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Neuroscience Near-Peer-Led Flipped Classroom Improves Student Confidence With Clinical Application of Content and Test-Taking Skills

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Abstract

Introduction: The ability to apply knowledge gained in neuroscience coursework to a clinical scenario is found to be difficult by many medical students. Neuroscience is both important for future clinical practice and an area frequently tested on USMLE Step 1 examinations. **Methods:** Second-year medical students created a peer-led flipped classroom to help first-year students practice applying medical neuroscience course information to clinical situations and demonstrate how that information might be tested in board-style questions. The second-year students designed a series of board-style questions that included explanations for both the correct and incorrect answers. We divided the first-year students ($n = 80$) into small groups during the flipped classroom sessions, where they were led by second-year medical students in discussion about the questions and clinical situations. **Results:** Students reported agreement that the session addressed gaps in their knowledge and provided them with useful critical thinking skills for approaching board-style questions (83% and 81% agreed or strongly agreed, respectively). **Discussion:** The flipped classroom improved student confidence in both applying neuroscience concepts to clinical scenarios and to board-style vignette questions.

Keywords
Neuroscience, Peer-Led, Flipped Classroom, Clinical Vignette, Neurology

Educational Objectives

By the end of this activity learners will be able to:

1. Identify areas of weakness in the application of neuroscience topics.
2. Improve understanding of various brainstem lesions for application in board-style vignettes and clinical scenarios.
3. Improve understanding of various brain lesions for application in board-style vignettes and clinical scenarios.
4. Improve understanding of various visual field defects for application in board-style vignettes and clinical scenarios.

Introduction

The application of neuroscience and neuroanatomy topics is important for students to understand given its relevance to their future clinical practice and to their board examinations. However, the application of neuroscience to clinical scenarios has been found to be difficult for medical students.[1] In seeking to address this area for improvement, medical educators have developed a variety of interactive teaching modalities, including team-based learning sessions. We approached this problem area by developing a peer-led flipped classroom utilizing student-created practice questions.

The use of practice exam questions as a learning tool has been shown to lead to improved exam performance and information retention.[2,3] This propensity for using practice questions can be seen in the increasing availability of resources for medical student such as PreTest books and question banks like UWorld, USMLE-Rx, Kaplan, and Amboss. Similar to practice exam questions, the use of peer-led teaching sessions has proven to be of benefit to student learning.[4] However, the effectiveness of peer-led teaching is often dependent on the peer's knowledge level and teaching ability.[4] Our goal was to combine the impact of peer-led sessions with the benefits of clinical vignettes to assist in student integration of neuroscience topics in clinical applications and board examinations.

Several educational interventions for neuroanatomy have been developed and made available in *MedEdPORTAL* within recent years. These include team-based interactive learning modules

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focused on identifying important neuroanatomical structures and their functions,[5,6] instructions for creating three-dimensional brain dissections,[7,8] and a rotatable, sliceable "virtual brain."[9] Although there is some commonality between our learning activity and these previous works, our module focuses on the application of neuroscience concepts to USMLE-type questions. Moreover, our module utilizes near-peer medical students who can provide a unique perspective for testing strategies. Several recent works have utilized the concept of near-peer teaching,[10,11] but none are designed to approach neuroscience concepts or board preparation. Our work is unique in that it combines a team-based session led by near-peer medical students with an interactive module to emphasize neuroscience concepts commonly tested on USMLE Step 1. This content can be utilized by educators to implement at their institution or to design a similar intervention in the preclinical curriculum to begin introducing students to testing strategies.

Methods

After completion of our second year of medical school and our preparation for the USMLE Step 1 examination, we created a flipped classroom session for first-year medical students as part of the medical neuroscience course at the Brody School of Medicine. The session consisted of answering, in small groups, a set of 12 clinical vignette-style questions we wrote to reflect high-yield themes in neuroscience that we recognized during our preparation for USMLE Step 1. We compiled the questions into an interactive PowerPoint file that included explanations for both the correct and incorrect answer choices. The interactive design of the PowerPoint allowed users to click the desired answer choice to advance directly to the answer explanation slide and to navigate between questions using specific icons located on the slides.

Eighty medical students consented to participate in the session. We divided them into four classrooms, each facilitated by one of the authors serving as a near-peer student facilitator, and then divided the classrooms further into small groups of four students each. Attendance at the session was mandatory for those enrolled in the neuroscience course, but completion of pre- and postsurveys (Appendix A) was optional and not reported to course faculty. Each near-peer was assisted by a neuroscience course instructor who could offer further clinical pearls or clarification. Students were given the student version of the questions (Appendix B), which did not have the explanations associated with each answer choice, to view on their computers during the session. At the front of the class, the near-peer displayed the teaching version of the questions (Appendix C), which contained the correct answers and associated diagrams. The student version was intended to be used if the room layout made viewing the facilitator's presentation difficult while the students answered the questions individually or in small groups. Since the student version did not contain the answers, the students who chose to view this version would not be able to see explanations or answers by advancing slides ahead of the rest of the class. Appendix D contains an instructor guide for leading the session.

Questions were presented one at a time to the whole classroom, and students were given 90 seconds to answer each question independently. We chose 90 seconds to be consistent with USMLE Step 1 question timing. The 90-second independent answering time was followed by an additional 2-3 minutes for students to discuss their selected answers within their four-person groups and to come up with a consensus group answer choice. Upon completion of the allotted time for discussion, the near-peer leader facilitated a discussion in the classroom by randomly selecting groups to provide the reasoning behind the group's answer selection. Even if the correct answer was initially chosen, the other groups were asked to explain why the remaining answer choices were incorrect. The facilitator used diagrams and information included in the teaching version to aid with explanations of answer choices. Any incorrect explanations or questions by the students were addressed by the facilitator prior to moving onto the next question as a group. After completion of the session, the students were given the full version of the questions so they could practice at home and have explanations for the questions. The design of the PowerPoint, when used outside of a session, allowed students to select their chosen answer and receive immediate feedback on whether it was correct or incorrect. If students chose the incorrect answer, then they could return to the question prompt and try again to select the correct answer without it being revealed to them.

To evaluate the efficacy of the session, we developed a voluntary survey to reflect the competencies that the intervention intended to improve. Written informed consent was obtained from all participants. Students were informed that participation was voluntary and that their involvement in the study would not affect their grade. Students completed the surveys prior to and after the session. The surveys assessed their perceived confidence in their ability to use a patient's history, physical exam, or neuroimaging results to identify a neurologic lesion or disease. The survey also included perceived confidence in the ability to approach board-style clinical vignettes on neurologic conditions. In the postsurvey, students responded to the usefulness of the session

as well as to the comparability of our questions to ones they had encountered on board-style question banks. All survey questions utilized a 5-point Likert scale (1 = *not confident* or *strongly disagree,* 5 = *very confident* or *strongly agree*). Pre- and postsession survey results were compared using a paired-sample *t* test.

Results

Of the 80 students who consented to participate in the study, 73 completed all survey questions in both the pre- and postsession surveys (91% completion rate). Prior to the session, the average student perception of confidence in the ability to identify a neurologic lesion or disease using a patient's history, physical exam, or neuroimaging was nearly neutral (Likert score of 3 out of 5): history, 2.9; physical exam, 3.2; and neuroimaging, 2.7. This was consistent with presession perceived confidence for board-style clinical vignettes regarding neurologic conditions (2.6). On the postsession survey, students' average confidence for each of the survey questions increased to above the neutral value compared to presession confidence (Table 1). The change in each area of confidence was statistically significant when comparing presession confidence to postsession confidence.

Eighty-one percent of participants either agreed or strongly agreed that the session revealed gaps in their ability to apply basic neuroanatomy knowledge to clinical vignettes, and 83% agreed or strongly agreed that the session successfully addressed these gaps (Table 2). Eighty-one percent of students agreed or strongly agreed that the activity helped them gain critical thinking skills that they would utilize in approaching future board-style questions. Students also reported better understanding of how content might be asked on board examinations (88% agreed or strongly agreed). Of the students who indicated they had already begun to utilize USMLE practice question banks ($n = 27$), 67% agreed or strongly agreed that the questions in the session were representative of the board-style questions used in those resources. When surveyed about the usefulness of second-year medical students as a resource for learning how to approach board-style questions, 81% agreed or strongly agreed that they were useful.

Table 1. Students' Average and Median Confidence Reported on Pre- and Postsession Surveys

Survey Question[a]	Average (Median)		*p*
	Presession	Postsession	
Confidence in ability to use a patient's history to identify neurologic lesion/disease.	2.9 (3.0)	3.6 (4.0)	<.0001
Confidence in ability to use physical exam findings to identify neurologic lesion/disease.	3.2 (3.0)	3.6 (4.0)	<.0001
Confidence in ability to use neuroimaging to identify neurologic lesion/disease.	2.7 (3.0)	3.5 (4.0)	<.0001
Confidence in ability to approach board-style question regarding neurologic conditions.	2.6 (3.0)	3.6 (4.0)	<.0001

[a]Rated on a 5-point Likert scale (1 = *not confident,* 5 = *very confident*).

Discussion

The first-year students at Brody School of Medicine participate in the medical neuroscience course during the second block of their first year of medical school. Students receive exposure to question styles from direct recall to clinical vignettes during formative and summative evaluations in every course at the institution. While students had received exposure to clinical vignette questions, at the time of the study they had not received any formal instruction on approaches to answering clinical vignette questions. The use of second-year student facilitators who had all completed their USMLE Step 1 preparation served to provide the participants with direction on how to approach board-style questions. The facilitators walked the participants through how to initially approach the questions and subsequently evaluate the answer choices. The survey results showed that the participants agreed the second-year medical students were

Table 2. Results of Postsession Survey

Survey Question Topic	Number (%)				
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
1. Session revealed gaps in applying basic neuroanatomy knowledge to clinical vignettes. ($n = 75$)	0 (0)	2 (3)	12 (16)	27 (36)	34 (45)
2. Session successfully addressed any revealed gaps. ($n = 75$)	1 (1)	3 (4)	9 (12)	36 (48)	26 (35)
3. Gained useful critical thinking skills for approaching future board-style questions. ($n = 74$)	1 (1)	2 (3)	11 (15)	27 (36)	33 (45)
4. Have a better understanding of how content may be asked on board exams. ($n = 74$)	0 (0)	2 (3)	7 (10)	25 (34)	40 (54)
5. Session questions were representative of board-style questions on other USMLE practice banks. ($n = 27$)	0 (0)	2 (7)	7 (26)	10 (37)	8 (30)
6. Second-year medical students are a useful resource for learning how to approach board-style questions. ($n = 73$)	0 (0)	1 (1)	13 (18)	17 (23)	42 (58)

a useful resource for learning how to approach board-style questions.

This session is designed to be led by medical students who have recently prepared for taking the USMLE Step 1 examination. Survey responses support the conclusion that peer-led educational sessions are seen by students as beneficial to learning. Students who are further along in their medical training and have prepared for taking USMLE Step 1 can share thought processes for approaching vignette-based questions and how to apply the material learned in a foundational neuroscience course. These more-senior students share an exposure to the material similar to that of the students in the course, as compared to the faculty; therefore, they may be able to better understand concerns that students in the course have. Another benefit of using near-peer student facilitators is that they have recent experience with Step 1 preparation resources and therefore can identify trends in high-yield topic areas to update questions. Though the session is designed to be peer led, it could be fully run by faculty or used independently as a study resource by students in the course. However, if a student does elect to complete the session independently, the student may not reap the reported benefits associated with the use of a peer facilitator. Further investigation would be necessary to compare the use of near-peer versus faculty facilitators in order to directly evaluate the benefit of using near-peers as facilitators. Although no official data were collected, the more-senior students felt that facilitating the session improved their understanding of the material, enhanced their confidence in their own teaching abilities, and helped to improve their own approaches to clinical vignette-style questions.

There were a variety of challenges with using near-peers both in the role as facilitators and with the creation of questions. While we, as near-peers, had recent exposure to Step 1 preparation and high-yield topics prior to creating the questions, we did not have formal training on writing clinical vignette questions. We found it helpful to run drafted questions and answers by department faculty members to ensure that questions were appropriate in difficulty, application, and content. Other challenges encountered during the process included that, as near-peer facilitators, we had to be able to effectively explain errors in thought processes brought up by the students in the course. The ability to respond with appropriate explanations depended on the facilitator's comfort with that topic and their own teaching ability. Replication of the session's success can be aided by the selection of facilitators who have previously demonstrated effective teaching skills and high performance in the neuroscience course. We have added Instructor Notes to the teaching version of the PowerPoint to help facilitators with the key points of explanation. Another important element of the session is that its success is somewhat dependent on the level of student engagement. Thus, facilitators face the challenge of keeping students engaged in the session and encouraging participation, which may prove difficult if the facilitators have little experience in similar teaching situations.

A limitation of the study is that we looked only at qualitative data to assess effectiveness; no knowledge test was administered to provide quantitative data to support our conclusions. The session could be improved by creating a knowledge test as an evaluation tool to align the session's objectives, instructional approach, and overall effectiveness. Furthermore, when assessing the advantages of the session, it was not possible to determine if they were entirely attributable to the use of near-peers, the PowerPoint presentation itself, or the length of time spent covering the material in the sessions. To further assess the benefits, additional testing would be necessary. On the survey, the lowest performing item concerned student agreement with session questions being reflective of those seen in test banks. This can be attributed to the fact that only 27 responders (38%) indicated using practice question banks, suggesting that many of the participants may have had limited exposure to clinical vignettes prior to the session. In addition, there were intentional design differences between several session questions and those found in question bank resources. We specifically designed questions to increase in complexity in order to help students learn to focus on their important points both as a test-taking skill and for the benefit of the review of the neuroscience material. Including too much unnecessary information in the session vignettes may detract from students' ability to apply the critical details to the problem at hand and thus not fully integrate the neuroscience knowledge with its application. Participants found the peer-led session on application of neuroscience knowledge to clinical vignettes a useful experience that provided them with both neuroscience knowledge and test-taking skills. Students were able to identify areas of weakness in their knowledge bases and improve upon those areas through the session.

Our study found that the implementation of this near-peer-led neuroscience session was beneficial to both the students in the course and the near-peer facilitators. The session provided the students in the course with early exposure to clinical vignette-style questions and with the unique opportunity to discuss the approach to questions and learn to apply the information with the

help of near-peers. The near-peers benefited from the in-depth exposure to the material and the unique opportunity to facilitate such a session. In future work, similar near-peer-led sessions can be created for other foundational science courses to continue to increase early student exposure to clinical vignette-style questions and yield similar benefits to those found in this study.

Appendices

A. Pre- and Postsession Surveys.pdf

B. Neuroscience Flipped Classroom PowerPoint Student.pptx

C. Neuroscience Flipped Classroom PowerPoint Facilitator.pptx

D. Neuroscience Flipped Classroom Facilitator Guide.docx

All appendices are peer reviewed as integral parts of the Original Publication.

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