the most considerable difficulties reported for the concept mapping method was the time-consuming nature of this technique. Medical students who continued to use concept mapping reported minimal improvement in study time. Additionally, time consumption was a top reason why medical students who tried concept mapping but did not continue to use concept mapping had stopped using this method. Future studies should work with medical students to modify the concept mapping method to be less time-consuming.

Similarly, future studies should ask medical students how long they tried to use concept mapping before they decided to no longer use it and the associated reasons for discontinuation. It is possible that different barriers would be found for students depending on the duration of concept mapping use. Students who stopped using concept mapping after a short period likely found an immediate severe obstacle. In contrast, the students who stopped using concept mapping after a longer duration likely found the method feasible in the short term but not sustainable.

### Strengths of this Study

Objective academic performance data was used to determine the characteristics of medical students who did and did not use concept mapping. Describing student characteristics with this objective educational performance data was important because this objective academic performance data ultimately determines whether medical students advance in their training. Understanding how concept mapping could potentially affect the advancement of medical students in their training is important information for organizations to consider when deciding whether resources should be invested in a concept mapping tutoring program. It was also a strength to break down the larger group of students who did not use concept mapping into two distinct groups: medical students who never attempted to use concept mapping and medical students who tried concept mapping but did not continue to use it. Authors MT and AK theorized that medical students who never attempted to use concept mapping already had robust study strategies. In contrast, authors MT and AK theorized that medical students who tried to use concept mapping but stopped using this method likely needed more academic support but could not adopt the concept mapping technique.

### Limitations

A major limitation of this study is that medical students were not asked whether they started using concept mapping because of the concept mapping tutoring program or whether they learned concept mapping through other means. This lack of information raises the possibility that concept mapping was already occurring regardless of the concept mapping tutoring program. However, arguing against this possibility is that only three qualitative comments suggested the use of concept mapping started before medical school (“It’s intuitive for me. It’s always been how I’ve studied.”; “I have been using concept maps since undergrad”; “I am just using the concept mapping method that I have used since high school”) (Supplemental Appendix B).

Although our response rate (37%) was very slightly above the average reported for organizational research (35.7%) [23], it would have been preferable to have a response rate greater than 50% to make the findings more generalizable. Thus, response bias was possible in this study. Students struggling academically might have had less time to respond to the survey causing results to be skewed towards higher performing medical students. In the future, instead of using an online survey, students should be given protected time during an already scheduled mandatory lecture to fill out the survey. Also, academic performance data should have been collected from non-responders to determine the amount of response bias present.

The study should have extended longitudinally over all four years of medical school to see how concept mapping use changes from the basic science years to the clinical years. Concept mapping is thought to help integrate basic science and clinical information, and to help develop clinical reasoning skills [16].

## Conclusion

There is some evidence that the concept mapping tutoring program provides academic benefit to a subset of medical students without causing significant harm to those unable to implement this study strategy. Additionally, the concept mapping tutoring program required relatively few resources, making this program feasible for implementation as an academic support tool for medical students.

Although our response rate was low, the findings regarding students' academic performance who did and did not use concept mapping provide multiple areas for future research. These various areas of research could include investigating the study habits of high-performing medical students, and development of early warning systems to identify and provide additional academic support for at-risk students.

## Conflicts of Interest

During the course of this research, Michael Terao was employed by Sketchy Medical, Enago, and MedStudy, but at the time of submission Michael Terao was no longer employed by Sketchy Medical, Enago, or MedStudy.

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## Data Availability Statement

Data available within the article or its supplementary materials.

The data presented in this manuscript was presented as a poster presentation at the University of California, San Francisco Inquiry Symposium (May 4, 2016. San Francisco, CA).

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## Supplemental Appendix A: Concept Mapping Tutoring Guide

The guide below is a suggested framework for how to perform concept mapping tutoring. How the actual tutoring sessions are performed by the concept mapping tutors at Eastern Virginia Medical School is at the discretion of each individual concept mapping tutor.

### Preparation work prior to 1 hour tutoring session

- Information/questions that the student will need to have provided/answered to the tutor prior to the tutoring session:
- When is your next medical school exam?
- What are the academic consequences of performing poorly on this medical school exam?
- Student is also asked to bring study materials that were used to prepare for both the Medical College Admissions Test, and study materials that are currently being used to prepare for medical school exams

### Outline for Initial 1 hour tutoring session

- Tutor first asks the student what questions they have/what they want to discuss first in regards to concept mapping
- This is to empower the student to be the agenda setter and allow the student to have their most urgent important concerns handled first
- After the student's most urgent/important concerns are handled first, the tutoring session then proceeds along one of the pathways below:
  - Pathway #1: If the student identified previously in the "Preparation work prior to 1 hour tutoring session" section above that the next exam will have severe academic consequences if there is poor performance on this exam (definition of severe academic consequences is determined by a discussion between the tutor and the student during this initial tutoring session), and the next exam is in approximately four weeks or sooner:
    - Student is taught the SuccessTypes Survival Strategy<sup>1</sup>
    - However, instead of having the student do this practice question analysis only on weekends, we strongly advise the student to do this practice question analysis on a daily basis as much as possible to try and dramatically improve exam performance in as short a time as possible especially if the next exam is in 7 days or less.
    - The tutor sets up another follow up tutoring session for the student immediately after the next exam to work with the student on Pathway #2 described below.
      - Pathway #2: This is for students who do not qualify for Pathway #1 above.
      - Tutor discusses previous study materials and exam performance from "Preparation work prior to 1 hour tutoring session" section above to attempt to identify why there have been previous problems with exam performance
        - Some common problems could include:
          - Study techniques did not involve comparison/integration of topics which is important for performing well on multiple choice question exams
          - Often this involves the student not using practice questions to study early enough before the exam or often enough before the exam
          - Also could involve the student using practice questions early and often enough but not having a way to effectively study/retain the comparative analysis from the practice questions
            - Study techniques did not effectively identify the material that is most likely to show up on the exam, so the student became cognitively overloaded trying to study all possible material that might show up on the exam
              - Study techniques did not allow for sufficient repetition of the material before the exam.
              - In general, we recommend a study technique that allows for at least 10-20 repetitions of the material before the exam.
              - Review of the concept map created by the tutor as described in the "Preparation work prior to 1 hour tutoring session" section above
              - Review of how to create a concept map as described in Chapter 7 of SuccessTypes in Medical Education<sup>2</sup> and as described in the videos at <https://www.youtube.com/watch?v=FSrIP3yVjs3> and at <https://www.youtube.com/watch?v=S4SwSheh7TI4>
              - Reviews with the student that each person's concept map for a topic/subject will look different:
                - Tutor emphasizes with the student that there is no one "right" concept map but instead each person's concept map reflects the person's unique cognitive approach to the material and thus is expected to be different for each person
                - Tutor describes that a good concept map meets all three of the following conditions and that none of these conditions involve the concept map looking similar to another person's concept map:
                  - Concept map is able to be created in a time feasible manner
                  - Concept map is able to be reviewed in a time feasible manner
                  - Concept map contributes to the student performing at a high level on medical school exams
                - Review of how to perform multiple choice question analysis as described in Chapter 8 of SuccessTypes in Medical Education<sup>2</sup> and in the video at <https://www.youtube.com/watch?v=jcfAtZhUP9w5>
                - Review of how to incorporate concept mapping into a daily study cycle as described in Chapter 10 of [SuccessTypes in Medical Education](#)<sup>2</sup>

- For the verification stage, in addition to describing verbalizing as a way to review maps, the tutor also provides two other additional methods for reviewing the maps
  - Pure visual review: This involves looking over the maps without verbalizing the maps
  - Some students have reported that it is too time consuming to verbalize all of their maps, so this option is offered as a less time intensive way to review
    - However, the pure visual review method is likely a less active learning process than verbalization
    - Cover and quiz yourself review: This involves the student covering up lower sections of the maps with their hands or a piece of paper, then attempting to recall from memory what material is present in these lower sections of the maps
      - This method provides the student with a way to quiz themselves but often can be more time consuming than the verbalization or pure visual review methods
        - Timeline for next follow up tutoring session is determined on a case by case basis by discussion between the tutor and the student
        - Often it will take a student several tutoring sessions to become proficient at the use of concept mapping

### **Outline for follow up 1 hour tutoring session**

- The agenda for these follow up tutoring sessions carries on a case by case basis by the student but often includes the following topics/concerns brought up by students:
  - Identifying and intervening on reasons why concept mapping is too time consuming:
    - Some common problems and interventions encountered:
      - Student has great difficulty making decisions on how to structure the concept map:
        - This problem often resolves with further practice once the student has established their preferred system for structuring concept maps such as using learning objectives to structure the main topics vs using lecture slide titles to structure the main topics, etc
          - Student is including so much detail in the concept map that it is not time feasible to continue mapping
          - Tutor will review the orientation stage of the study cycle (see Chapter 10 of SuccessTypes in Medical Education<sup>2</sup>) regarding how to pick out the most high yield material from lectures
            - Tutor will also review the question analysis methods (Chapter 8 of SuccessTypes in Medical Education<sup>2</sup> and in the video at <https://www.youtube.com/watch?v=jcfAtZhUP9w3>) as another way to determine what material needs to be in the concept map and what material doesn't need to be in the concept map
              - Addressing student's concerns that the student concept map looks different than the tutor's concept map for a specific lecture/subject:
                - Tutor emphasizes with the student that there is no one "right" concept map but instead each person's concept map reflects the person's unique cognitive approach to the material and thus is expected to be different for each person
                  - Tutor describes that a good concept map meets all three of the following conditions and that none of these conditions involve the concept map looking similar to another person's concept map:
                    - Concept map is able to be created in a time feasible manner
                    - Concept map is able to be reviewed in a time feasible manner
                    - Concept map contributes to the student performing at a high level on medical school exams
                  - Tutor and student review recent concept maps that the student has created
                    - This review often includes the student asking the tutor whether the concept map is created properly. In this case, the tutor verifies that the map is created properly by determining whether the student can verbalize the material coherently and accurately based on the student reading from the concept map.
                      - Student reports that concept mapping is very exhausting, tiring
                        - This problem often is encountered during the first few weeks of learning to concept map when the student doesn't have a robust system setup for how to structure their maps and thus needs to expend significant cognitive energy making decisions on how to structure concept maps. Over time once the student has developed a system for structuring their concept maps, this level of cognitive energy expenditure tends to go down dramatically.

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## Supplemental Appendix B: 1st year, Concept Mapping Survey results, descriptive statistics for academic metrics

### Descriptive Statistics for Academic Metrics for 1st Year Medical Students

|   | <u>Using concept mapping at least once a week</u>                                     | Attempted to use concept mapping but no longer using concept mapping                 | Never attempted to use concept mapping   |
|---|---|--|--|
| <u>Medical College Admissions Test score</u>  | Mean: 31<br>Std Deviation: 2.8<br>Median: 32<br>Minimum: 24<br>Maximum: 36            | Mean: 31<br>Std Deviation: 2.8<br>Median: 31.5<br>Minimum: 27<br>Maximum: 39         | Mean: 32<br>Std Deviation: 2.7<br>Median: 32<br>Minimum: 28<br>Maximum: 36           |
| Grade point average from all college/university courses taken before medical school | Mean: 3.63<br>Std Deviation: 0.278<br>Median: 3.73<br>Minimum: 3.03<br>Maximum: 3.97  | Mean: 3.58<br>Std Deviation: 0.304<br>Median: 3.67<br>Minimum: 2.96<br>Maximum: 4.00 | Mean: 3.52<br>Std Deviation: 0.299<br>Median: 3.58<br>Minimum: 3.04<br>Maximum: 3.96 |
| Medical school grade point average for 2014-2015 academic year                      | Mean: 2.13<br>Std Deviation: 0.702<br>Median: 2.15<br>Minimum: 0.860<br>Maximum: 3.00 | Mean: 1.97<br>Std Deviation: 0.585<br>Median: 1.92<br>Minimum: 1.14<br>Maximum: 3.00 | Mean: 2.56<br>Std Deviation: 0.425<br>Median: 2.64<br>Minimum: 1.71<br>Maximum: 3.00 |

### Concept Mapping Survey Results for 1st Year Medical Students

#### Questions answered by all students

- Definition of Concept Mapping: A visual knowledge representation tool that helps the learner understand material by creating a hierarchical organization and "crosslinks" that shows relationships between ideas in different segments of the map.<sup>1</sup>

#### 1. What class are you in?

B. Doctor of medicine program, class of 2018 (1st year medical student) 56

**2. What is your 5 number and 1 letter EVMS student ID number (PLEASE ENTER THIS NUMBER VERY CAREFULLY AS YOUR STUDENT ID NUMBER WILL BE USED TO IDENTIFY YOU IF YOU SHOULD WIN ONE OF THE STARBUCKS GIFT CARDS. IF YOU FAIL TO FULLY AND PROPERLY ENTER YOUR STUDENT ID NUMBER PROPERLY WITH 5 NUMBERS AND 1 LETTER YOU WILL NOT BE ELIGIBLE TO WIN A STARBUCKS GIFT CARD)?**

**3. Do you use concept mapping at least once a week to study course material (This includes either creating concept maps, modifying concept maps, or studying from concept maps in either paper or electronic form)?**

A. Yes 26 (46%)

B. No 30 (54%)

#### **Questions for students who answered "No" to question #3**

**4. Did you ever attempt to use concept mapping as a study method while you've been a student at Eastern Virginia Medical School (This includes either creating concept maps, modifying concept maps, or studying from concept maps in either paper or electronic form)?**

A. Yes 18 (60%)

B. No 12 (40%)

**Questions for students who answered "No" to question #3 and "No" to question #4 (Students who never attempted to use concept mapping, NeverCMI group)**

**For the 2014 - 2015 academic year, on average, how many hours per week did you spend studying course material (not including attendance at lecture or watching lectures online)?**

Total responses: 12

Median: 20

Mean: 22

Minimum: 6

Maximum: 50

**Did you attend the optional session on concept mapping training at the beginning of the first year of medical school?**

A. Yes 4 (20%)

B. No 8 (80%)

**How many times have you met with a concept mapping tutor or a member of the Office of Academic Development about concept mapping during your time at Eastern Virginia Medical School (not including the mandatory large group lecture at the beginning of first year of medical school)?**

\_\_\_\_\_

0 for all 12 responses

**Which of the following best describes why you never attempted to use concept mapping as a study strategy while at EVMS?**

A. Had tried to use concept mapping prior to coming to EVMS and did not find it to be an effective study strategy: 1 (8%)

B. Was having enough success with my current study strategy and did not feel the need to try a new study strategy such as concept mapping: 8 (67%)

C. Concept mapping appeared to be too time intensive to be useful: 1 (8%)

D. Did not feel that concept mapping would be useful for me since I am not a visual learner: 1 (8%)

E. Other (please specify): \_\_\_\_\_ : 1 (8%)

"Course material was not difficult enough to require to do mapping in order to study"

**Questions for students who answered "No" to question #3 and "Yes" to question #4** (Students who attempted to use concept mapping but no longer using concept mapping, TriedCMI group)

**For the 2014 - 2015 academic year, on average, how many hours per week did you spend studying course material (not including attendance at lecture or watching lectures online)?**

\_\_\_\_\_

Total responses: 18

Median: 38

Mean: 45

Minimum: 20

Maximum: 80

**How many times have you met with a concept mapping tutor or a member of the Office of Academic Development about concept mapping during your time at Eastern Virginia Medical School (not including the mandatory large group lecture at the beginning of first year of medical school)?**

\_\_\_\_\_

4 respondents met once each with a concept mapping tutor or a member of the Office of Academic Development about concept mapping

14 other respondents never met with a concept mapping tutor or a member of the Office of Academic Development about concept mapping

**Did the use of concept mapping IMPROVE your grades for the related courses?**

1: No, grades decreased quite a bit

2: No, grades decreased somewhat 2 (11%)

3: Neutral, grades remained the same 10 (56%)

4: Yes, somewhat 5 (28%)

5: Yes, quite a bit 1 (6%)

**Did the use of concept mapping DECREASE the amount of time spent studying per week for the related courses?**

1: No, study time increased quite a bit 2 (11%)

2: No, study time increased somewhat 5 (28%)

3: Neutral, study time remained the same 9 (50%)

4: yes, somewhat 1 (6%)

5: yes, quite a bit 1 (6%)

**Which of the following best describes why you stopped using concept mapping as a study method?**

A. Concept mapping was too time consuming to be effective 10 (56%)

B. Concept mapping did not help improve my grades 3 (17%)

C. Other (please specify): \_\_\_\_\_ 5 (28%)

"I find that concept maps could get messy and leave out some important details"

"I only use it occasionally for some classes (like biochem)."

"Required too much work to make my own concept maps"

"I could not figure out how to concept map successfully"

"I am still not sure exactly the definition of concept mapping, so I'm not sure if and how much I do it. I found the concept maps that Dr. \_\_\_\_\_ provides for CSF incredibly helpful, and I used them. I think that I don't have a strong enough grasp of the material, and once I am getting close to having enough knowledge, I don't have time to then make a concept map. Maybe if I had an example before lectures/blocks to see how everything fits together I would then be able to make my own."

**Which of the following would have been most helpful to make concept mapping a successful study strategy for you?**

A. More availability of concept mapping tutors for 1 on 1 tutoring sessions 5 (28%)

B. More online videos on concept mapping 3 (17%)

C. More large group lectures on concept mapping 1 (6%)

D. More small group sessions on concept mapping 4 (22%)

E. Other (please specify) \_\_\_\_\_ 5 (28%)

"I like concept mapping. I do it when I have the time to. I don't have time to concept map everything."

"Available pre-made concept maps for course material"

"premade concept maps"

"I would be interested in learning more about concept mapping and think a video and then small group or 1 on 1 tutoring could be helpful."

"Some advice on the better concept mapping software to use for medical school classes might have been useful"

**How satisfied are you with the concept mapping method?**

1: very unsatisfied, concept mapping was detrimental to my academic success

2: 3 (17%)

3: Neutral, concept mapping is not better and not worse than my past studying methods 12 (67%)

4: 3 (17%)

5: Very satisfied, would recommend concept mapping to a friend

**Questions for students who answered "Yes" to question #3 (students currently using concept mapping, UsingCMI group)**

**For the 2014 - 2015 academic year, on average, how many days a week do you use concept mapping (This includes either creating concept maps, modifying concept maps, or studying from concept maps in either paper or electronic form)?**

\_\_\_\_\_

Total responses: 26

Median: 2

Mean: 3

Minimum: 1

Maximum: 7

**How many times have you met with a concept mapping tutor or a member of the Office of Academic Development about concept mapping during your time at Eastern Virginia Medical School (not including the mandatory large group lecture at the beginning of first year of medical school)?**

\_\_\_\_\_

Total responses: 26

Median: 0

Mean: 1

Minimum: 0

Maximum: 4

**For the 2014 - 2015 academic year, on average, how many hours per week have you spent studying course material (not including attendance at lecture or watching lectures online)?**

---

Total responses: 26

Median: 40

Mean: 39

Minimum: 4

Maximum: 70

**For how many months have you been using concept mapping at least once a week as a student at Eastern Virginia Medical School (This includes either creating concept maps, modifying concept maps, or studying from concept maps in either paper or electronic form)?**

---

Total responses: 26

Median: 8

Mean: 8

Minimum: 4

Maximum: 16

**Did the use of concept mapping (This includes either creating concept maps, modifying concept maps, or studying from concept maps in either paper or electronic form) IMPROVE your grades for the related courses?**

1: No, grades decreased quite a bit

2: No, grades decreased somewhat

3: Neutral, grades remained the same 3 (12%)

4: Yes, somewhat 18 (69%)

5: Yes, quite a bit 5 (19%)

**Did the use of concept mapping (This includes either creating concept maps, modifying concept maps, or studying from concept maps in either paper or electronic form) DECREASE the amount of time spent studying per week for the related courses?**

1: No, study time increased quite a bit

2: No, study time increased somewhat 3 (12%)

3: Neutral, study time remained the same 11 (42%)

4: yes, somewhat 8 (31%)

5: yes, quite a bit 4 (15%)

**Which of the following best describes why you continue to use concept mapping?**

A. Concept mapping has significantly improved my grades 5 (19%)

B. Concept mapping has significantly decreased the amount of time I need to spend studying 5 (19%)

C. Other (please specify) \_\_\_\_\_ 16 (62%)

"The total time I spend studying remains the same, however I can now cover more material repeatedly."

"Good thought process."

"It helps me organize the material."

"I still need to modify the way I concept map because it takes up a significant portion of my time (2-3 hours per lecture). However, it helps me understand the materials better and it forces me to sit down and study "

"Both of the above "

"Instead of memorizing discrete pieces of information it allows me to see how it all fits together. "

"Creating them is hard, but if done well they are an invaluable tool. "

"I like to look at material multiple times in different forms"

"Concept mapping is something I use only for specific subjects, especially those which required memorization of many facts. I feel that this will be more important for 2nd year than 1st year."

"Concept maps help me keep things organized in my mind and I often think about the maps when taking exams."

"Concept mapping increases the time that I spend studying because making the concept maps takes more time than the notes that I used to take. I do not mind this because my looking at the few concept maps that I make right before a test is a great way of jogging my memory for a thorough review.

"Concept mapping provides another way for me to engage actively with the material I'm studying. I usually go to lecture (first pass), write out notes in narrative form (second pass), and then concept map my narrative notes (third pass). "

"Retaining information beyond cramming, resource for STEP1"

"It helps me understand the material better."

"concept mapping has significantly increased my depth of understanding of the material and allows for much better recall on tests. "

"Habit"

**Which of the following has been MOST HELPFUL to make concept mapping a successful study strategy for you?**

A. Concept mapping tutors for 1 on 1 tutoring sessions 2 (8%)

B. Online videos on concept mapping 1 (4%)

C. Large group lectures on concept mapping 4 (15%)

D. Small Group sessions on concept mapping 6 (23% )

E. Other (please specify) \_\_\_\_\_ 13 (50%)

"The concept maps were provided in one of the courses during the first semester, and I found that really helpful. So, I started using concept maps for some of the other courses that I found would be helpful as well. "

"Making my own concept maps from course material."

"I usually only study from previously made concept maps"

"I organize my notes in the way that I think will help me understand the materials. I don't really have a specific strategy"

"I like when our lectures are created so it's easy for us to make a concept map. I feel like when a lecture is presented with a good amount of connection and diagrams, it's easier to make concept maps. All lectures that were like that, I feel like I got the most out of the material. All lectures should be organized more."

"Although concept mapping significantly benefitted me, I honestly think concept mapping isn't for everyone- mandatory small group/large group or tutoring would be superfluous. I think maybe optional online videos would help but it's something for the individual to learn about on their own"

"It's intuitive for me. It's always been how I've studied. Only learn what it seems like someone will put on an exam, and only bother learning enough to correctly distinguish multiple choice answers from each other."

"I make my own"

"I have been using concept maps since undergrad"

"I am just using the concept mapping method that I have used since high school."

"N/A"

"Making my own concept maps."

"practice, practice, practice and try different methods and mediums. Concept mapping wasn't a new idea for me but a very new way to make notes and study so I tried pretty much every technique and medium (mapping during lectures, centrally located idea with many branches, paper and pen, coggle, mindmap programs, white erase boards, etc) and have finally solidified what works best for me. The biggest thing I have found is that it does require a bit of time to get use to, the majority of the work is upfront in creating and organizing the map, but once that is done, so much time is saved allowing for time for practice questions and fine tuning of the information. I don't map each lecture, I have found it is most successful for me when I map topics or subject matter together because there is often repeat information between lectures or critical connections that may have three lectures in between them that I wasn't making when producing maps for each lecture. I have combined an app called Cam Scan Pro where I take a pic of my "final" maps then will print them. (my maps are in a medium size artist spiral so by printing them they are more manageable on the nml size paper) as I need to add information either from things I was missing with practice questions or more specific details for class tests. This way I have my final versions which I can use for board studying, am able to evaluate if I need to add the "detail" part from

specific lectures or I may notice a theme of types of questions I get wrong. Then I can modify the map. Also, if something were to happen to my originals, I still have them."

### How satisfied are you with the concept mapping method?

- 1: very unsatisfied, will stop using it very soon  
 2: 1 (4%)  
 3: Neutral, it is not better and not worse than my past studying methods 5 (19%)  
 4: 10 (38%)  
 5: Very satisfied, would recommend concept mapping to a friend 10 (38%)

### References

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## Supplemental Appendix C: 2nd year, Concept Mapping Survey results, descriptive statistics for academic metrics

### Descriptive Statistics for Academic Metrics for 2nd Year Medical Students

|   | Using concept mapping at least once a week   | Attempted to use concept mapping but no longer using concept mapping                 | Never attempted to use concept mapping   |
|---|--|--|--|
| <u>Medical College Admissions Test score</u>  | Mean: 30<br>Std Deviation: 2.2<br>Median: 30<br>Minimum: 26<br>Maximum: 35           | Mean: 32<br>Std Deviation: 2.2<br>Median: 32<br>Minimum: 28<br>Maximum: 37           | Mean: 34<br>Std Deviation: 1.1<br>Median: 34<br>Minimum: 32<br>Maximum: 35           |
| Grade point average from all college/university courses taken before medical school | Mean: 3.54<br>Std Deviation: 0.275<br>Median: 3.54<br>Minimum: 2.89<br>Maximum: 3.97 | Mean: 3.57<br>Std Deviation: 0.237<br>Median: 3.55<br>Minimum: 2.83<br>Maximum: 3.98 | Mean: 3.60<br>Std Deviation: 0.253<br>Median: 3.57<br>Minimum: 3.13<br>Maximum: 3.96 |
| Medical school grade point average for 2014-2015 academic year                      | Mean: 1.53<br>Std Deviation: 0.657<br>Median: 1.20<br>Minimum: 1.00<br>Maximum: 3.00 | Mean: 1.86<br>Std Deviation: 0.731<br>Median: 1.80<br>Minimum: 1.00<br>Maximum: 3.00 | Mean: 1.68<br>Std Deviation: 0.709<br>Median: 1.50<br>Minimum: 1.00<br>Maximum: 3.00 |

### Concept Mapping Survey Answers for 2nd Year Medical Students

#### Questions answered by all students

- Definition of Concept Mapping: A visual knowledge representation tool that helps the learner understand material by creating a hierarchical organization and "crosslinks" that shows relationships between ideas in different segments of the map.<sup>1</sup>

#### 1. What class are you in?

B. Doctor of medicine program, class of 2018 (1st year medical student) 53

**2. What is your 5 number and 1 letter EVMS student ID number (PLEASE ENTER THIS NUMBER VERY CAREFULLY AS YOUR STUDENT ID NUMBER WILL BE USED TO IDENTIFY YOU IF YOU SHOULD WIN ONE OF THE STARBUCKS GIFT CARDS. IF YOU FAIL TO FULLY AND PROPERLY ENTER YOUR STUDENT ID NUMBER PROPERLY WITH 5 NUMBERS AND 1 LETTER YOU WILL NOT BE ELIGIBLE TO WIN A STARBUCKS GIFT CARD)?**

**3. Do you use concept mapping at least once a week to study course material (This includes either creating concept maps, modifying concept maps, or studying from concept maps in either paper or electronic form)?**

- A. Yes 16 (30%)  
 B. No 37 (70%)

#### Questions for students who answered "No" to question #3

**4. Did you ever attempt to use concept mapping as a study method while you've been a student at Eastern Virginia Medical School (This includes either creating concept maps, modifying concept maps, or studying from concept maps in either paper or electronic form)?**

- A. Yes 29 (78%)  
B. No 8 (22%)

**Questions for students who answered "No" to question #3 and "No" to question #4** (Students who never attempted to use concept mapping, NeverCM2 group)

**For the 2014 - 2015 academic year, on average, how many hours per week did you spend studying course material (not including attendance at lecture or watching lectures online)?**

\_\_\_\_\_  
Total responses: 8

Median: 23

Mean: 26

Minimum: 5

Maximum: 60

**Did you attend the optional session on concept mapping training at the beginning of the first year of medical school?**

- A. Yes 4 (50%)  
B. No 4 (50%)

**How many times have you met with a concept mapping tutor or a member of the Office of Academic Development about concept mapping during your time at Eastern Virginia Medical School (not including the mandatory large group lecture at the beginning of first year of medical school)?**

\_\_\_\_\_  
All 8 respondents reported 0 times

**Which of the following best describes why you never attempted to use concept mapping as a study strategy while at EVMS?**

- A. Had tried to use concept mapping prior to coming to EVMS and did not find it to be an effective study strategy  
B. Was having enough success with my current study strategy and did not feel the need to try a new study strategy such as concept mapping 3 (38%)  
C. Concept mapping appeared to be too time intensive to be useful 4 (50%)  
D. Did not feel that concept mapping would be useful for me since I am not a visual learner  
E. Other (please specify): \_\_\_\_\_ 1 (13%)  
"I need everything written out, concept mapping left too many holes"

**Questions for students who answered "No" to question #3 and "Yes" to question #4** (Students who attempted to use concept mapping but no longer using concept mapping, TriedCM2 group)

**For the 2014 - 2015 academic year, on average, how many hours per week did you spend studying course material (not including attendance at lecture or watching lectures online)?**

\_\_\_\_\_  
Total responses: 29

Median: 30

Mean: 32

Minimum: 12

Maximum: 70

**How many times have you met with a concept mapping tutor or a member of the Office of Academic Development about concept mapping during your time at Eastern Virginia Medical School (not including the mandatory large group lecture at the beginning of first year of medical school)?**

\_\_\_\_\_  
Total responses: 29

2 respondents reported 2 times, 2 respondents reported 1 time, all other respondents reported 0 times

**Did the use of concept mapping IMPROVE your grades for the related courses?**

- 1: No, grades decreased quite a bit 1 (3%)  
 2: No, grades decreased somewhat 5 (17%)  
 3: Neutral, grades remained the same 22 (76%)  
 4: Yes, somewhat 1 (3%)  
 5: Yes, quite a bit

**Did the use of concept mapping DECREASE the amount of time spent studying per week for the related courses?**

- 1: No, study time increased quite a bit 4 (14%)  
 2: No, study time increased somewhat 11 (38%)  
 3: Neutral, study time remained the same 13 (45%)  
 4: yes, somewhat 1 (3%)  
 5: yes, quite a bit

**Which of the following best describes why you stopped using concept mapping as a study method?**

- A. Concept mapping was too time consuming to be effective 13 (45%)  
 B. Concept mapping did not help improve my grades 6 (21%)  
 C. Other (please specify): \_\_\_\_\_ 10 (34%)

"Found it ineffective. It required more time than my normal studying methods while yielding no improvement in retention of the material."

"I don't find the style of material organization conducive to my manner of learning material."

"preferred to make study guides in an outline format. easier to fit more details and not a new technique to use"

"It was too time consuming, but I also didn't really find it helpful."

"Both of those answers. I also switched to more note taking/outline making instead of concept mapping, I found it to be similar but more helpful for me."

"Did not feel as though concept mapping helped solidify important details which is what I needed to work on"

"not every concept lent itself to quick learning via concept maps. in that sense, they took too much time to make."

"It took a lot of time and was not effective enough for me to take time out of my normal methods of studying."

"I didn't like that it did not include all the details. I prefer outlining."

"Time and labor intense. AOA keep growing and outgrowing the paper and were a hot mess by the time it was all done and was totaly useless mess."

**Which of the following would have been most helpful to make concept mapping a successful study strategy for you?**

- A. More availability of concept mapping tutors for 1 on 1 tutoring sessions 7 (24%)  
 B. More online videos on concept mapping 5 (17%)  
 C. More large group lectures on concept mapping  
 D. More small group sessions on concept mapping 5 (17%)  
 E. Other (please specify) \_\_\_\_\_ 12 (41%)

"None. Just don't think it's for me."

"N/A"

"I think there was appropriate instruction on concept mapping and the people that benefitted from it ended up being able to use it effectively."

"I dont think anything could have made concept mapping a successful strategy for me. I was getting average grades with concept mapping because I was just learning the main concepts, and getting Honors requires knowing nitty gritty details that aren't captured in concept mapping."

"It didn't match how I learn so I found other ways."

"Lectures actually organized in a way that didn't take forever to parse through and reorganize"

"The only think that would have made me use concept maps is a tutorial on the use of an electronic mapping program. One of the biggest, if not the biggest, barriers for me was how spatially-challenged and un-neat I am."

"I don't enjoy concept mapping."



"None of these- concept mapping was wonderful for me first year. Second year there was too much information, so I adapted my study habits when i saw that concept mapping was working out."

"I don't think that more instruction would've made concept mapping more effective for me."

"None, concept mapping just was not for me."

"Not pushing it on everyone"

**How satisfied are you with the concept mapping method?**

1: very unsatisfied, concept mapping was detrimental to my academic success 3 (10%)

2: 9 (31%)

3: Neutral, concept mapping is not better and not worse than my past studying methods 16 (55%)

4: 1 (3%)

5: Very satisfied, would recommend concept mapping to a friend

**Questions for students who answered "Yes" to question #3** (students currently using concept mapping, UsingCM2 group)

**For the 2014 - 2015 academic year, on average, how many days a week do you use concept mapping (This includes either creating concept maps, modifying concept maps, or studying from concept maps in either paper or electronic form)?**

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Total responses: 16

Median: 5

Mean: 5

Minimum: 1

Maximum: 7

**How many times have you met with a concept mapping tutor or a member of the Office of Academic Development about concept mapping during your time at Eastern Virginia Medical School (not including the mandatory large group lecture at the beginning of first year of medical school)?**

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Total responses: 16

Median: 1

Mean: 1

Minimum: 0

Maximum: 4

**For the 2014 - 2015 academic year, on average, how many hours per week have you spent studying course material (not including attendance at lecture or watching lectures online)?**

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Total responses: 16

Median: 35

Mean: 35

Minimum: 3

Maximum: 70

**For how many months have you been using concept mapping at least once a week as a student at Eastern Virginia Medical School (This includes either creating concept maps, modifying concept maps, or studying from concept maps in either paper or electronic form)?**

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Total responses: 16

Median: 18

Mean: 17

Minimum: 4

Maximum: 24

**Did the use of concept mapping (This includes either creating concept maps, modifying concept maps, or studying from concept maps in either paper or electronic form) IMPROVE your grades for the related courses?**

- 1: No, grades decreased quite a bit
- 2: No, grades decreased somewhat
- 3: Neutral, grades remained the same 3 (19%)
- 4: Yes, somewhat 6 (38%)
- 5: Yes, quite a bit 7 (44%)

**21. Did the use of concept mapping (This includes either creating concept maps, modifying concept maps, or studying from concept maps in either paper or electronic form) DECREASE the amount of time spent studying per week for the related courses?**

- 1: No, study time increased quite a bit
- 2: No, study time increased somewhat 4 (25%)
- 3: Neutral, study time remained the same 8 (50% )
- 4: yes, somewhat 4 (25%)
- 5: yes, quite a bit

**Which of the following best describes why you continue to use concept mapping?**

- A. Concept mapping has significantly improved my grades 4 (25%)
- B. Concept mapping has significantly decreased the amount of time I need to spend studying 1 (6%)
- C. Other (please specify) \_\_\_\_\_ 11 (69%)

"Concept mapping better allows me to store information for the long term. By studying through info groupings and looking at the big picture- I'm able to better understand how the material all relates. Also It helps me with faster recall as well."

"I'm not sure whether concept mapping improves my grades or not, because I find it useful for certain courses and not for others. For example, for classes with a large amount of information of a categorical nature, such as microbiology & pharmacology, I used concept maps to group the information in a way that made sense to me and also as a reference to easily look up information while studying (rather than studying directly from the concept maps). In other classes that were more conceptual, such as physiology & pathology, I didn't use concept mapping because I felt my time was better spent trying to understand the information through reading & re-affirming concepts with practice questions. I did well in both types of classes, but I'm unable to directly attribute the success to concept mapping, because I don't know how I would have done if I hadn't concept mapped in the classes I chose to. However I will say that I felt it worked for me in particular classes & I would do it again if I had the choice. "

"It helped me see the big picture and connect ideas."

."

"I feel like I understand the content better. I would continue to use it even if my grades/time spent studying stayed the same (I might have tried something different if my grades had dropped while mapping)."

"Has improved my grades in 4/5 courses, reduced time variably, depending on who gave the lecture"

"Concept mapping lets me see everything simplified on one page. It helps me to have a big picture understanding before I try to learn the smaller details."

"I have a difficult time just reading texts, so writing is key to me. I found concept mapping the best way to create a note set for easy review later on. It is very visual, so I often found myself being able to visualize where a certain topic or concept was located on my map while taking a test. I can think of countless questions where I may not remember a certain fact, but got it correct because I knew where it was located on my map (ex: couldn't remember the mechanism by drug name, but remembered that the drug was written on the top left corner of a page where other alpha agonists were located, etc.)"

"I only use concept maps for certain topics that require an understanding of the categories/organization. It is easier to remember a lot of information when it is all presented on one page."

"I did not love concept mapping, but I could not find a better alternative so I continued to do it."

"I realized that I am a visual learner, and it helped me organize information in a way that made sense to me (vs. how it made sense to other students or even the lecturer)"

**Which of the following has been MOST HELPFUL to make concept mapping a successful study strategy for you?**

- A. Concept mapping tutors for 1 on 1 tutoring sessions 2 (13%)
- B. Online videos on concept mapping

C. Large group lectures on concept mapping 5 (31%)

D. Small Group sessions on concept mapping 1 (6%)

E. Other (please specify) \_\_\_\_\_ 8 (50%)

"I incorporated concept mapping into my studies in a way that intuitively made sense to me & did not refer to outside sources."

."

"I didn't really have anyone show me what to do. I went to a large lecture and was inspired by the speaker's story, but I don't map the same way he did, so I can't say that's what made me successful. It was trial and error, finding out how much or little information to include, and the types of structures and connections I needed for the information to make sense."

"Going through the process of concept mapping myself"

"I attended the concept mapping meeting/workshop(?) at the beginning of M1 year, but I ended up doing my own thing for my maps."

"Self practice"

"Trial and error based on my own successes/failures."

"I met with a 4th year student familiar with concept mapping and also spoke with Dr. Knight about the process during my medical master year. I mostly developed my own form of mapping, and have continually modified it to suit my needs."

#### **24. How satisfied are you with the concept mapping method?**

1: very unsatisfied, will stop using it very soon

2: 2 (13%)

3: Neutral, it is not better and not worse than my past studying methods 1 (6%)

4: 6 (38%)

5: Very satisfied, would recommend concept mapping to a friend 8 (50%)

#### **References**

1. Novak JD. Learning, Creating, and Using Knowledge: Concept Maps as Facilitative Tools in Schools and Corporations. Taylor & Francis; 2010.