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Abstract

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Keywords

Critical thinking, concept mapping, instructional methods, educational technology, constructivist learning theory

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Concept Mapping as an Instructional Method to Support Critical Thinking in Occupational Therapy Students: A Pilot Study

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ABSTRACT

In occupational therapy practice, critical thinking is a foundational skill for the delivery of effective care; however, there is limited evidence on the development of critical thinking skills in occupational therapy education. The purpose of this study was to explore the effects and student perceptions of concept mapping on critical thinking skills in occupational therapy education. This study used a quasi-experimental design with a retrospective pre-post assessment after two teaching conditions: (a) traditional lecture and (b) concept mapping. The same convenience sample of students was used for each condition. Additional outcome measures included assessment of student concept maps using a scoring rubric and a survey of students' perceptions on the use of concept mapping. Results of the retrospective pre-post assessment indicated significant gains in student knowledge ($p<.001$) following both the concept mapping activity ($n=39$) and traditional lecture ($n=46$). Assessment of the concept maps along with the results of the student survey indicated that concept mapping supported student use of key critical thinking skills including interpreting knowledge, understanding relationships, communicating their rationale, and reflecting on their thinking. Overall, students reported strong affective acceptance of concept mapping and found concept mapping easy to use. Given these findings, occupational therapy educators need to consider incorporating concept mapping as a form of active, student-centered learning to support enhanced knowledge of content and higher-level thinking.

Introduction

Critical thinking remains a widely debated topic within educational literature with varying definitions of what skills should be included in the definition; however, most scholars agree that critical thinking is a complex set of skills involving higher-level thinking beyond rote learning of content knowledge (Gunawardena & Wilson, 2019). This study explored critical thinking skills in terms of enhanced knowledge required for meaningful learning and problem solving; specifically, the ability to accurately interpret knowledge, understand relationships and make connections between knowledge, communicate one's rationale, and critically self-reflect on one's thinking (Facione, 2020; Garwood et al., 2019; Wu & Wu, 2020). Within occupational therapy, critical thinking plays an important role in supporting clinical reasoning, which is generally defined as the process by which healthcare professionals make decisions during patient care (Pitonyak et al., 2020). Clinical reasoning is a key competency for occupational therapy practitioners (American Occupational Therapy Association [AOTA], 2018a); however, it is strongly influenced by experiences, with minimal emphasis on challenging the practitioner's assumptions and biases (Berg et al., 2021). Critical thinking is distinct from clinical reasoning because critical thinking skills prompt the occupational therapy practitioner to examine how their personal biases and assumptions might influence patient-therapist interactions (Mills et al., 2018). Additionally, critical thinking skills are used by the occupational therapy practitioner to evaluate the credibility of, interpret, and synthesize knowledge prior to applying it within the clinical reasoning process (Berg et al., 2021). Despite critical thinking's relevance to clinical reasoning and effective occupational therapy practice, there is limited research on methods to support critical thinking skills in students (Pitonyak et al., 2020).

Further inquiry into teaching methods for critical thinking are needed to identify best practices and maximize student learning (AOTA, 2018b; Henderson et al., 2017). Concept mapping is one potential teaching method that may promote critical thinking skills by providing students with a framework to structure their thinking and integrate knowledge through the creation of meaningful links across content areas (Garwood et al., 2018; Mahanal et al., 2019). Further, a competent occupational therapy practitioner is believed to be one that is 'critical' in their self-reflection as part of the daily decision-making processes (Robertson et al., 2015) and concept mapping is a process in which active reflection occurs during its utilization (Bressington et al., 2018). While current evidence supports the use of concept mapping in healthcare education to promote critical thinking (Yue et al., 2017), little is known about the use of concept mapping within occupational therapy education. Currently, occupational therapy educators report that concept mapping is one of the least used teaching strategies (Henderson et al., 2017). More information is needed about the use and perceptions of concept mapping in occupational therapy to determine its relevance and effectiveness as an instructional method.

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The purpose of this project was to explore the use of concept mapping and explicit instruction on critical thinking as instructional methods to support occupational therapy students' enhanced knowledge and higher-level thinking related to functional neuroanatomy, occupational therapy theory, and evaluation methods. This study aimed to answer the following questions: What is the effect of concept mapping and explicit teaching of critical thinking concepts compared to a traditional classroom lecture on students' ability to interpret, synthesize, and communicate knowledge related to neurological conditions and occupational therapy? What are the perceptions of entry-level occupational therapy students on the use of concept mapping as an instructional method?

Literature Review

Theoretical Frameworks

The exploration of concept maps as an educational tool is based in constructivism and cognitivism learning theories, where the student is engaged in active, learner-centered teaching methods (UC Berkeley, 2016). Constructivism learning theory credits meaningful learning experiences as contributing to learning (Mukhalati & Taylor, 2019). Cognitivism learning theory supports learning as occurring through a reflective learning process, where thoughts and behaviors are challenged and changed based on new information received (Sahu et al., 2022). These learning theories are often combined in education as both approaches emphasize the learner taking a lead role in enhancing their understanding of information (Mukhalati & Taylor, 2019; Sahu et al., 2022). Congruent with these theories, concept mapping is an active learning instructional method with evidence to support its use in promoting meaningful learning of content knowledge in healthcare education (Bixler et al., 2015; Powell et al., 2021). Specifically, when using concept mapping, students demonstrated greater breadth and depth of learning which enhanced their knowledge acquisition and long-term memory (Grice, 2016; Wu & Wu, 2020).

Concept Mapping

Concept maps are visual tools used to organize and represent knowledge through identification of important connections between multiple related concepts (Passmore, 2021). Training students to make connections between previous content and new relevant information is identified as an important component of critical thinking (Mahanal et al., 2021). Concept maps encourage more advanced thinking through completion of the five major components: concepts, concept links, hierarchies, cross-links, and examples (Gil & Lee, 2022; Novak & Cañas, 2008). Concept maps have also been shown to support the development of critical thinking skills and metacognition in healthcare students (Garwood et al., 2018; Kaddoura et al., 2016). The process of creating a concept map provided students with a framework to structure the development of critical analysis, problem-solving, and self-reflection skills (Kaddoura et al., 2016; Joshi et al., 2022). Further, concept mapping enhanced critical thinking skills by promoting integration of knowledge across content areas, such as linking basic science with clinical features or theory with practice to support clinical reasoning (Bressington et al., 2018; Garwood et al., 2018; Gil & Lee, 2022).

Overall, students appear to have positive attitudes and satisfaction with concept mapping as a learning method (Hsu et al., 2016; Wu & Wu, 2020). Students reported that concept maps were useful for visualizing the broad picture of a concept, inducing interest in a concept, and promoting in-depth meaningful learning (Gil & Lee, 2022; Grice, 2016). Importantly, students perceived concept mapping as contributing to their understanding of content knowledge and identified it as being easy to learn and use; however, they also expressed concerns about the time required to complete them (Bixler et al., 2015). This concern may be alleviated through computer-based concept mapping which can decrease the amount of time needed and make it easier to modify, add, or delete content (Mammen, 2016).

Concept maps can be reliably used to assess student learning and their ability to think critically (Passmore, 2021). Assessment can be achieved via the use of a holistic scoring rubric with criteria related to accuracy and relevancy of concepts, complexity and meaningfulness of relationships, and overall clarity of appearance (e.g., Gil & Lee, 2022; Slieman & Camarata, 2019). While this requires extra work from educators, assessment of concept maps has been shown to help educators provide effective feedback to correct student misconceptions and promote student reflection on their learning (Gil & Lee, 2022; Slieman & Camarata, 2019). This provides educators with an opportunity to take remedial action and correct student shortcomings prior to patient exposure (Passmore, 2021). Receiving feedback and learning from experiences is also supported by the cognitivism theory which emphasizes that learning occurs with changing thoughts and behaviors based on new information (Sahu et al., 2022). Similarly, providing students with an opportunity to recognize their own assumptions is a skill identified as important to critical thinking (Mills et al., 2018).

Critical Thinking Instruction

Current evidence on instructional methods for critical thinking indicates that a combination of explicit and implicit instruction may be most effective (Morris et al., 2019). This should be threaded across the curriculum with increasing complexity and is best achieved through a “backward design” approach to curriculum planning which first identifies specific critical thinking skills as intended learning outcomes and then selects instructional and assessment methods to align with these goals (Berg et al., 2021; Fink, 2003; Pitonyak et al., 2020). Explicit instruction consists of students engaging in a reading, lecture, and/or discussion focused on the required skills and dispositions associated with effective critical thinking (Bakker et al., 2015; Morris et al., 2018). In a combined instructional approach, the explicit instruction would then be followed by implicit instruction in which teaching methods are selected based on their ability to promote both critical thinking and subject specific learning objectives. These methods include activities such as authentic case studies (Allen & Toth-Cohen, 2019), experiential learning (Kong, 2021), critical dialogue (Abrami et al., 2015), and concept mapping (Grice, 2016). Despite a growing body of evidence to support the use of a wide variety of instruction methods for critical thinking, a survey of occupational therapy educators revealed that the actual use of different methods is limited and should be expanded to improve student preparation (Henderson et al., 2017).

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Determining the effectiveness of instructional methods for critical thinking requires the use of reliable and valid assessment methods. Additionally, incorporating meaningful assessment tools helps educators recognize areas for student growth and motivates educators to use more diverse instruction methods (Haynes et al., 2016). Unfortunately, there is limited consensus on best practices for assessment of critical thinking (Berg et al., 2021). One common method is the use of rubrics to analyze the quality of critical thinking. This is most beneficial for assignments where students are expected to explicitly demonstrate their thinking process (Facione & Facione, 2014). Rubrics can be developed to align assessment criteria with the learning objectives of a course or educational curriculum. Additionally, providing rubrics to students in advance promoted explicit communication of the intended purpose and expectations of the learning activity and allowed students to self-evaluate their work (Reynders et al., 2020). Limitations of using rubrics include the potential for poor content validity, construct validity, reliability, and fairness (Reynders et al., 2020).

Methods

Design

Study methods were submitted and approved by the university's Institutional Review Board. This one-group repeated measures study used a retrospective pretest-posttest to explore the effects of instructional method on student use of critical thinking skills to interpret, synthesize, and communicate knowledge. A convenience sample of students enrolled in a functional neuroanatomy course was used for this study, in which all students enrolled in the class participated in two learning modules separated by a period of three weeks. This course was specifically chosen for the study as previous literature has found that students have difficulty understanding more complex concepts within functional neuroanatomy (Slominski et al., 2017). The first module used a traditional classroom lecture as the primary instruction method while the second module used concept mapping paired with explicit instruction on critical thinking. At the end of each module, students completed the retrospective pretest-posttest survey. Additionally, after the concept mapping module, students completed a perceptions of concept mapping survey and submitted their concept maps to be scored. Once their concept maps were submitted, students were provided with an instructor created "expert" concept map. This fully complete "expert" map was meant to serve as a comparative tool to promote student reflection on their own learning (Powell et al., 2021; Slieman & Camarata, 2019).

As the study was completed within an educational setting, it was not feasible to use the same topics in both learning modules. Therefore, the authors selected two topics from the course that were most similar in their levels of familiarity and complexity. Based on the prevalence of data, multiple sclerosis and moderate-severe traumatic brain injury were determined to be the most similar with regards to the students' general awareness of the condition. Further, the neuroanatomy content related to these conditions had similar levels of difficulty based on previous student feedback and teaching experience. See Table 1 for project summary.

Table 1

Description of Project Design

Learning Module	Content	Outcomes
Traditional lecture	Cellular level neuroscience and multiple sclerosis	O1
Concept mapping	Prefrontal cortex functions and traumatic brain injury	O1, O2, O3

O1=Retrospective pre-post assessment
O2=Concept map perceptions survey
O3=Concept map scores

Participants and Setting

Participants were a convenience sample of first year graduate students who were in good academic standing and actively enrolled in an entry-level Doctor of Occupational Therapy (OTD) program at a university in the midwestern United States. Students were recruited from two sections of a functional neuroanatomy course taught by the first author. This was a required course taken during the second semester of the entry-level OTD program alongside a set of courses which covered content on occupational therapy assessment and evaluation of pediatric, adult, and older adult populations. Each section had an enrollment of 24 students, for a total participant pool of 48. All aspects of the project were completed by the first author during the scheduled class time on the university campus.

Procedures

Both learning modules included one-hour of prerecorded (asynchronous) video lecture that the students watched prior to participating in a three hour in-person class session. The asynchronous content focused on the normal function of the human nervous system. The in-person portion was used to answer student questions and apply the asynchronous content by describing how dysfunction of the nervous system results in clinical conditions commonly encountered in occupational therapy practice.

Traditional Classroom Lecture

The asynchronous content for the traditional lecture module described cellular level neuroanatomy, including types of cells in the nervous system, synaptic communication, and neuromessengers. The associated clinical conditions covered during the in-person class included Guillain-Barré, multiple sclerosis, and myasthenia gravis. The primary instruction method for the in-person portion was a traditional classroom lecture with a projected slideshow. To add a human dimension, the lecture was accompanied by real patient stories and videos for each condition. The class time was spent in the following manner: review of asynchronous content and student questions (35 minutes), break (5 minutes), Guillain-Barré (30 minutes), multiple sclerosis (30 minutes), break (10 minutes), myasthenia gravis (20 minutes), small group discussion using case studies and questions from the course textbook (40 minutes).

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Concept Mapping and Critical Thinking

The asynchronous content for the concept mapping module described the anatomy and associated functions of the prefrontal cortex including consciousness, memory, communication, spatial perception, executive functions, emotions and motivation, decision making, and personality. The clinical conditions covered during the in-person class included dementia and traumatic brain injury. The primary instruction method for the in-person portion on traumatic brain injury was concept mapping. Students worked in self-selected pairs to develop a concept map using the free, web based Cmap Cloud online software (https://cmapcloud.ihmc.us/) and a concept map skeleton provided by the instructor (available to view at: https://cmapscloud.ihmc.us:443/rid=1Y72Q64N3-1GLT4Y4-7J892C). The concept map was based on a neurological case study and students were instructed to answer the question: "What is a traumatic brain injury and how does it affect occupational participation?". To promote motivation and engagement, the students were informed that the same case study would be used later in the semester within a different course as a simulated patient encounter. The case study included realistic documents detailing multiple aspects of the case including a medical sequence of events, occupational therapy discharge summary from inpatient rehabilitation, medical history and physical evaluation, and a social work note. Students were encouraged to make connections to the case study pulling from their knowledge of content from the asynchronous lecture and content learned in their theory and assessment courses. While students completed their concept maps, the instructor walked around the room and remained available to answer questions and assist with any technology problems as needed. At the end of class, students were invited to share interesting connections they made, aspects they enjoyed, or challenges they experienced. The class time was spent in the following manner: review of asynchronous content and student questions (25 minutes), lecture on dementia (25 minutes), break (10 minutes), concept map and case study instructions (5 minutes), concept map development (100 minutes), and large group discussion (10 minutes).

As concept mapping was anticipated to be a novel learning activity for students, they were introduced to this concept a week prior to the module via a 20-minute in-person lecture on critical thinking and concept mapping. This lecture defined critical thinking, described how critical thinking applies to occupational therapy, and explained how concept mapping can be used to promote higher level critical thinking skills. Additionally, the lecture included step-by-step instructions on how to build a concept map and a sample concept map on the topic "What is a cerebrovascular accident?". This demonstration was used to scaffold student knowledge of concept mapping while also modeling the expected level of complexity within a concept map.

Outcome Measures

Retrospective Pretest-Posttest Survey

A retrospective pretest-posttest design was selected to improve the accuracy of student responses by minimizing the likelihood that students would over or underestimate their knowledge (Geldhof et al., 2018; Lang & Savageau, 2017). The 14-item self-assessment survey (see Appendix A) was developed by the authors and completed by

the students immediately after each learning module. The survey used Likert items in which students were asked to rate their ability before class and after class on a 5-point scale (1=no ability, 5=excellent ability). Survey items were divided into three sections: general information, neurological dysfunction, and treatment. The general information section included basic knowledge on the neurological condition such as incidence or prevalence, risk factors, signs and symptoms, and types. The neurological dysfunction section focused on the specific function and dysfunction of neurological components associated with the condition. Finally, the treatment section included content such as medical interventions, occupational therapy assessment, and effects of the condition on occupational performance. Survey development was informed by the conceptual underpinnings and terminology of critical thinking (Facione, 2020) and Fink's Taxonomy of Significant Learning (Fink, 2003) to promote assessment of learning outcomes beyond rote recall of content knowledge. For example, Question 12 asked the student to rate their ability to "predict how the neurological condition will impact occupational performance." This question was designed to assess student perceptions of their ability to make inferences (critical thinking skills) and integrate knowledge (Fink's [2003] taxonomy).

Concept Map Rubric

A concept map scoring rubric was adapted from the Bartels' Scoring Rubric for Concept Maps (Center for Teaching, n.d.) with modifications influenced by the Holistic Critical Thinking Scoring Rubric (Facione & Facione, 2014). The combination of these two rubrics was selected to assess both the quality of critical thinking and the depth of knowledge demonstrated by the students' concept maps. The 30-point rubric consisted of three equally weighted sections: (a) concepts; (b) relationships; and (c) communication. The concepts section assessed the students' ability to identify important concepts and use terminology accurately; the relationships section assessed the use of simple (hierarchy, propositions) and complex (cross links) connections to identify meaningful relationships among concepts; and the communication section assessed the organization, logic, and overall clarity of the concept map. Students were provided with a copy of the rubric in advance and encouraged to use the rubric to self-assess their work. The rubric included descriptions for each section describing work that "exceeds expectations" (10 points), "meets expectations" (8-9 points), and is "below expectations" (5-7 points). At the end of the concept mapping module, students submitted their completed concept maps with names removed to an online learning management system. An anonymous marking feature was used which hid students' names within the online system and allowed for blind assessment of assignments using the scoring rubric by the first author. To further reduce bias, the second author also graded the concept maps with no student names or knowledge of the first author's scoring assessment. Comparison of the two sets of scores revealed that 97% of section scores and 74% of summed scores were within one point of each other. The remaining six summed scores had a discrepancy of two points. The authors shared their rationale for each of these scores and came to agreement on a score. After discussion, 100% of scores were within one point of each other. For analysis purposes, the scores from each author were then averaged to determine an official score.

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Perceptions of Concept Mapping Survey

The third outcome measure was a student survey on the use and perceptions of concept mapping developed by the authors (see Appendix B). The survey included a set of Likert-response items followed by two open-ended written response questions. Likert-response items were developed and selected to assess student perceptions related to three areas using a 5-point scale (1=strongly disagree, 5=strongly agree): effect of concept mapping on content knowledge and critical thinking, ease of use, and benefits and difficulties associated with concept mapping. Two open-ended written response questions asked students about the perceived benefits and difficulties of concept mapping. Students completed this survey at the end of the concept mapping module prior to receiving a grade for their concept map.

Data Collection

All students were required to participate in the learning activities for the modules as part of the course requirements, which included quantitative assessment of their completed concept maps. Students who voluntarily agreed to participate in the research study provided informed consent prior to completing the retrospective pretest-posttest survey after each module as well as the survey on perceptions of concept mapping after the concept mapping module.

Data Analysis

Data input and statistical analysis of descriptive and inferential statistics were conducted using Excel for Mac 16.65 (Microsoft Corporation, Redmond, WA, USA) and SPSS 28.0 (IBM Corporation, Armonk, NY, USA). Paired samples *t*-tests were used to analyze for changes in content knowledge within each instruction method using the results of the retrospective pretest-posttest survey. An independent sample *t*-test was used to compare differences in change scores between the two methods. All analyses used a two-tailed test with an alpha value of .05. Descriptive statistics of concept map scores were calculated for objective assessment of the impact of concept mapping on the accuracy, quality, and depth of student knowledge. Additionally, qualitative descriptive data is included regarding student self-perceived learning performance and affective acceptance of concept mapping.

Results

Student participants were recruited at the end of both learning modules from a convenience sample of entry-level OTD students enrolled in the sections of a graduate-level functional neuroanatomy course taught by the first author. Of the 48 possible participants, 46 students completed the retrospective pretest-posttest survey to assess their change in knowledge after the traditional lecture module. One student took a leave of absence from the program due to a family illness and did not participate in the concept mapping module. Of the 47 possible participants, 39 completed the retrospective pretest-posttest survey after participating in the concept mapping module. The survey on perceptions of concept mapping was completed by 38 students. A total of 23 concept maps were submitted by student pairs and assessed using the scoring rubric. While concept mapping was completed in pairs, the retrospective pretest-posttest surveys were completed individually.

Retrospective Pretest-Posttest Survey Results

Table 2 summarizes the results from paired samples *t*-tests for the retrospective pretest-posttest knowledge survey. Within each instruction method, students demonstrated significant improvement with a medium affect size across all sections for both methods, traditional lecture (n=46) and concept mapping (n=39). Comparisons between the two instruction methods indicated no significant differences between the pretest or posttest scores except for the neurological dysfunction learning outcome. Specifically, posttest scores for neurological dysfunction were significantly higher for the traditional lecture than for concept mapping. Analysis of the mean differences in scores indicated students demonstrated significantly greater improvement on neurological dysfunction knowledge and content knowledge following the traditional lecture compared to concept mapping (see Table 3).

Table 2

Pretest-Posttest Knowledge Survey Results

Learning Outcome		**Traditional Lecture *M* (*SD*)**	**Concept Mapping *M* (*SD*)**	***p***
General Information	Pre	2.19 (.67)	2.39 (.57)	.139
	Post	3.87 (.46)	3.87 (.53)	.914
	Paired t-test	*t*(45)=18.74, *p*<.001*	*t*(38)=14.38, p<.001*	
	Cohen's *d*	.61	0.64	
Neurological Dysfunction	Pre	1.98 (.67)	2.18 (.69)	.180
	Post	3.89 (.53)	3.65 (.56)	.046*
	Paired t-test	*t*(45)=18.59, *p*<.001*	*t*(38)=14.92, p<.001*	
	Cohen's *d*	.69	.61	
Treatment	Pre	2.08 (.75)	2.36 (.67)	.071
	Post	3.59 (.64)	3.73 (.56)	.302
	Paired t-test	*t*(45)=14.43, *p*<.001*	*t*(38)=12.38, p<.001*	
	Cohen's *d*	.71	.69	
Overall	Pre	2.09 (.57)	2.32 (.57)	.065
	Post	3.77 (.43)	3.76 (.45)	.854
	Paired t-test	*t*(45)=20.65, *p*<.001*	*t*(38)=16.16, p<.001*	
	Cohen's *d*	.55	.55	

*Indicates statistically significant change

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Table 3

Mean Difference in Scores from Pretest-Posttest Knowledge Survey

Learning Outcome	Lecture (n=46) *M* (*SD*)	Concept Mapping (n=39) *M* (*SD*)	*p*
General Information (Δ)	1.67 (.60)	1.48 (.64)	.161
Neurological Dysfunction (Δ)	1.90 (.69)	1.46 (.61)	.003*
Treatment (Δ)	1.51 (.71)	1.36 (.69)	.332
Overall (Δ)	1.68 (.55)	1.43 (.55)	.042*

*Indicates statistically significant difference

Concept Map Scores

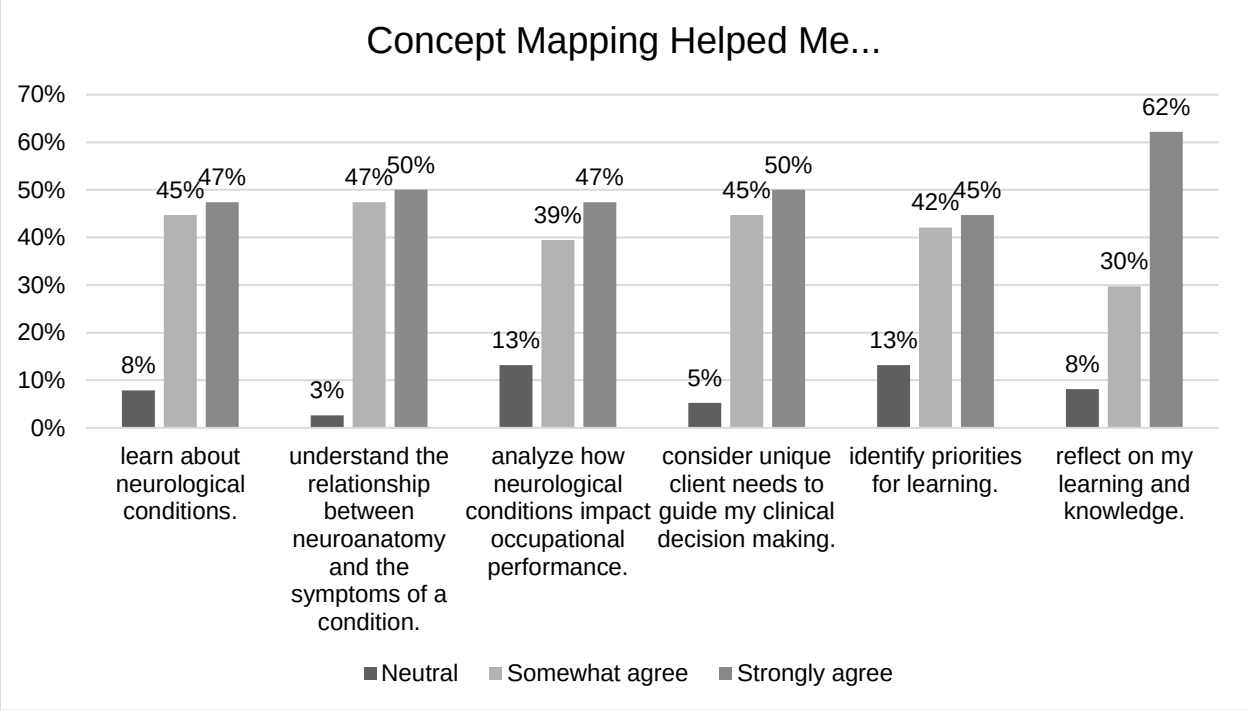
Analysis of scores from the concept map rubric indicated that summed scores (n=23) ranged from 26.5-29.5 with a mean score of 27.91 (SD=0.79). Overall, eight of the 23 concept maps exceeded expectations by achieving a total score of 28.5 or higher. The remaining 15 concept maps met expectations with a score of 26.5-28. Within the concept sections, students demonstrated a high level of content accuracy with all 23 submissions exceeding expectations. Scores were lowest on the relationships section. All concept maps effectively used the hierarchical structure and linking words to make simple connections. Five concept maps included appropriate cross-links between sections of the map to demonstrate complex relationships; however, only three of these included enough cross-links to achieve a score of exceeds expectations. Fourteen of the concept maps exceeded expectations with regards to communication by effectively using their concept maps to demonstrate original insights and superior understanding. An example of a student concept map that exceeded expectations in all areas is available to view at https://cmapscloud.ihmc.us/viewer/cmap/1YHFN379R-1NKV2FH-6THRZ8.

Perceptions of Concept Mapping Survey Results

Results from the survey about concept mapping (n=38) indicated that over 86% of students either agreed or strongly agreed that concept mapping supported their learning and application of course content. No negative responses were recorded related to the effect of concept mapping on the students' ability to learn (see Figure 1). When asked about their affective acceptance of concept mapping, most students (87%) indicated that concept mapping was a new learning method and 95% of students agreed that they enjoyed using concept mapping as a learning activity in class. Only 8% of students felt that concept mapping was difficult to use and 18% of students felt that concept mapping took too long. Regarding future use, 82% of students either strongly or somewhat agreed that they would like to use concept mapping again as an in-class activity and 61% would like to use it on their own.

Figure 1

Effects of Concept Mapping on Student Learning



Qualitative responses (n=36) from the open-ended question on the benefits of concept mapping were reviewed using an inductive thematic analysis in which the primary investigator analyzed student responses using a five-step process to reveal themes. As described by Veers and Gillam (2022), this process involves the researcher reading and comprehending data, organizing and labeling data to identify codes, reviewing codes and performing a second-round of coding including identification of subcategories, reviewing and refining subcategories, and finally synthesizing and interpretating data that reveals meaningful themes. Three themes related to the benefits of concept mapping were revealed through this process: making connections, improved learning, and visual organization. Within the theme of making connections, 16 students made comments related to how concept mapping helped them make connections, such as “see the connections between different aspects of a condition” and make “connections between two ideas or concepts”. Another student noted that concept mapping made it “easy to relate, compare, contrast, etc. different aspects of a topic”. A second set of 10 comments described how concept mapping improved learning by “getting more in detail”, “exploring more about a concept”, “consider many factors of a topic, broadening knowledge”, and “explore concepts on our own which can help promote learning”. Finally, 15 comments referenced the visual organization as a benefit of concept mapping that “helps to lay out all of the information” and “see the big picture”. Another student commented “I like being able to see everything laid out and in one place, rather than all in one big word document where ideas aren't clearly visible. I thought it was a unique way of organizing material”. Some students included multiple comments, for a greater number of comments across the three themes than total number of responses.

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A second inductive thematic analysis was conducted using qualitative comments (n=36) from the open-ended survey question on the difficulties of concept mapping. This process revealed three main challenges: feeling overwhelmed, time consuming, and technology problems. Of the 36 responses, 17 students mentioned or alluded to feeling overwhelmed at some point during concept mapping. Most comments referenced experiencing this feeling at the beginning of the process, indicating that it was “difficult to get started and include all of the ideas”. Other students commented on how the completed concept map was “overwhelming and hard to follow once completed” and “overwhelming [because] you don’t necessarily know what you’re missing”. Importantly, four of these comments were related to how the skeleton helped reduce this feeling and that “it would have been more difficult if we didn’t have the skeleton already created to work from”. A second challenge was the amount of time required as noted by comments from 10 different students such as “takes a lot of time”, “too time consuming”, and “takes a while and requires searching”. Notably, one student commented “takes a while to do, but I love them” suggesting that they felt the required time was justified by the benefits. Finally, nine students commented on technology problems, stating that the “software takes a bit to get used to” and difficulty “navigating the tools”.

Discussion

Effect of Concept Mapping on Content Knowledge

The findings from this study indicate that concept mapping positively impacts occupational therapy students’ self-perceived knowledge of functional neuroanatomy and treatment strategies for persons with traumatic brain injury. These results are consistent with past research demonstrating that concept maps were effective at increasing student content knowledge in healthcare education (Bixler et al., 2015; Powell et al., 2021). In this study, case-based learning was used in combination with concept mapping which is supported by previous research for its usefulness in assisting students to make connections between theoretical knowledge and application of learning (Powell et al., 2021; Slieman & Camarata, 2019). Specifically, assessment of concept maps provided students with more detailed and personal feedback while also providing the instructor with meaningful insights into the depth and breadth of student knowledge (Gil & Lee, 2022; Grice, 2016). These insights helped the instructor provide more tailored instruction in future class sessions to address and correct common student misconceptions. As suggested by Powell et al. (2021), the use of an “expert” concept map in addition to the scoring rubric helped decrease the time required for providing student feedback while still promoting reflection and additional learning. The inclusion of the “expert” concept map was not only a time-saving tool for instruction, but was also a necessary component of learning, providing structure for participants to reflect on their own learning and decision making. Specifically, by having students compare their completed map to the “expert” concept map they could self-reflect on their own assumptions and biases, which is an important component of critical thinking (Berg et al., 2021; Mills et al., 2018) and is part of learning according to cognitivism theory (Powell et al., 2021; Sahu et al., 2022).

Effect of Concept Mapping on Critical Thinking Skills

While this study did not include a formal assessment of critical thinking skills due to time and feasibility constraints, specific items were included across all three outcome measures to assess student application of critical thinking skills. Evaluation of student concept maps revealed that students demonstrated good use of critical thinking skills as noted by meaningful links between the neuroanatomy content, the case study content, and content learned in other courses. Specifically, students demonstrated higher level thinking through their ability to make inferences from this content to identify relevant assessment tools given the client's injury, deficits, and risk factors. Students effectively communicated these thinking processes and rationale through the organization of their concept maps. From their perspective, students reported that concept mapping supported their critical thinking skills by helping them understand relationships, analyze the impact of the traumatic brain injury, make inferences to guide their thinking, and reflect on their learning. Additionally, increased scores on the posttest knowledge survey indicated student knowledge of content improved following concept mapping when implemented with explicit instruction on critical thinking. This suggests that concept mapping may be a beneficial tool to support application of critical thinking skills within the subject-specific context of occupational therapy education. These findings are consistent with previous studies in which students reported improved critical thinking skills following concept mapping (Bressington et al., 2018; Garwood et al., 2018; Slieman & Camarata, 2019; Wu & Wu, 2020).

Student Perceptions on the Use of Concept Mapping

In response to the second research question of this project, the results agree with previous research that students reported positive attitudes toward and satisfaction with concept mapping as a learning activity (Gil & Lee, 2022; Hsu et al., 2016; Wu & Wu, 2020). Student feedback on the specific benefits of concept mapping was also consistent with past research, with students reporting they were better able to visualize the broad picture and obtain a more in-depth understanding of the course content (Gil & Lee, 2022; Grice, 2016). Additionally, students reported minimal challenges with concept mapping despite it being a novel learning activity. This confirms previous findings that concept mapping was easy for students to learn and use (Bixler et al., 2015). In comparison to previous research, students in this study reported fewer concerns with the amount of time required to complete a concept map and more students indicated that they would like to continue using concept mapping (Bixler et al., 2015; Gil & Lee, 2022). These differences may be attributed to students being provided with a concept map skeleton which decreased the time burden of starting and organizing the concept map structure. Additionally, having the students complete the concept map in class rather than as a take-home assignment and using a computer application likely contributed to the reduced number of time-related concerns (Mammen, 2016). The most frequent student complaint in this study was feeling "overwhelmed" due to the amount of information; however, this challenge appeared to have minimal effect on overall student learning and may be more reflective of the novelty of concept mapping.

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Verbal comments provided during the end of class discussion indicated that students felt the class time went by quickly and that it was easier to stay engaged in the process compared to a traditional lecture. This suggests that students may have a higher learning satisfaction with concept mapping compared to traditional lecture, which is consistent with past research by Hsu et al. (2016). These comments are supported by the survey results in which students overwhelmingly agreed that they would like to use concept mapping again as an in-class activity. Additionally, observations made by the instructor during the class period indicated that students appeared to ask more questions to each other and to the instructor, explore a greater variety of resources, and stay more engaged in the learning process during concept mapping compared to traditional lecture. This is notable as it lends support to previous research which suggested that concept mapping with peer discussion can help facilitate the student's role as an active learner (Joshi et al., 2022).

Study Limitations and Future Research

The results of this study were limited by the lack of a true control group, unknown reliability and validity of the outcome measures, and limited time frame. Due to the use of an educational setting, it was not feasible or ethical to limit the intervention to a sub-set of students. As a result, a pseudo-control condition was created by selecting a topic that had similar complexity and familiarity for the traditional lecture based on prevalence data and the instructor's previous teaching experience; however, differences in pre-class knowledge of the two conditions may have affected and potentially limited the results. Additionally, the concept mapping module contained a more detailed and authentic case study, which may have helped student learning compared to using concept mapping alone. As the outcome measures were developed and used for the first time in this study, there is no data on their reliability and validity. Moreover, the change in student knowledge was only measured through the retrospective student self-assessment. While the retrospective method was chosen to minimize the likelihood that students would misrepresent their knowledge (Geldhof et al., 2018; Lang & Savageau, 2017), it is possible that students did not respond consistently across the two time points. This project had a limited time frame which prohibited the collection of follow-up data to determine the long-term effect of concept mapping compared to traditional lecture. The short time frame also made it unrealistic to include an assessment of critical thinking as previous research suggests that at least eight weeks of intervention are needed to see measurable changes in critical thinking skills (Kaddoura et al., 2016; Slieman & Camarata, 2019).

With regards to the effectiveness of concept mapping compared to traditional lecture, concept mapping produced equal knowledge gains on two sections of the retrospective pre-post survey: general information and treatment methods. On the third section (neurological dysfunction), students reported greater knowledge gains following the traditional lecture compared to concept mapping; however, it is not clear if these findings are meaningful due to limitations in the project design, as student pretest scores were higher for concept mapping module (TBI) compared to traditional lecture module (MS). These differences may have been caused by limitations in the outcome measure, specifically a ceiling effect combined with a higher pretest knowledge of TBI

compared to MS suggesting that students may have had more background knowledge relevant to TBI compared to MS prior to participating in class. This could have allowed for students to report a greater increase in knowledge following the traditional lecture on the MS diagnosis. This explanation is supported by comparison of posttest findings as overall posttest scores were nearly identical for the traditional lecture and concept mapping indicating that the two instruction methods resulted in similar knowledge and ability outcomes.

Previous studies have identified concept mapping as a useful tool for developing critical thinking skills in healthcare education, yet more rigorous studies with greater sample sizes are needed to better understand its effectiveness (Bixler et al., 2015; Yue et al., 2017). This study included a small sample size and was conducted in a limited time frame, where consequently only short-term knowledge was assessed. Future research regarding concept mapping as an instructional method should consider the long-term results with retention of knowledge and critical thinking skills. Adding to the multiplicity of this need, critical thinking remains a highly debated topic in how it is defined (Gunawardena & Wilson, 2021). In this study, the application of certain critical thinking skills was assessed, including participants' ability to make meaningful links between content previously learned, assessment of inferences made, and students' perceived understanding of pretest and posttest knowledge. Part of the learning process congruent with principles of critical thinking was that students would recognize their own assumptions and biases through the provided feedback; however, this was not an outcome measure included in this study and should be further studied. Finally, the authors did not assess student engagement, yet noted that students "asked more questions" and "seemed more engaged" during the class activity. This inference could be due to personal bias, and additional research on active student engagement with concept mapping is needed.

While this study has its limitations, it may show promise for future use, specifically by encouraging the development of more rigorous research regarding concept mapping and critical thinking. Research is needed to fully explore the effects and benefits of concept mapping and critical thinking instruction on the learning outcomes and thinking skills of occupational therapy students. More long-term information is needed on the use of concept mapping including consideration of how student perceptions and knowledge changes with increased frequency of concept mapping. As concept mapping is not commonly used in occupational therapy education, it would also be beneficial to determine the optimal methods for introducing concept mapping as an instruction method and explore the use of concept maps with other content and learning outcomes. Finally, future studies should consider assessment methods with higher validity and reliability such as an objective knowledge test to measure and compare the effectiveness of concept mapping with other instruction methods.

Implications for Occupational Therapy Education

Given these results, occupational therapy educators should consider implementing concept mapping as an active, student-centered learning activity to support enhanced knowledge and critical thinking. Currently, concept maps are one of the least frequently

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used instructional methods in occupational therapy education (Henderson et al., 2017) and only one published study could be found that explores concept mapping as a learning tool in occupational therapy education (Grice, 2016). This study demonstrates that students identify concept mapping within occupational therapy education as a useful tool in supporting critical thinking skills. Not only is concept mapping easy to learn and use, but it also has benefits that are not offered by a traditional lecture format. For example, concept mapping encourages students to initiate and direct their own learning and promotes connections between explicit and implicit instruction (Bixler et al., 2015) and information learned in other courses, as demonstrated in this study.

This study was unique in that it explored the combination of concept mapping with a clinical case study that was used in conjunction with a separate course. Despite this added content and complexity, students still indicated that concept mapping supported their learning. Future research might consider also pairing concept mapping activities with case-based learning. Occupational therapy educators should consider integrating concept mapping with case-based instruction or problem-based learning. Case-based instruction is a frequently used and valuable method for promoting thinking skills in occupational therapy students (Henderson et al., 2017). The unique structure and visual layout of concept maps can provide students with a useful template to organize their approach to learning as part of case-based instruction (Farrokhnia et al., 2019). In this study, students used concept mapping with a clinical case study to make explicit connections between basic science and theoretical knowledge, the patient's unique needs, and the proposed treatment plan. Particularly in the early stages of the curriculum, occupational therapy students may benefit from the combination of concept mapping and case-based instruction to scaffold their development of critical thinking skills (Gunawardena & Wilson, 2019).

Conclusion

This study adds to the literature on concept mapping in healthcare education by expanding study populations to include occupational therapy graduate students and demonstrating that concept mapping can produce similar results of enhanced knowledge of learning outcomes compared to traditional lecture. The results of this study provide encouraging support for the use of concept mapping and explicit instruction on critical thinking skills to promote self-directed learning and content knowledge in graduate students enrolled in an entry-level occupational therapy program. Future studies should build on these findings by exploring the ability of concept mapping to produce long-term, significant learning in students as measured both by student self-assessment and objective criterion-based assessments. Importantly, this study demonstrated that students have high affected acceptance of in-class concept mapping to direct and promote their learning of content knowledge. Concept mapping may also help promote critical thinking skills and the ability to make complex connections across the occupational therapy education curriculum, although further research is needed to fully support this claim.

References

Abrami, P. C., Bernard, R. M., Borokhovski, E., Waddington, D. I., Wade, C. A., & Persson, T. (2015). Strategies for teaching students to think critically: A meta-analysis. *Review of Educational Research*, *85*(2), 275–314. https://doi.org/10.3102/0034654314551063

Allen, D. D., & Toth-Cohen, S. (2019). Use of case studies to promote critical thinking in occupational therapy students. *Journal of Occupational Therapy Education, 3*(3). https://doi.org/10.26681/jote.2019.030309

American Occupational Therapy Association. (2018a). 2018 Accreditation Council for Occupational Therapy Education (ACOTE®) standards and interpretive guide (effective July 31, 2020). *American Journal of Occupational Therapy*, *72*(Supplement 2), 7212410005p1-7212410005p83. https://doi.org/10.5014/ajot.2018.72S217

American Occupational Therapy Association. (2018b). Occupational therapy education research agenda – revised. *American Journal of Occupational Therapy, 72*(Supplement 2), 7212420070p1-7212420070p5. https://doi.org/10.5014/ajot.2018.72S218

Bakker, A., Smit, J., & Wegerif, R. (2015). Scaffolding and dialogic teaching in mathematics education: introduction and review. *ZDM Mathematics Education,* 47, 1047–1065. https://doi.org/10.1007/s11858-015-0738-8

Berg, C., Philipp, R., & Taff, S. D. (2021). Scoping review of critical thinking literature in healthcare education. *Occupational Therapy in Health Care*, 1–18. https://doi.org/10.1080/07380577.2021.1879411

Bixler, G. M., Brown, A., Way, D., Ledford, C., & Mahan, J. D. (2015). Collaborative concept mapping and critical thinking in fourth-year medical students. *Clinical Pediatrics*, *54*(9), 833–839. https://doi.org/10.1177/0009922815590223

Bressington, D. T., Wong, W., Lam, K. K. C., & Chien, W. T. (2018). Concept mapping to promote meaningful learning, help relate theory to practice and improve learning self-efficacy in Asian mental health nursing students: A mixed-methods pilot study. *Nurse Education Today*, *60*, 47–55. https://doi.org/10.1016/j.nedt.2017.09.019

Center for Teaching. (n.d.). *Concept map rubrics.* University of Iowa. https://teach.its.uiowa.edu/resources/collections/concept-maps

Facione, P. A. (2020). *Critical thinking: What it is and why it counts*. Insight Assessment.

Facione, P. A., & Facione, N. C. (2014). *The Holistic Critical Thinking Scoring Rubric – HCTSR: A tool for developing and evaluating critical thinking*. Insight Assessment. https://www.insightassessment.com/wp-content/uploads/HCTSR-2014-Insight-Assessment.pdf

Farrokhnia, M., Pijeira-Díaz, H. J., Noroozi, O., & Hatami, J. (2019). Computer-supported collaborative concept mapping: The effects of different instructional designs on conceptual understanding and knowledge co-construction. *Computers & Education, 142,* 103640. https://doi.org/10.1016/j.compedu.2019.103640

Fink, L. D. (2003). *Self-directed guide to designing courses for significant learning*. Retrieved from https://www.deefinkandassociates.com/GuidetoCourseDesignAug05.pdf

DOI: 10.26681/jote.2023.070307

Garwood, J. K., Ahmed, A. H., & McComb, S. A. (2018). The effect of concept maps on undergraduate nursing students' critical thinking. *Nursing Education Perspectives*, *39*(4), 208–214. https://doi.org/10.1097/01.NEP.0000000000000307

Geldhof, G. J., Warner, D. A., Finders, J. K., Thogmartin, A. A., Clark, A., & Longway, K. A. (2018). Revisiting the utility of retrospective pre-post designs: The need for mixed-method pilot data. *Evaluation and Program Planning*, *70*, 83–89. https://doi.org/10.1016/j.evalprogplan.2018.05.002

Gil, Y. M., & Lee, B. (2022). Concept map-based learning in an oral radiographic interpretation course: Dental students' perceptions of its role as a learning tool. *European Journal of Dental Education,*12828. https://doi.org/10.1111/eje.12828

Grice, K. (2016). Concept mapping as a learning tool in occupational therapy education. *Occupational Therapy in Health Care, 30*(3), 309-318. https://doi.org/10.3109/07380577.2015.1130886

Gunawardena, M., & Wilson, K. (2021). Scaffolding students' critical thinking: A process not an end game. *Thinking Skills and Creativity, 41*, 100848. https://doi.org/10.1016/j.tsc.2021.100848

Haynes, A., Lisi, E., Goltz, M., Stein, B., & Harris, K. (2016). Moving beyond assessment to improving students' critical thinking skills: A model for implementing change. *Journal of the Scholarship of Teaching and Learning, 16*(4), 44-61. https://doi.org/10.14434/josotl.v16i4.19407

Henderson, W., Coppard, B., & Qi, Y. (2017). Identifying instructional methods for development of clinical reasoning in entry-level occupational therapy education: A mixed methods design. *Journal of Occupational Therapy Education, 1*(2). https://doi.org/10.26681/jote.2017.010201

Hsu, L.-L., Pan, H.-C., & Hsieh, S.-I. (2016). Randomized comparison between objective-based lectures and outcome-based concept mapping for teaching neurological care to nursing students. *Nurse Education Today*, *37*, 83–90. https://doi.org/10.1016/j.nedt.2015.11.032

Joshi, R., Hadley, D., Nuthikattu, S., Fok, S., Goldbloom-Helzner, L., & Curtis, M. (2022). Concept mapping as a metacognition tool in a problem-solving-based BME course during in-person and online instruction. *Biomedical Engineering Education*. https://doi.org/10.1007/s43683-022-00066-3

Kaddoura, M., Van-Dyke, O., & Yang, Q. (2016). Impact of a concept map teaching approach on nursing students' critical thinking skills: Concept maps for critical thinking. *Nursing & Health Sciences*, *18*(3), 350–354. https://doi.org/10.1111/nhs.12277

Kong, Y. (2021). The role of experiential learning on students' motivation and classroom engagement. *Frontiers in Psychology*, *12*, 771272. https://doi.org/10.3389/fpsyg.2021.771272

Lang, D., & Savageau, J. A. (2017). *Starting at the end: Measuring learning using retrospective pre-post evaluations.* Center for Health Policy and Research (CHPR) Publications. Retrieved from https://escholarship.umassmed.edu/healthpolicy_pp/207

Mahanal, S., Zubaidah, S., Sumiati, I. D., Sari, T. M., & Ismirawati, N. (2019). RICOSRE: A learning model to develop critical thinking skills for students with different academic abilities. *International Journal of Instruction, 12*(2), 417-434. https://doi.org/10.29333/iji.2019.12227a

Mammen, J. R. (2016). Computer-assisted concept mapping: Visual aids for knowledge construction. *Journal of Nursing Education*, *55*(7), 403–406. https://doi.org/10.3928/01484834-20160615-09

Mills, K., Creedy, D. K., & West, R. (2018). Experiences and outcomes of health professional students undertaking education on Indigenous health: A systematic integrative literature review. *Nurse Education Today, 69*, 149-158. https://doi.org/10.1016/j.nedt.2018.07.014

Morris, R. J., Gorham-Rowan, M. M., Robinson, J. H., & Scholz, K. (2018). Assessing and teaching critical thinking in communication science and disorders. *Teaching and Learning in Communication Science & Disorders, 2*(1). https://doi.org/10.30707/TLCSD2.1Morris

Morris, R. J., Brockner, A. E., & Coleman, S. E. (2019). Effectiveness of two methods for teaching critical thinking to communication sciences and disorders undergraduates. *Canadian Journal of Speech-Language Pathology and Audiology, 43*(1), 21-34.

Mukhalalati, B. A., & Taylor, A. (2019). Adult learning theories in context: A quick guide for healthcare professional educators. *Journal of Medical Education and Curricular Development, 6*, 2382120519840332. https://doi.org/10.1177/2382120519840332

Novak, J. D., & Cañas, A. J. (2008). *The theory underlying concept maps and how to construct and use them* (Technical Report IHMC CmapTools 2006-01 Rev 2008-01). Institute for Human and Machine Cognition.

Passmore, G. G. (2021). Concept mapping: A meaningful learning tool to promote conceptual understanding and clinical reasoning. In M. J. Bradshaw, B. L. Hultquist & D. A. Hagler (Eds.), *Innovative teaching strategies in nursing and related health professions* (8th ed., pp. 375-396). Jones & Bartlett Learning.

Pitonyak, J. S., Nielsen, S., O'Brien, S. P., Corsilles-Sy, C., Lambert, D. O., & Jaffe, L. E. (2020). Critical thinking in occupational therapy education: A systematic mapping review. *Journal of Occupational Therapy Education*, *4*(4). https://doi.org/10.26681/jote.2020.040403

Powell, B. D., Oxley, M. S., Chen, K., Anksorus, H., Hubal, R., Persky, A. M., & Harris, S. (2021). A concept mapping activity to enhance pharmacy students' metacognition and comprehension of fundamental disease state knowledge. *American Journal of Pharmaceutical Education*, *85*(5), 8266. https://doi.org/10.5688/ajpe8266

Reynders, G., Lantz, J., Ruder, S. M., Stanford, C. L., & Cole, R. S. (2020). Rubrics to assess critical thinking and information processing in undergraduate STEM courses. *International Journal of STEM Education*, *7*(1), 9. https://doi.org/10.1186/s40594-020-00208-5

Robertson, D., Warrender, F., & Barnard, S. (2015). The critical occupational therapy practitioner: How to define expertise?. *Australian Occupational Therapy Journal*, *62*(1), 68-71. https://doi.org/10.1111/1440-1630.12157

Sahu, P. K., Dalcik, H., Dalcik, C., Gupta, M. M., Chattu, V. K., & Umakanthan, S. (2022). Best practices for effective implementation of online teaching and learning in medical and health professions education: During COVID-19 and beyond. *AIMS Public Health, 9*(2), 278. https://doi.org/10.3934/publichealth.2022019

Slieman, T. A., & Camarata, T. (2019). Case-based group learning using concept maps to achieve multiple educational objectives and behavioral outcomes. *Journal of Medical Education and Curricular Development*, *6*, 238212051987251. https://doi.org/10.1177/2382120519872510

Slominski, T. N., Momsen, J. L., & Montplaisir, L. M. (2017). Drawing on student knowledge of neuroanatomy and neurophysiology. *Advances in Physiology Education, 41*(2), 212-221. https://doi.org/10.1152/advan.00129.2016

UC Berkeley. (2016). *Teaching guide for graduate student instructors*. http://gsi.berkeley.edu/teachingguide/theories/learning-chapter.pdf

Wu, H. Z., & Wu, Q. T. (2020). Impact of mind mapping on the critical thinking ability of clinical nursing students and teaching application. *Journal of International Medical Research*, *48*(3), 030006051989322. https://doi.org/10.1177/0300060519893225

Yue, M., Zhang, M., Zhang, C., & Jin, C. (2017). The effectiveness of concept mapping on development of critical thinking in nursing education: A systematic review and meta-analysis. *Nurse Education Today, 52*, 87-94.

Appendix A: Retrospective Pretest-Posttest Survey

For each of the objectives listed below, please check the box under the number that indicates your skill level both before and after completion of the learning module.

1 = none; have no ability
2 = low; have little ability
3 = average; have basic ability (but there is more to learn)
4 = high; have good ability
5 = superior; have excellent ability

How would you rate your ability to…	**BEFORE class**					**AFTER class**				
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
GENERAL INFORMATION										
Q1. Describe the incidence and prevalence of the neurological condition.										
Q2. Understand the risk factors and/or causes that contribute to the disease process.										
Q3. Identify how social determinants of health are related to risk factors for the condition.										
Q4. List the primary signs and symptoms (e.g., sensory, cognitive) of the condition.										
Q5. Classify the different types and/or severity levels of the condition.										
NEUROLOGICAL DYSFUNCTION										
Q6. Identify specific components of the nervous system involved in the condition.										
Q7. Describe the normal function of the involved neurological components.										
Q8. Explain how the nervous system is damaged during the disease process.										
Q9. Describe how the neurological dysfunction is connected to specific signs and symptoms.										
TREATMENT										
Q10. Describe medical interventions used to diagnosis and/or treat the condition.										
Q11. Select relevant OT assessment tools for this condition.										
Q12. Predict how the condition will impact occupational performance.										
Q13. Consider the client's unique needs when planning for OT evaluation and treatment.										
Q14. Examine how your personal biases and assumptions influence your client-centered care decisions.										

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Appendix B: Perception of Concept Mapping Survey

1. Please indicate your level of agreement with the following statements:

Concept mapping helped me…	**Strongly disagree (1)**	**Somewhat Disagree (2)**	**Neutral (3)**	**Somewhat Agree (4)**	**Strongly agree (5)**
learn about neurological conditions.					
understand the relationship between neuroanatomy and the signs and symptoms of a condition.					
analyze how neurological conditions impact occupational performance.					
consider unique client needs to guide my clinical decision making.					
identify priorities for learning.					
reflect on my learning and knowledge.					

Concept mapping…	**Strongly disagree (1)**	**Somewhat Disagree (2)**	**Neutral (3)**	**Somewhat Agree (4)**	**Strongly agree (5)**
was a new learning method for me.					
was difficult to use.					
takes too long.					
was an enjoyable learning activity.					

I would like to…	**Strongly disagree (1)**	**Somewhat Disagree (2)**	**Neutral (3)**	**Somewhat Agree (4)**	**Strongly agree (5)**
continue using concept maps on my own.					
use concept maps again as an in-class activity.					

2. What do you see as the benefits of concept mapping?

3. What do you see as the difficulties of concept mapping?