Exploratory Steps to Stimulate a Deep Learning Micro-Culture. Introducing Concept Mapping Strategies into a Pharmacy Curriculum.

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Abstract

To create a culture of deep learning needed to prepare pharmacy students for their roles involving patient care and team-based clinical decision-making concept mapping strategies were integrated in an entry-level and advanced-level pharmacy doctorate courses. Findings indicated that concept mapping strategies can help students build and represent complex conceptual models and that this strategy can be successfully adapted to match the level of skills and knowledge. Concept mapping also revealed areas where students need improvement in the organization and depiction of their knowledge.

Background and Objective of the Study

Pharmacists are continuously expanding their role in health professions beyond the traditional roles of dispensing medications and medication management for patients. They are increasingly expected to be able analyze new information, draw valid conclusions and use them to solve complex problems in individual and population-level patient care. To prepare pharmacy students for these new professional roles, instructors need to integrate in the instructional process strategies that promote conceptual integration skills across various topics covered in their courses. In addition, current pharmacy accreditation standards emphasize problem-solving and creative thinking competencies which aligned with the new professional roles of pharmacists (Medina et al., 2013).

Concept maps and concept mapping strategies are mindtools that have been shown to be effective in engaging students in the process of building complex mental models, similar to what is required in real-world problem solving situations and generating creative solutions to known challenges (e.g. Balaid et al., 2016; Bilik et al., 2020; Jonassen, 2000). While concept mapping was introduced at a larger scale in education during the 1970’s, more current reviews of the literature show the potential impact of this tool across various areas of health professions such as medicine (Daley & Torre, 2010), nursing (Daley et al., 2016; Garwood et al., 2018) and pharmacy (Carr-Lopez et al., 2004; Noble et al., 2011).

Concept mapping proved to be an effective tool when integrated with other active learning instructional tool and strategies. For example, Addae et al., (2012) proposed a modified Problem Based Learning (PBL) strategy where concept mapping was combined with the traditional PBL phases to produce a new 5-phase learning approach in which three of the phases were designed as identifiable concept mapping tasks. In this strategy the first concept map was developed as a group map focused on the structure of the clinical problem and served as the center of the overall map that was developed in the other two concept mapping tasks. From an assessment perspective, concept maps proved to be very effective tools to measure both surface and deep-learning outcomes (Hay, 2007).
Finally, concept mapping proved to be an effective strategy not only for individual students but also for group instructional tasks (Mukherjee et al., 2018), as were implemented in the research being reported in this paper.

Despite the many benefits of using concept mapping to increase depth of learning, concept mapping is a type of open-ended instructional strategy that can pose challenges to both instructors and students and therefore potentially create resistance to its use in the current pharmacy classroom. Lim and colleagues (2009) examined the effect of different concept mapping generativity level that ranged from expert-generated maps to partially learner-generated maps and to fully learner-generated maps. They found that while the students in the fully learner-generated concept maps outperformed the other two groups, those students with high self-regulating skills significantly outperformed those with low self-regulating skills. Therefore, staging the introduction of concepts maps starting with the lowest generative level, expert-generated maps and increasing the engagement with the next levels of generativity can help decrease the gap between various level of self-regulating skills specific for a student cohort, especially in large courses. The major objective of this study was to explore to what degree concept mapping strategies can be integrated in both entry-level and advanced pharmacy courses as part of a pharmacy doctorate curriculum.

**Instructional Design Interventions**

During the Fall 2018 semester, an instructional designer worked with two instructors to implement concept mapping strategies in two courses across a pharmacy doctorate (PharmD) curriculum. The first course was Public Health for Pharmacists, an advanced-level course for the third year (P3) PharmD students and the second was Pathophysiology, an entry-level clinical course for first year (P1) PharmD students.

Because of the advanced level of the course and its structure with a lecture module and an active learning module, the concept mapping intervention in the P3 course was integrated in two stages. At a first stage, in the lecture part of the course the instructor developed a complex concept map that synthesized the main elements related to the role of pharmacists in ensuring population health, the focus of the course (Fig. 1). However, due to its complexity the concept map was not presented in the beginning of the course in its totality but rather was integrated as sub-maps throughout the lectures. Figure 2 shows a partial map presented and discussed with students as the semester progressed. The goal of the partial concept map integration into the lecture was two-fold. First, the instructor introduced students to concept mapping strategies by providing example of maps ranging from simple to complex. Second, the instructor used the concept maps to both emphasize the interconnectivity and complexity of the course topic and to generate class-wide discussions about the course topics. These discussions had the additional outcome of making edits and ultimately, completion of the partial and the final concept maps.

As a second step, in the active learning part of the class the instructor used one of the major team-based case studies addressing the analysis of the burden of Hepatitis C (Hep C) on the population health system as the context for a student-generated concept mapping task. Student teams were tasked with the development of a concept map that reflected strategies that pharmacists can use to help in reducing the Hep C burden and improve population health. The major goal of this activity was to engage students in course-related tasks that were beyond the traditional role of a pharmacist and consequently to increase students’ beliefs in the usefulness of the skills they built in this course.
The active learning part of the course was held in a technology-rich classroom that had a SCALE-UP design with round tables that host groups of up to 9 students. Each team used post-it notes provided by the instructor to write the major concepts on and had access to a whiteboard or a big empty post-it-note to build their concept map (see Figure 3).

**Figure 1**
Pharmacists’ role in ensuring population health. Instructor-developed concept map.

**Figure 2**
Pharmacists’ role in ensuring population health. Partial concept map integrated in lectures.
As shown in Figure 3, each group found the best strategy to collaborate on integrating the knowledge built during the lecture and from the analysis of the Hep C case study into their own concept map.

Figure 3
Concept mapping activity. Working as groups to build HepC concept maps.

At the end of the activity, one representative from each group presented their group’s concept map to the entire class (Fig.4).

Figure 4
Concept map presentation for the entire class

Finally, the instructor showed his own concept map and used it to generate discussion about the topic that was the focus of the in-class concept mapping activity. Because of the relative novelty of the concept mapping strategy, the resulted concept maps were not included in the course assessment strategy.

For the entry-level P1 course, the opportunity to test the potential of the concept mapping activity occurred toward the end of the semester. The timing of this activity was considered optimal because most students were enrolled simultaneously in both the immunology and the pathophysiology courses.
Therefore, the topic of the lecture integrated a significant amount of instructional material that was already covered in the immunology course. Consequently, the implementation of concept mapping activity was less structured than in the previous course. To build their concept maps, students were required to focus on the major relationships between immunology and pathophysiology through the perspective of the role of the pharmacist by integrating these two areas of study. Students were able to actively refresh immunology concepts while attempting to link them with pathophysiology concepts. Compared to a standard lecture, students were expected to be a significantly more engaged in the topic as a result of overlap of topics and courses. During the first half of the class period, teams of students engaged in building the concept maps with a minimum introduction by the instructor of what a concept map is. Whiteboards were used to provide a space for each team to collaborate in the development of their concept map. In the second half of the class period, the instructor built on the concept mapping activity to expand, emphasize, and reinforce the major relationships between immunology and pathophysiology concepts from a pharmacist’s practice perspective. The resulted concept maps were not included in the grading scheme of the course.

**Research Focus and Methodology**

Due to the relatively low impact of the use of concept mapping activities in the two courses, the major goal of this study was to evaluate the potential impact of the concept mapping on students’ ability to represent the depth of their learning at various levels across the curriculum.

**Participants**

A convenience sampling was used for this study. For the P1, entry-level course, the class size was 78 students and all of them volunteered to participate in the study. For the P3 course, the class size was 89 and 87 (98%) students volunteered to participate in the study.

**Data Collection and Analysis**

All group concept maps were captured by the instructor as a photograph at the end of the activity. There were 18 groups for the P1, entry-level course, and 11 groups in the P3, advanced-level course. Considering the exploratory nature of this intervention and the span of knowledge and skills of the two groups, to evaluate the overall quality of the concept maps, an evaluation rubric was developed with three assessment dimensions adapted from the literature (e.g. Jonassen, 2000): accuracy of instances (concept-link-concept) used in the concept map, depth of the map structure, and connectedness of the map structure. Each dimension was defined and scored ranging from 1 (low) to 5 (high) as shown in Table 1 below. To determine the final map score, the three scores were summed and computed as percentage of the total potential score.

In addition, to check if the course-related activities could impact the overall development of the concept maps, students’ course self-efficacy was measured using items adapted from constructs validated in the literature. The self-efficacy construct was adapted from Cernusca & Price (2013). The self-efficacy construct used a 5-point Likert evaluation scale. Scores for each construct were computed as the average of the scores of its individual questions, resulting in a continuous score ranging from 1 to 5.
This construct was part of an exit online survey administered in Qualtrics® during the last week of the course. Self-efficacy data and cohort analysis were performed with SPSS v25®.

Table 1
Concept map scoring rubric

<table>
<thead>
<tr>
<th>Accuracy of instances (concept-link-concept)</th>
<th>5 – at least half of the instances (concept-link-concept) have both the concepts and links labeled correctly as single term node or link significant for the topic at hand</th>
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<td>3 – one third or more of the instances (concept-link-concept) have both the concepts and links labeled correctly as single term node or link significant for the topic at hand</td>
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<tr>
<td></td>
<td>1 – less than one third or more of the instances (concept-link-concept) have both the concepts and links labeled correctly as single term node or link significant for the topic at hand</td>
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Depth – the level of hierarchical links

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<tr>
<th>5 – at least half of concepts are linked in 2 or more hierarchical levels (from general to specific)</th>
<th>3 – one third to about half of the concepts are linked in 1 or 2 hierarchical levels</th>
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<tbody>
<tr>
<td>1 – less than one third of the concepts are linked in two hierarchical levels</td>
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Connectedness – ratio to dead-end to multiple-linked nodes

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<th>5 – high ratio of multiple-linked to dead-end nodes indicating a good understanding of the complexity of the topic</th>
<th>3 - dead-end nodes are same or slightly more than multiple-linked nodes indicating a fair understanding of the complexity of the topic</th>
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<tr>
<td>1 – dead-end nodes are significantly more than multiple-linked nodes indicating poor understanding of the complexity of the topic</td>
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Findings

The qualitative evaluation of the student-team concept maps indicated that, relative to the complexity of the task for each course, the maps had a relatively high complexity and correctly represented the conceptual models associated with the focal topic. As expected, due to the differences in the academic level of the two groups and the complexity of the concept map integration in the instructional process the scores of the P3 cohort (67% to 93%) were overall higher than the one for the P1 group (27% to 87%). The main evaluation dimension that differentiated the two groups was the accuracy of the instances in the map structure. Most of the concept maps built by the P1 student groups had correctly labeled nodes with individual concepts but the links between the nodes were not labeled and often were not directional. However, two of the P1 groups scored 4 and 5 on the accuracy dimension.

On the other hand, the connectedness of the maps for the P1 group was much closer to the P3 group with more than two thirds of the connectedness scores for P1 concept maps being at or above 3, the average of the evaluation score for this dimension. Figure 5 shows the concept map developed by the group that earned the highest score. As a comparison, Figure 6 shows a P1 map with a low score, while Figure 7 shows the highest scored concept map developed by a P3 group.
Figure 5
*P1 concept map that had the higher score in their cohort*

Figure 6
*P1 concept map that had one of the lowest scores in their cohort*
These findings show that while clearly the quality of the concept maps are higher when the concept mapping strategy is integrated in the instructional process and the task is part of an active learning activity, as was the case with the P3 group, where students were able to represent with concept mapping the complexity of their knowledge even when this strategy was introduced as an ad-hoc task in the instructional process.

For the self-efficacy data, the construct used had weak internal reliability for P1 cohort with Cronbach’s alpha of 0.42, but a very high internal reliability for the P3 course with Cronbach’s alpha of 0.93. Both cohorts reported above the mean to high self-efficacy levels, with P1 students having an average score of 3.87 (SD=.46) and P3 students an average score of 4.03 (SD=.62), on a 1 – low to 5 – high self-efficacy evaluation scale. An independent sample t-test showed no statistically significant difference was found between the mean self-efficacy scores of the two cohorts, t(163)=.189, p = .06. Also, a one-sample t-test indicated that both cohorts reported self-efficacy scores statistically significantly higher (p < .001) than the mean (3) of the evaluation scale. This suggests that both courses provided students with similar engagement and feedback opportunity to increase their beliefs in the ability to learn in their course.

Conclusion

The finding of this exploratory study indicated that concept mapping strategies can help students build and represent complex conceptual models relating complex roles of pharmacists that go beyond the traditional medication dispensing roles. This strategy can be successfully adapted to match the level of skills and knowledge for both entry and advanced-level pharmacy students. Future research will focus on the concept mapping to provide instructors with a clearer picture of areas that need improvement to further help pharmacy students prepare for their professional journey, especially for advanced-level courses.
References


