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Assessment of students' ability to represent determinants of health and health systems science content on concept maps in a pre-clerkship curriculum

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Abstract

Background Hackensack Meridian School of Medicine (HMSOM) was founded on a vision of addressing the determinants of health (DoH) in the daily practice of medicine. The school has an active learning curriculum partially conducted through a small group modified problem-based-learning entitled Patient Presentation Problem-based-learning Curriculum (PPPC). This course includes a Monday discussion of a patient case and a Friday small group session includes concept mapping of the week's basic, clinical, and health systems science (HSS) content. To help students contextualize and bring HSS principles into practice, PPPC at HMSOM requires that concept maps include not just basic science content from the week but also explicitly HSS topics and the DoH.

Methods We reviewed group concept maps from 7 pre-clerkship courses. There were an average of 18.9 group concept maps per course available to review, with roughly 8 students per group. We reviewed concept maps for inclusion of DoH icons and HSS content and followed the trend throughout each course of the pre-clerkship curriculum.

Results HSS content appeared in 45% of group concept maps in the first pre-clerkship course, but did not appear in any concept maps in subsequent courses. DoH content was inconsistently present in group concept maps throughout the first three courses, increased towards the end of the first academic year, and then showed a steady decline towards the end of the pre-clerkship curriculum.

Conclusions Students sometimes include DoH on their concept maps and this improves from the first three courses towards the end of the first academic year. However, students do not prioritize inclusion of DoH in their concept maps at the end of the pre-clerkship curriculum. HSS content is included in less than half of the concept maps in the first course, and then is not included in any group concept maps for the remainder of the curriculum. This may be due to a decreased focus on DoH and HSS, or related to students' tiring of pre-clerkship curricular activities including concept mapping. Providing feedback to students on inclusion of DoH and HSS in concept mapping may help improve this skill prior to the start of clerkships.

Keywords Competency-based medical education, Health systems science, Determinants of health, Concept maps

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Background

The Determinants of Health (DoH) have a greater impact on health and well-being than the biological basis of disease and clinical care [1, 2]. Training future physicians with the knowledge, skills, and attitudes to address all DoH is necessary in order to improve health outcomes, reduce disparities, and promote equity [2, 3]. Teaching DoH falls under one domain of health systems science (HSS), a pillar of medical education focused on improving students' inadequate understanding of the healthcare system. Few medical schools give the same longitudinal attention to DoH and health systems science thinking as they do the basic and clinical sciences [2]. Students give short shrift to learning about DoH and HSS for several reasons including lack of time, prioritization, faculty knowledge, as well as the fact that the impacts of DoH are not routinely taught [2, 3]. Many of these concepts are not assessed on institutional and national board exams, and while recommended, are not required teaching subjects by accrediting bodies [2]. Because of this, pre-clerkship students have a hard time connecting the DoH and HSS to basic science, despite growing consensus about the importance of training students to better understand DoH and the systems they will practice in [4]. Previous research demonstrates that students with more "systems-related experience", and those who engage in this content early and in an immersive fashion are most likely to consider and incorporate the determinants of health into their future practice [5, 6]. Students are also more adept at identifying DoH when they represent gaps in care [5].

Hackensack Meridian School of Medicine (HMSOM) is a mission and vision driven curriculum that strives to train physicians to improve health outcomes for all individuals regardless of background [7]. HMSOM addresses the teaching of determinants of health via a distinct longitudinal health systems science (HSS) curriculum and the Human Dimension course—a community engaged medical education curriculum. A critical tenet of HMSOM's curriculum aims to have students integrate content across disciplines. The central mechanism for aggregating DoH, HSS, clinical skills, and basic science content is the Patient Presentation Problem-Based-Learning Curriculum (PPPC) [8]. Students at HMSOM are framed from an early developmental stage to focus on DoH and HSS content, therefore, we anticipate that they will be able to label and represent this in their pre-clerkship curricular content via the PPPC curriculum. An initial indicator of student integration is examining the incorporation of content, as integration inherently requires this first step.

In PPPC, a weekly case is used as the scaffolding for the week's content which is then concept mapped by our students to show the interrelationship between the basic, clinical, and health systems sciences content. Concept maps provide several critical education functions; (1) as a complex organizer to help with knowledge integration, (2) to build clinical reasoning skills, (3) to promote active and self-directed learning, and (4) to provide an opportunity for real time feedback and knowledge assessment [9–15]. While the inclusion of DoH and HSS content in PPPC and Problem-Based-Learning (PBL) is believed to enhance integration across content areas (5), meager data exists on students' ability to incorporate this content into their learning. Assessment of integration activities is difficult due to a lack of data and a clear method of assessment [3, 4]. PPPC small group faculty receive multiple development sessions throughout the course of the year, specifically concentrated in the beginning of the academic year about theory of course content, theory of concept maps, and use of concept maps as an integration tool. There are subsequent monthly faculty development sessions centered around course content throughout the rest of the year. Students receive direction on purpose and creation of concept maps throughout the course. Iterative instruction is given that concept maps should include DoH icons and connections between the case and weekly course content, including HSS content.

Health systems science (HSS) is a longitudinal course spanning the entire pre-clerkship curriculum. The course meets weekly for a 2-h large group active learning session. These sessions are facilitated by the course director (JJ) and guest faculty based on the weekly topics. The course was structured using the American Medical Association (AMA) ChangeMedEd Initiative textbook [16]; including the core, common, foundational, and linking domains. HSS and PPPC integration takes place via regular planning meetings between each courses' core faculty.

Concept maps offer an opportunity to assess a learner's knowledge [12, 17, 18], but there is limited literature on their use as an assessment tool. The group concept maps created at the end of each week should include 5 DoH tags—biologic, genetic, social, environmental, and healthcare system (Fig. 1). The group map is created by combination of the individual concept maps that students create throughout the week. We hypothesize that DoH and HSS content will be frequently represented in concept maps and assessing representation in this assignment can help to give us clues into students' abilities to integrate content.

Methods

In PPPC, students are split into 21 groups of approximately 8 students. We reviewed group concept maps from 1 weekly case for each of the 7 pre-clerkship courses (Fig. 2). The weekly case is delivered on Monday mornings and includes a full patient history and physical exam,

Fig. 1 Determinants of Health (DoH) and icons utilized for concept mapping

along with labs and other data. On average, there were 18.7 concept maps to review for each course, as some weeks not all groups submitted a group concept map. Students are required to complete and submit an individual concept map each week in order to successfully pass the course. Individual concept maps are not graded, but students receive feedback on them approximately once a month during individual meetings with their faculty facilitator. These meetings last approximately 10 min and focus on overall class performance which includes concept map creation. Student groups complete a group concept map during the small group discussion session on Friday, and submission of these maps is also required. In the pre-clerkship curriculum, students receive a formal individual grade on one concept map during each of the checkpoint Objective Structured Clinical Exam (OSCE) that occur at the end of year 1 and at the end of the pre-clerkship curriculum.

For each week's case that was chosen to review, we selected 2 DoH that we expected the students would identify (Fig. 3). We chose 1 case per course that had the strongest linkages between HSS content as well as obvious DoH considerations that impacted the pathophysiology of disease. All available groups' concept maps were reviewed for the weeks selected. We reviewed concept maps for linkages to the DoH either through inclusion of DoH icons (Fig. 1) or with the names of the DoH. Maps were also reviewed to check for inclusion of the week's HSS content. We calculated the percentage of group maps that included any DoH, and the percent of DoH that were tagged with DoH icons.

Results

We found that students included any DoH on their maps between 40 and 80 percent of the time depending on the course (Fig. 4). DoH inclusion was in 72% of concept maps during Molecular and Cellular Principles (MCP), in 66.7% of concept maps in Structural Principles (SP), and in 57% of concept maps in Infection, Immunity, and Cancer (I2C). Inclusion of DoH peaked during The Developing Human (73% of maps) and Homeostasis and Allostasis courses (81% of maps), which take place midway through the pre-clerkship curriculum. Inclusion downtrends in the last two courses of the pre-clerkship

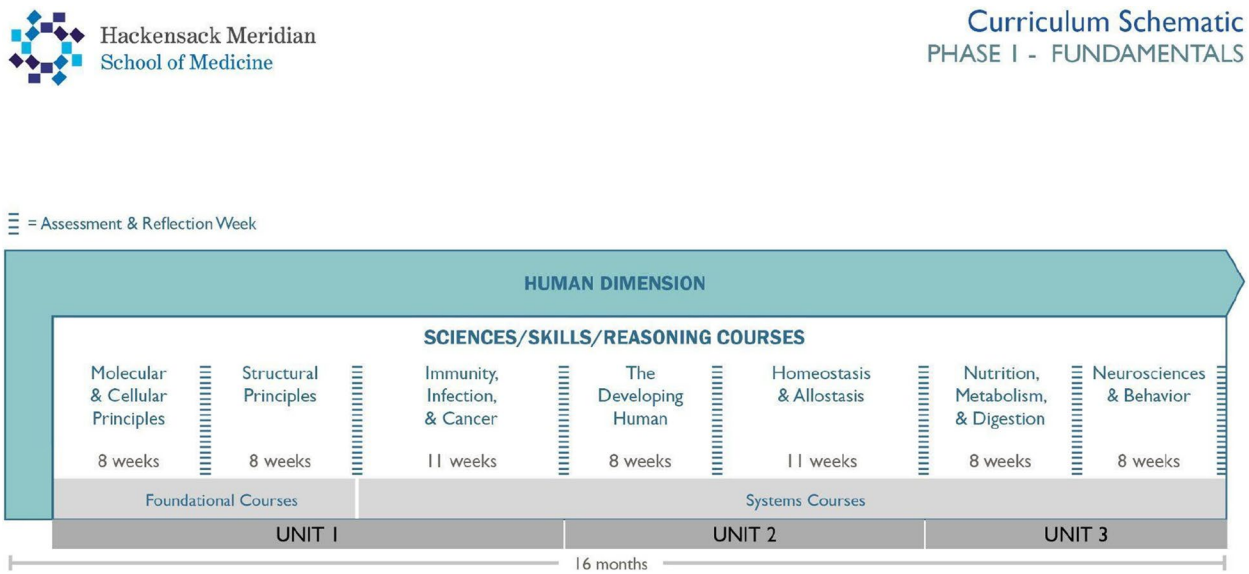

Fig. 2 HMSOM Curriculum Pre-Clerkship Schematic. PPPC spans 16 months of "Phase 1"

Fig. 3 Cases chosen over the course of the pre-clerkship curriculum and DoH expected to be included in group concept maps. Acronyms stand for MCP (Molecular & Cellular Principles), SP (Structural Principles), I2C (Infection, Immunity, & Cancer), TDH (The Developing Human), HA (Homeostasis & Allostasis), NMD (Nutrition, Metabolism & Digestion), NB (Neuroscience & Behavior)

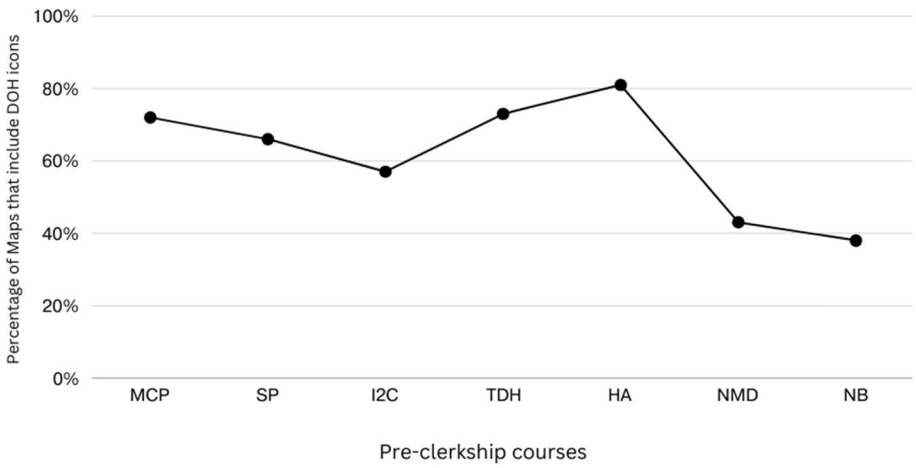

Fig. 4 Percentage of group concept maps that included any DoH linkages by course, showing an overall decline of inclusion of DoH icons from the beginning of the pre-clerkship curriculum to the end

curriculum, with DoH inclusion in 43% of concept maps in Nutrition, Metabolism, and Digestion (NMD) and in 38% of concept maps in Neuroscience and Behavior (NB). No apparent pattern emerged on which type of specific DoH was tagged. The breakdown of percentages of maps with included and tagged DoH content, included but not

tagged DoH content, and missing DoH content can be seen in Figs. 5, 6, and 7 (separated by courses, sequentia lly).

HSS content was only included in concept maps during the first pre-clerkship course (MCP), 45% of the time. In all subsequent courses, no group concept maps included HSS content from the week.

Discussion

Fostering early integration of DoH and HSS content in the pre-clerkship curriculum is essential for developing more proficient physicians [2, 3]. This can promote a broader impact on the healthcare system [1, 19]. We hypothesized that students would be effective at representing DoH and HSS content, as evaluated in their concept maps from an early stage, and would improve throughout the pre-clerkship curriculum. Student performance grew initially, peaking in TDH and HA and then rapidly declined. We suspect this is related to a mix of student, faculty and technological factors.

First, students tend to resist concept mapping because it requires a higher cognitive load to learn through integration and critical thinking [10]. Students find this requires more active engagement than other study methods previously utilized which creates a barrier to buy-in. Students become less engaged in concept mapping and coursework towards the end of the pre-clerkship curriculum. As the curriculum progresses, students also focus their concept map and discussions more on the clinical presentation and reasoning and less on the basic and health systems science as they feel this mirrors the upcoming clerkship experience. Students are also expected to complete and present other assignments during the week, both in PPPC and other curricular areas, which may take away from students' focus on DoH, HSS content, and concept mapping. In the first course (MCP), because of high student engagement, DoH inclusion is

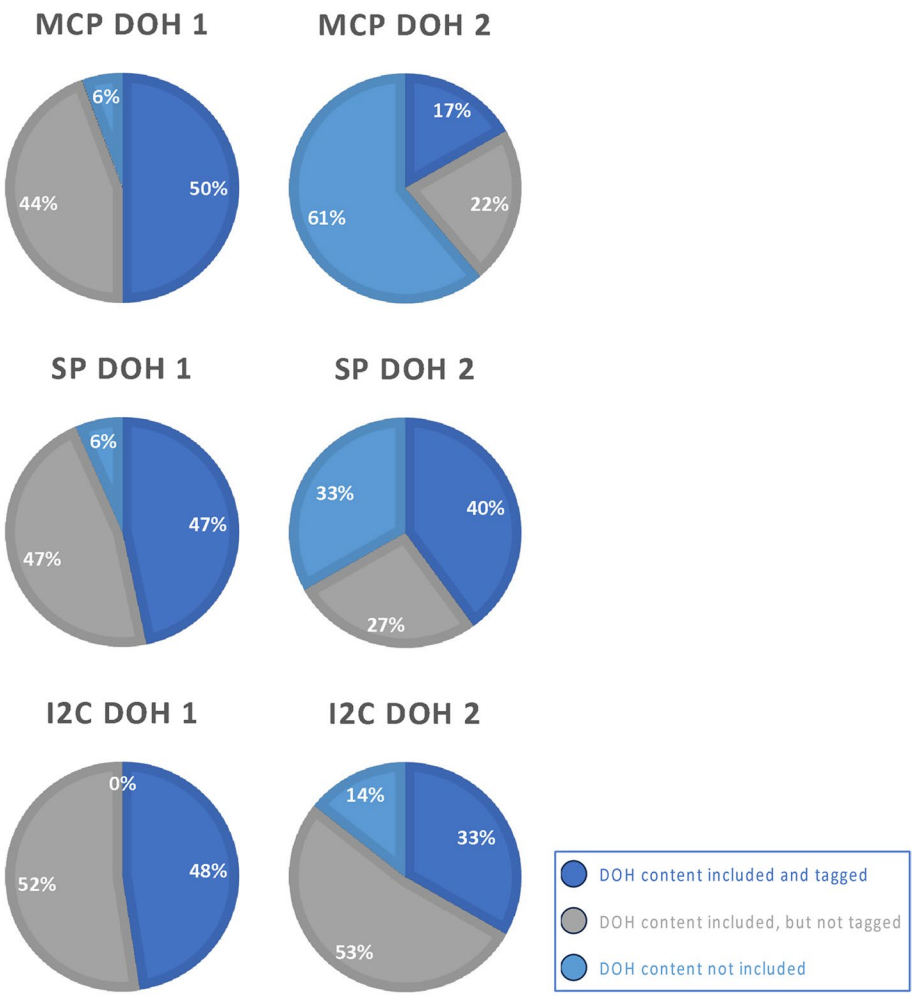

Fig. 5 Breakdown of inclusion of DoH content in group concept maps for the first three pre-clerkship courses (Unit 1)

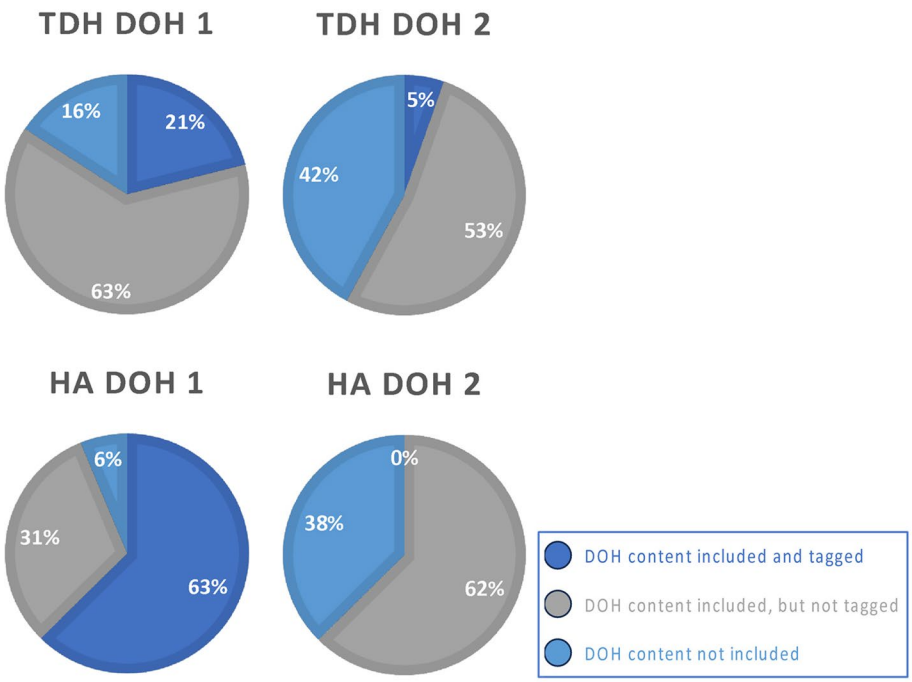

Fig. 6 Breakdown of inclusion of DoH content in group concept maps for the fourth and fifth pre-clerkship courses (Unit 2)

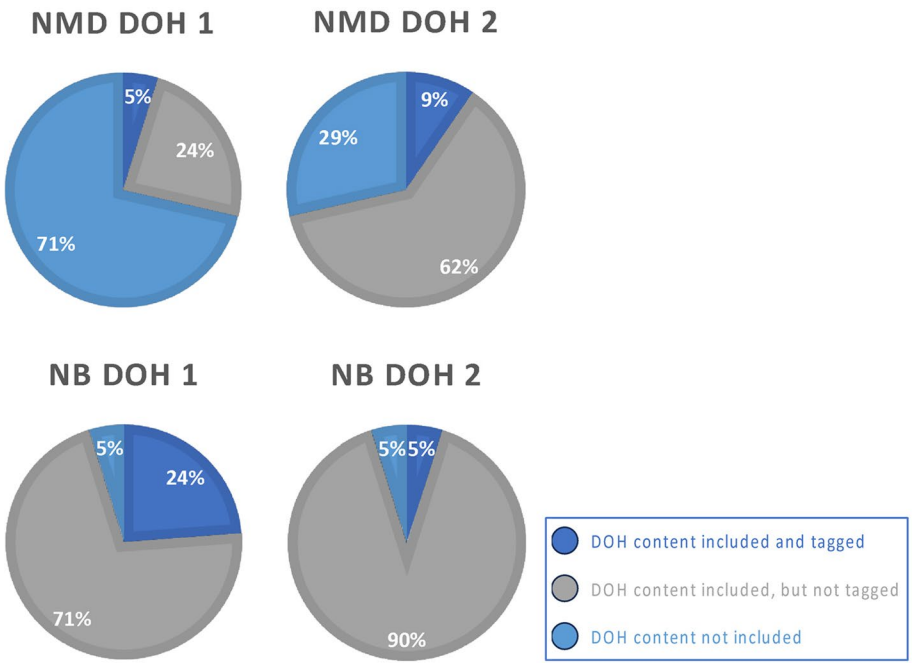

Fig. 7 Breakdown of inclusion of DoH content in group concept maps for the final two pre-clerkship courses (Unit 3)

high, despite heavily basic science course content. The second course (SP), which is primarily anatomy, poorly integrates with health systems science. The succeeding courses contain more clinical content and integrate better with PPPC and HSS. The scores likely decline in the last two courses due to student burnout and reduced participation.

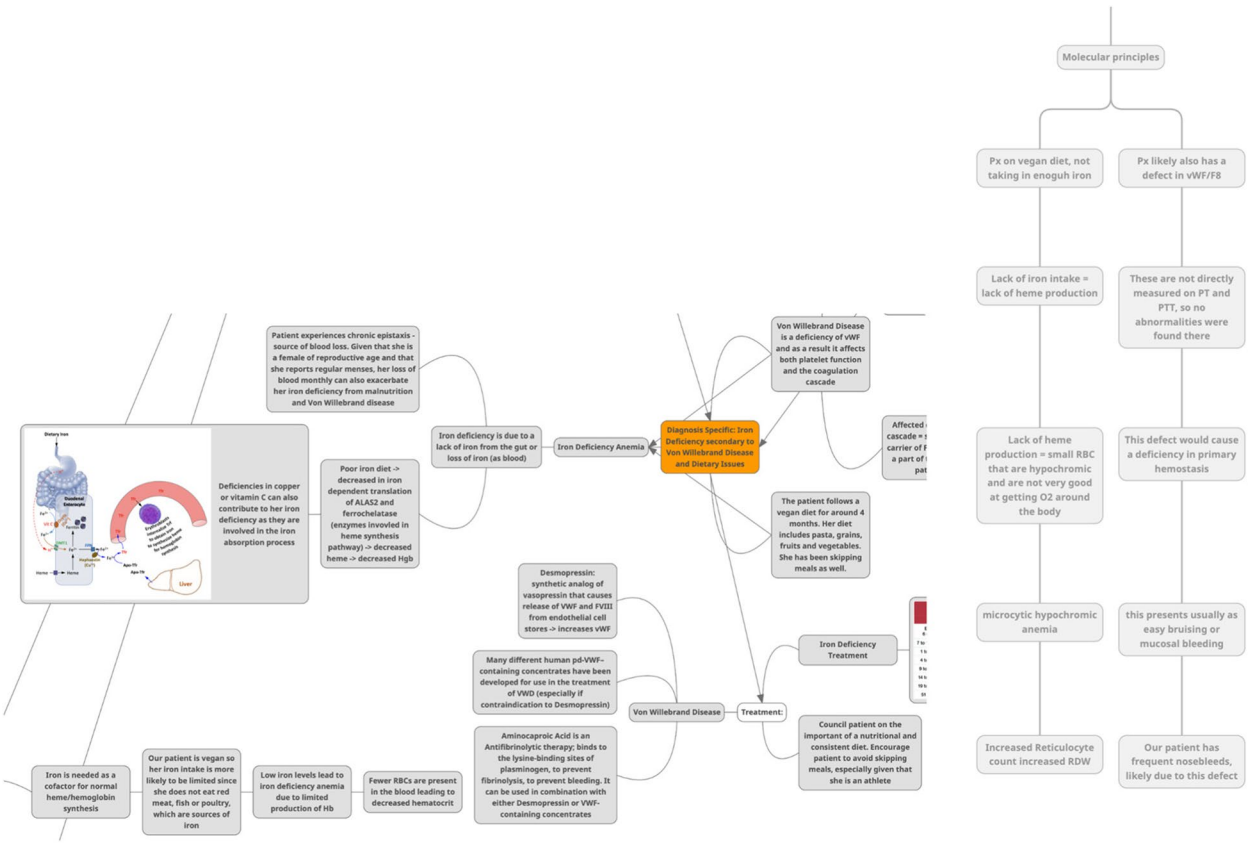

Fig. 8 Excerpts from concept maps that did not include DoH icons but included pathophysiology content (from TDH case on anemia)

Faculty have received dedicated development on the role of concept mapping, the HSS curriculum, and incorporation of DoH content both prior to and during the course of PPPC. Unfortunately, small group faculty who teach these sessions inconsistently hold students accountable for inclusion of this content during class and the group mapping process. Many of our faculty trained in an era where DoH and systems content was not prioritized [1–4]. Small group discussions also have multiple competing priorities that may hinder students from focusing on the DoH and HSS content. When met with student resistance, faculty may forgo this exercise and steer their discussions to biomedical content with which they are more familiar. Furthermore, if faculty are not spending time on concept mapping in class, there may be a disconnect between students' individual concept map and the group map, such that the DoH icons may not carry over. Because concept maps were accessed de-identified, there is no way to track differences in inclusion of DoH and HSS content on group concept maps based on the facilitator. This could serve as a quality improvement project in the future in order to give targeted support to faculty struggling with integration of this content. Further faculty development sessions are being planned to address this, including direct observations and faculty-simulated concept mapping.

Student feedback on the technological platform used to concept map, Mindmup, is consistently reported as a barrier to concept mapping. To ease the creation of concept maps, we have provided template concept maps that include the DoH icons that students can copy and paste on their map. Incorporation of DoH content remains low despite removing a potential technological hindrance.

We also noticed that even in the concept maps that included DoH icons (Figs. 8 and 9), the icons were routinely tagged to the patient history only, and were not connected via the basic science pathophysiology. Further studies are planned to assess the degree of pathophysiology and basic science content in concept maps. Reinforcing the connection between the basic sciences and DoH can be done during the Friday discussion via creation of additional structured class-time activities as well as more timely and regular feedback to students on their concept maps. Further studies will look at the degree of integration between PPPC cases and HSS content to ensure that this is not the barrier to meeting the educational goals.

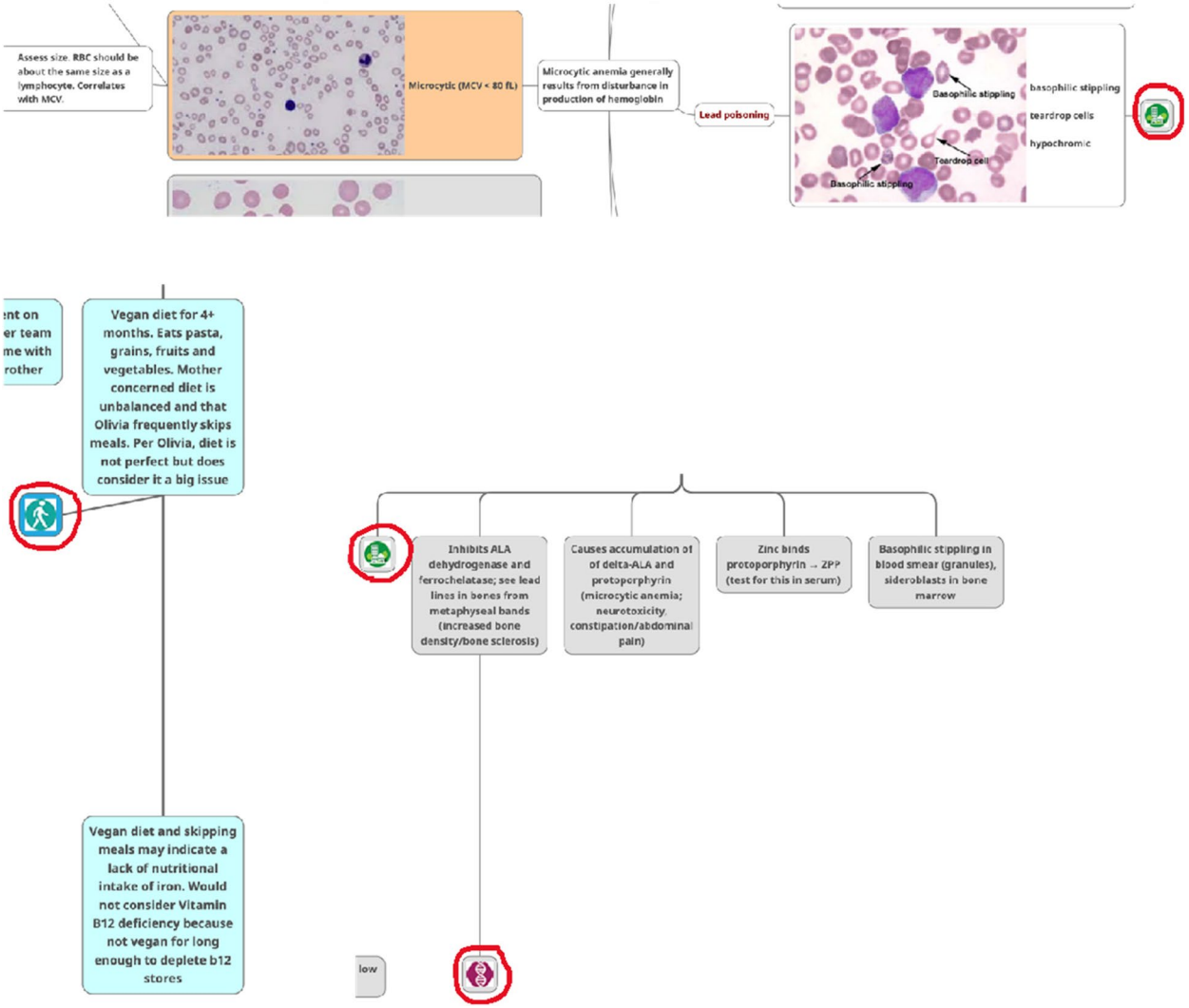

Fig. 9 Excerpts from concept maps that included DoH icons (circled in red) tagged to relevant case information (from TDH case on anemia)

HSS content inclusion on the maps followed a different course than the DoH content. HSS content fell off rapidly with only maps from the first course having any notable HSS content. This was true even though weeks with obvious integration points were selected from courses to review such as the teaching of sensitivity, specificity, negative and positive predictive values during the week when students learned about rheumatologic illness. Unfortunately not all examples used in HSS sessions are related to the core material for that week and we suspect that correcting this would improve connection of the content.

The data is limited in that we were unable to assess all of the group concept maps for each course, as there are close to 1000 over the span of the PPPC curriculum. Because each of the approximately 167 students submit an individual concept map each week, we were similarly unable to look at differences between students' individual maps and their group's map. We do not have good data or an understanding of why the HSS content disappears after the first pre-clerkship course. The reason for the different pattern of HSS content inclusion compared to the determinants of health could not be identified.

Future directions for research include looking at why students are struggling to include the DoH and HSS in their maps. Evaluating the faculty's understanding of the need for the application of this content would also help better understand this as a possible barrier. Further research could be done on the concept maps created during checkpoint OSCEs that take place midway through and at the end of clerkship year. This could determine how students are translating these skills in the clinical learning environment and if there is more engagement during a high stakes assessment.

Conclusions

There is value in engaging early learners to understand the impact of DoH and health systems science content, however despite HMSOM's curricular focus, students have not shown to be good at linking this content to the basic science and clinical sciences. Further faculty development, increasing feedback to students, explicit incorporation of DoH content in initial case presentations, modeling adequate DoH icon linking and creating more integrated HSS and PPPC sessions may help improve this for our students. Future work aims at looking at overall student engagement in concept mapping as an educational tool, including inclusion of pathophysiology and more broad HSS content on concept maps, as well as the ability of clerkship students further to more appropriately link DoH content.

Abbreviations

DoH	Determinants of Health
HSS	Health Systems Science
HMSOM	Hackensack Meridian School of Medicine
PPPC	Patient Presentation Problem-based-learning Curriculum
MCP	Molecular & Cellular Principles
SP	Structural Principles
I2C	Infection, Immunity, & Cancer
TDH	The Developing Human
HA	Homeostasis and Allostasis
NMD	Nutrition, Metabolism and Digestion
NB	Neurosciences & Behavior

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Authors' contributions

TT, JJ, and MM analyzed and interpreted data from concept maps. All authors read and approved the final manuscript. TT was the primary manuscript author; JJ was a major contributor in writing the manuscript.

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Data availability

Repository of reviewed concepts maps are not publicly available as these are student assignments. Excerpts of concept maps are included in Figs. 7 and 8. All data generated and analyzed are included in this article. Further examples of concept maps are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Study compliant/adhered to Helsinki Declaration; Study received ethical approval (IRB exempt, category 1 (educational settings)) by Hackensack Meridian Health Institutional Review Board Pro2024-0244; Risk Level: no greater than minimal risk; Need for consent to participate was waived by Hackensack Meridian Health Network IRB under Protocol Pro2024-0244.

Consent for publication

There are no identifying images or other personal or identifying details of participants that would compromise anonymity in the study thus this is not applicable to our study.

Competing interests

The authors declare no competing interests.

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Publisher's Note

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