Teaching and Learning in Communication Sciences & Disorders

Volume 3 | Issue 2 Article 6

2019

Bridging the Gap: An Approach to Facilitating Integrated Application of Neuroanatomy and Neurophysiology in Graduate-Level Speech-Language Pathology Across the Semester

Jennine M. Harvey-Northrop
Illinois State University, jmharv2@ilstu.edu

Lisa A. Vinney
Illinois State University, lavinne@ilstu.edu

DOI: https://doi.org/10.30707/TLCSD3.2Harvey-Northrup

Recommended Citation

Harvey-Northrop, J. M., & Vinney, L. A. (2019). Bridging the Gap: An Approach to Facilitating Integrated Application of Neuroanatomy and Neurophysiology in Graduate-Level Speech-Language Pathology Across the Semester. *Teaching and Learning in Communication Sciences & Disorders, 3*(2). DOI: https://doi.org/10.30707/TLCSD3.2Harvey-Northrup

Bridging the Gap: An Approach to Facilitating Integrated Application of Neuroanatomy and Neurophysiology in Graduate-Level Speech-Language Pathology Across the Semester

Abstract

The current study builds upon a previous one that discovered students' knowledge and application of neurological constructs improved following integrated instruction at the beginning of two medically-based, disorder-specific courses (motor speech disorders and aphasia). The current study tracks students' ability to address increasingly more challenging case-based questions across a semester of integrated instruction between the same two disorder-specific courses (motor speech disorders and aphasia). Specifically, students' original rubric-scored case responses, following a foundational integrated review (time 1), were compared to case responses involving differential diagnosis of motor speech disorders (time 2) or aphasias (time 3), and differential diagnosis of both aphasia and motor speech disorders within the same case question(time 4). Comparisons between average rubric scores for each time point revealed significant improvements in content knowledge and application from time 1 to times 2, 3, and 4 and from times 2 and 3 to time 4. Results suggest that integrating foundational course content and case-based activities may enhance or improve students' application of knowledge to case scenarios requiring differential diagnosis of multiple disorder types.

Keywords

Speech-Language Pathology, Integrated Curriculum

Cover Page Footnote

The authors would like to acknowledge the Center for Teaching, Learning, and Technology at Illinois State University for funding this project via a Teaching Innovation Grant.

Silos in Speech-Language Pathology Education: An update

Recently, interest in exploring alternatives to traditional speech-language pathology (SLP) curriculum has gained momentum. Traditional SLP curriculum is often siloed into courses by disorder types (i.e. one course in aphasia, another in motor speech disorders (MSD), etc.) based on the nine major subject areas required for graduate SLP programs by the Council for Clinical Certification in Audiology and Speech-Language Pathology of the Americna Speech-Language Hearing Association (2013). Yet, there is growing evidence that integrating content across courses, rather than separating such content by disorder types, may yield more advanced understanding and clinical application of crucial SLP concepts (Friberg & Harbers, 2016; Vinney & Harvey, 2017).

What is an Integrated Curriculum?

Integrated curriculum is based on the idea that interrelated concepts, foundational to specific disorders, are introduced together (e.g., neurological etiologies underlying swallowing and MSD) to facilitate efficiency in instruction and allow students to identify etiologies that may be common to multiple disorders. Extending this integrated instruction beyond foundational concepts to complex case presentations with multiple disorders allows students to eventually address complex cases effectively in clnical practice. Indeed, literature supports instruction that first exposes students to foundational knowledge of multiple disorder types and then discusses each disorder's clinical presentation separately and together (Snyman & Kroon, 2005).

Support for an integrated curriculum. Integrating curriculum in SLP is supported by a cognitivist view of learning as well as by horizontal and vertical learning integration models (see Vinney & Harvey, 2017). Broadly, horizontal integration is considered " integration of knowledge and skills between clinical subjects" and vertical integration is the "integration of basic knowledge and skills in the clinical context" (Snyman & Kroon, 2005, p. 26). When creating an integrated course experience, horizontal integration is the assimilation of content across courses with vertical integration referring to the applications of content to clinical practice. The need for significant learning experiences through horizontal and vertical integration is supported by reports from practicing SLPs who described difficulty linking foundations in neuroanatomy and neurophysiology to clinical practice until working in the field (Martin, Bessell, & Scholten, 2014).

Integration is also supported by a cognitivist view of learning which focuses on how information is facilitated (Cooper, 1993; Ertmer & Newby, 1993; Mayer, 1997, 2002, 2009). In particular, cognitive and perceptual skills activated during learning can affect how efficiently information is processed (Mayer, 2009; Mayer & Moreno, 2003). Specifically, evidence suggests that information presented through integrated perceptual domains (i.e. auditory and visual), will be better encoded into memory (Clark & Harrelson, 2002; Mayer, 2009).

Pedagogies supportive of an integrated curriculum. Researchers for the current study continue to hold the models detailed above as foundational to the creation of integrated curricular design, but have added the practices of Team-Based Learning (TBL; Sweet & Michaelsen, 2007) and Peer Collaboration (PC; Van Meter & Stevens, 2000) to further shape the integrated pedagogy. Both TBL and PC focus on collaborating with peers to learn new concepts (Van Boxtel, van der Linden,

& Kanselaar, 2000; Van Meter & Stevens, 2000). Further, research indicates that TBL and PC may incorporate students from many different backgrounds in various learning contexts; thereby facilitating cross-disciplinary learning that will support future interprofessional practice (Aarestad & Mowewes, 2004; McInerney, 2003; Meeuwsen, 2002; O'Malley, Moran, & Haidet, 2003; Weeks, 2003).

Previous Investigations of Integration in CSD

The use of integrated curriculum in SLP graduate-level programs appears promising based on recent research (Friberg & Harbers, 2016; Vinney & Harvey, 2017). For example, researchers recently examined whether the integration of foundational neuroanatomy and neurophysiology content across MSD and aphasia courses promoted students' abilities to describe common neurological constructs and apply them to clinical cases (Vinney & Harvey, 2017). Students' responses to case questions were evaluated following their completion of five neuroanatomy and neurophysiology online modules independently and after in-class instructional augmentation of each modules' content. Students' case responses were rubric-scored for how well they exhibited neuroanatomy and neurophysiology content knowledge (CK) and clinical application (CA) of that knowledge to case features. Findings indicated that both CK and CA significantly improved from post-module to post in-class integrated instruction for four of the five module topics.

Despite these findings, further research is needed to explore learning gains related to integration that lasts across a semester of integrated coursework. Specifically, the pilot study, detailed above, examines only integration of foundational information introduced at the beginning of both courses and its application to cases demonstrating basic deficits with an underlying neurological etiology (e.g. difficulty with expressive language, poor coordination). This previous research does not explore students' ability to apply such information to differentially diagnose patients with co-occuring aphasia and MSD.

Current Study

Thus, the current study expanded on the pilot by examining changes in students CK and CA across a semester of integrated instruction via a variety of unique pedagogies. Students were given multiple opportunities to interact with course content through a variety of perceptual domains (Vinney & Harvey, 2017). One example of this integration involved a lab in which partnered students assessed one another demonstrating assigned cranial nerve and language deficits common to patients with MSDs and aphasia. Students were tasked with performing cranial nerve examinations and a variety of standardized language and speech motor assessment tasks on one another. Such a simulated assessment required students to visually and auditorally assess one another, as well as engage in physical (kinesthetic) tasks like assessing the strength of partners' tongue as it was pressed to a tongue depressor. Students taking on the role of the patient, must simulate auditory, visual, and movement characteristics based on their knowledge of their assigned deficit.

Students also had more opportunities to learn from each other (i.e., TBL and PC). During the previously described lab, they worked in pairs to role-play client and clinician. Similarly, the culimating event for this semester-long integrated experience heavily relied on students working

DOI: https://doi.org/10.30707/TLCSD3.2Harvey-Northrup

with one another to address challenging case scenarios. Specifically, students were paired with one another to differentially diagnose a fictional patient (introduced via a written clinical case) presenting with both an MSD and an aphasia. As a diagnostic team, students had to collaborate, just as they might in a clinical setting in order to determine diagnoses and develop a treatment plan to address the deficits presented by their fictional patient.

Most centrally, the current study expands on the pilot by examining changes in students' CK and CA across the semester. Specifically, researchers did not just study students' ability to identify which part or system of the brain was compromised because of a particular speech or language deficit (i.e., expressing language) following integrated instruction. Instead, growth in their ability to use these foundations to differentially diagnose an MSD in a fictional patient and an aphasia in another fictional patient at the mid-point of each semester, and differentially diagnose both an MSD and aphasia in the same fictional patient after a semester of integrated instruction was examined. These features were evaluated during a foundational integrated exam (beginning of both courses; Time 1), during an MSD exam requiring differential diagnosis of MSDs (mid-point of semester in MSD, Time 2), during an aphasia exam requiring differential diagnosis of an aphasia (mid-point of semester in aphasia, Time 3), and during an integrated case-based final exam including patients demonstrating both an MSD and aphasia (end of both course, Time 4). Thus, the purpose of this study was to examine changes in content knowledge and application across a semester that integrated a variety of teaching pedagogies and MSD and aphasia content which researchers hoped to address by answering the following questions:

1. Does students' CK of two disorder types and their neurological underpinnings, improve across the semesters of aphasia and MSD courses?
2. Does students' CA of foundational and disorder-specific knowledge to clinical cases improve across the semesters of aphasia and MSD courses?

Methods

Participants. Thirty-eight graduate students, enrolled in a clinical SLP Master's degree program (Female= 36, Male= 2), participated in this retrospective study. All students were enrolled in aphasia and MSD courses during the Spring 2016 semester at Illinois State University as part of their program of study. All students were at the end of their 1st year in graduate school. To our knowledge, all students had equal opportunity for exposure to aphasia and MSD in their clinical placements. Project approval was granted by Illinois State University's Institutional Review Board.

In order to maintain confidentiality and minimize instructor bias, all student information was redacted by a graduate research assistant prior to retrospective analysis of students' case question responses across the Spring 2016 semester. While the aphasia and MSD courses were assigned to an individual instructor, all integrated materials were co-developed and co-taught by the course instructors as described in the procedures section.

Procedure.

Foundational review. The pilot study examined a foundational review of neuroanatomy and neurophysiology concepts (Vinney & Harvey, 2017). Students were required to complete modules and a survey prior to the beginning of both MSD and aphasia courses, participate in a review of modules spanning both courses, and subsequently complete an integrated foundational exam. More information about module components is provided in the next several sections.

Pre-course module components. Four weeks prior to the beginning of the Spring 2016 semester, fiveneuroanatomy and neurophysiology modules were released on the topics of the brain, brainstem, spinal cord, motor unit, and vascular system. The modules included a (1) narrated lecture; (2) multiple choice and matching questions about module contents; and (3) a set of clinical case questions to allows students to apply foundational concepts. Students were provided with the answer keys to the multiple choice/matching questions, and asked to submit follow-up questions prior to an in-course review starting the first day of Spring semester classes. The pre-course modules were provided well in advance of the semester in order to give students more time to study, manipulate, and apply foundational content essential to the aphasia and MSD courses.

In-course review of modules and foundational exam (Time 1). An in-course review of module content was administered over four course sessions (2 MSD and 2 aphasia class periods). These sessions were co-taught and addressed advanced content and any questions students had about content from the modules. Each review session included CK questions to prime students for case activities and in-class discussion. Finally, an in-class foundational exam (time 1) was administered the second week of class to assess students' mastery of neuroanatomy and neurophysiology content and interpretation. (See Vinney & Harvey (2017) for further details regarding the in-class foundation exam). During retrospective analysis of this exam, clinical questions from each exam were rubric-scored on the parameters of CK and CA. One score for CK and CA was determined per student by averaging CK and CA rubric scores across all case questions. To investigate whether students' ability to identify and describe foundational neuroanatomy and neurophysiology content improved from pre-course module completion to the exam, a rubric was tailored to assessing free responses to case-based questions (Appendix A). Instructors scored each case response from zero to sixteen across the categories of CK and CA. For CK, a score of zero to five indicated that, overall, target foundational CK was not demonstrated in the case response. On the other hand, a score of fourteen to sixteen indicated that, overall, foundational CK was demonstrated throughout the case response. For the second category of the rubric, CA, a score of zero to five indicated that, overall, case features were incorrectly interpreted leading to inaccurate case conclusions (i.e., predictions about resulting deficits from neurological damage). Further, a score of zero to five indicated that integration between foundational knowledge and case features was generally not apparent throughout the case response. A score of fourteen to sixteen in this category indicated that, overall, all case features were correctly interpreted leading to accurate case conclusions (i.e., predictions about resulting deficits from neurological damage). A score of fourteen to sixteen also indicated that integration between foundational knowledge and case features was generally apparent throughout the case response. The rubric categories included a range of scores because all categories were based on the demonstration of CK and CA in a percentage of the case response. For example, score from 0-5 for CK and CA indicated that neither was demonstrated overall. Students might still have up to 25% of their responses demonstrating some appropriate CA and CK, and still fall within this category. Thus, scores accounted for small variations in case responses such that an individual who demonstrated no evidence of CA and CK would receive a zero for both categories. On the other hand, an individual who demonstrated evidence of CA and CK in a quarter of their response would receive a five.

DOI: https://doi.org/10.30707/TLCSD3.2Harvey-Northrup

Applications of the foundational review protocol. Once students completed the foundational review, they continued studies in their individual classes, with integrated application opportunities offered throughout the semester. These additional opportunities provided students with individual and paired experiences via clinical cases and practical clinical skills practice, and connectedconcepts from both aphasia and MSD. Application activities included an integrated neuroanatomy and neurophysiology lab, mid-course assessments containing case questions (Time 2 and Time 3), and an integrated case application final assessment (Time 4).

Integrated neuroanatomy and neurophysiology lab. After the foundational review protocol was completed, and basic concepts of aphasia and MSDs were introduced, instructors implemented an in-class integrated neuroanatomy and neurophysiology lab. As previously noted, this lab provided students with an opportunity to administer a screen similar to a clinical bedside cranial nerve exam. The screen consisted of multiple parts, including a conversational interview, language and cognitive screen screen, and tasks to evaluate cranial nerves I-XII,n. During the lab, partnered students assessed one another demonstrating assigned basic cranial nerve and language deficits common to patients with MSDs and aphasia, but were not asked to demonstrate an MSD or an aphasia. This lab facilitated application of basic neurophysiological etiologies of aphasia and MSD. For example, a student may have been given a deficit to cranial nerve VII. The student was asked to to demonstrate or verbally indicate potential deficits if they did not feel they could “act them out.” (i.e., difficulty producing bilabial sounds). Each student giving the exam would then use his/her knowledge to hypothesize if demonstrated or verbally acknowledged deficits are likely due to an MSD or an aphasia. (See Appendix B for examples of lab components.)

Mid-course application assessment (Times 2 and 3). Following the integrated neuroanatomy and neurophysiology lab, the individual aphasia and MSD courses continued. Each course included a mid-course exam with clinical case application questions focusing specifically on either MSD (Time 2) or aphasia content (Time 3). During retrospective analysis of these exams, clinical questions from each exam were scored using the same previously-described rubric (Appendix A). One score for CK and CA was determined per student for Time 2 (MSD assessment) and Time 3 (aphasia assessment). See Appendix C for examples of mid-course application questions.

Integrated case application final assessment (Time 4). Four weeks prior to the end of the semester, instructors introduced an integrated case-based final (See Appendix D). Pairs of students were provided with anassigned clinical case, which included both motor speech impairments and language deficits. Students were required to review the case studies and create a diagnostic report documenting patients’ case history and assessment results. Then, students were asked to interpret these results to differentially diagnose patients with a specific MSD (e.g., flaccid dysarthria) and aphasia (e.g., Broca’s aphasia). Finally, students created treatment recommendations including long-term and short term goals based on their differential diagnoses and patient background information. Pairs were required to submit a draft of the case history and assessment results two weeks after cases were assigned. The initial draft was reviewed by both instructors and feedback was provided. The second, and final draft of the report included students’ interpretation of assessments towards differential diagnosis of MSD and aphasia, as well as treatment recommendations. The final report was then retrospectively analyzed via both authors. The integrated application final was evaluated for CK and CA using the same rubric implemented to assess the demonstration of these on assessments at times 1, 2, and 3. (See Figure 1 for a timeline of all pedagogical methods that were detailed in the previous sections.)

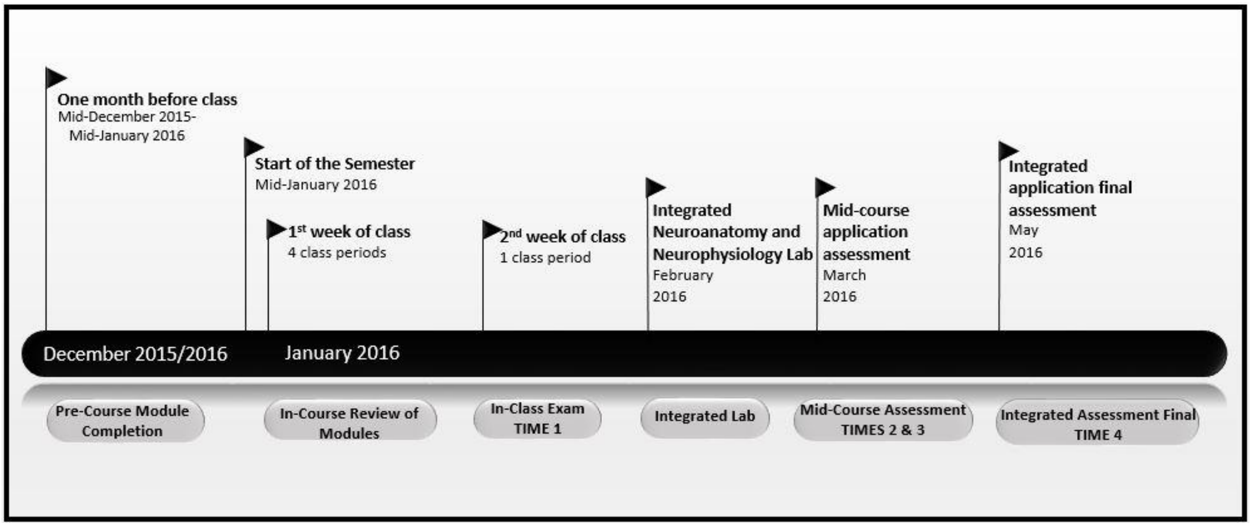

Figure 1. Timeline of Pedagogical Methods.

Quantitative Outcome Measures. Changes in average rubric-scored CK and CA were measured from the integrated foundational exam (time 1) to two mid-course exams in MSD (time 2) and aphasia (time 3) to the integrated case application final (time 4). At time 1, (integrated foundational exam) case study questions from all five module areas (brain, brainstem, spinal cord, neuron, vascular system) were addressed. Because there were five different cases, an overall CK and CA scores were determined by averaging each individual CK and CA score per case. Only one case study was evaluated for CK and CA at times 2, 3, and 4. Thus, a single CK and a single CA score was determined per student at each of these timepoints. In summary, one CK score and CA score was determined for every student enrolled in the MSD and aphasia courses for each of the assessments described from time 1 to time 4 (i.e., foundational exam (time 1), MSD mid-course exam (time 2), aphasia mid-course exam (time 3), and clinical application final (time 4)).

Results

To determine if the rubric-scored dependent variables of CA and CK significantly improved from the foundational integrated exam, mid-semester exams, and integrated case application final, a repeated measures analysis of variance (ANOVA) was performed. Alpha level was set at .05. The analysis indicated significant differences in student performance during applied assessments throughout the semester [Wilks' Lambda $F(6, 208) = 37.74$, $p= <.001$, $\eta2=.521$].

Assessment Analysis.
Content Knowledge. The univariate analysis revealed that there was a significant main effect for CK [$F(3,94.195)= 67.801$, $p= <.001$, $\eta2=.660$, (Greenhouse-Geisser Adjustment)] and CA [$F(3,82.226)= 29.445$, $p= <.001$, $\eta2=.457$, (Greenhouse-Geisser Adjustment)] from Time 1 to Time 4. See Table 1 for mean content scores and absolute differences as well as associated standard deviations by assessments at the four time points across the semester. Specifically, students demonstrated significantly greater CK at Time 2 (mid-course motor speech exam; M= -

7.972, p= <.001) versus Time 1 (integrated foundational exam); Time 3 (mid-course aphasia exam, M= -7.833, p= <.001) versus Time 1; and Time 4 (integrated application final, M= -10.222, p= <.001) versus Time 1. Additionally, significantly greater gains in CK were noted at Time 4 (M= -2.250, p= .018) compared to Time 2 and at Time 4 (M= -2.389, p= .012) compared to Time 3. Participants demonstrated statistically similar performance at Time 2 (mid-course motor speech exam) and Time 3 (mid-course aphasia exam).

Table 1
Mean rubric scores and mean absolute difference scores for responses' content knowledge

Assessments	Means and Standard Deviations	Absolute Change in Rubric Score Pre to Post (Content)
Time 1 vs. Time 2	4.4 (2.9) vs 12.4 (3.7)	8.0**
Time 1 vs. Time 3	4.4 (2.9vs 12.3 (3.1)	7.8**
Time 1 vs. Time 4	4.4 (2.9) vs 14.7 (2.1)	10.2**
Time 2 vs. Time 4	12.4 (3.7) vs. 14.7 (2.1)	2.3*
Time 2 vs. Time 3	12.3 (3.1) vs 12.4 (3.7)	.1
Time 3 vs. Time 4	12.3 (3.1) vs 14.7 (2.1)	2.4*

Note. Mean rubric scores and mean absolute difference scores for responses' content knowledge (16=full demonstration of content knowledge; 0=no demonstration of content knowledge) at Time 1 (integrated foundational exam), Time 2 (mid-course MSD exam), Time 3 (mid-course aphasia exam), & Time 4 (integrated case application final). Stars signal a significant difference in performance between the assessments at differing time points. * p<.05, **p<.001

Clinical Application. Within-subjects contrasts were also conducted to examine the significant effect of CA across assessments. Findings indicate that students demonstrated significantly greater CA at Time 2 (mid-course MSD exam, M= -6.583, p= <.001),versus Time 1 (integrated foundational exam; Time 3 (mid-course aphasia exam; M= -5.333, p= <.001) versus Time 1; and Time versus Time 4 (integrated application final, M= -2.889, p= .004). See Table 2 for mean CA scores and absolute differences as well as associated standard deviations by assessments at the four time points across the semester. Significantly greater CAs was also noted for Time 2 versus Time 4 (M= 3.694, p= <.001). No significant differences in CA were found from Time 2 (mid-course motor speech exam) to Time 3 (mid-course aphasia exam), and Time 3 (mid-course aphasia exam) compared to Time 4 (integrated application final).

Table 2
Mean rubric scores and mean absolute difference scores for responses' content application

Assessments	Means and Standard Deviations	Mean Absolute Difference (Content)
Time 1 vs. Time 2	7.9 (3.5) vs. 14.4 (1.9)	6.6**
Time 1 vs. Time 3	7.9 (3.5) vs. 13.2 (4.4)	5.3**
Time 1 vs. Time 4	7.9 (3.5) vs. 10.8 (3.0)	2.9*
Time 2 vs. Time 4	14.4 (1.9) vs. 10.8 (3.0)	3.6*
Time 2 vs. Time 3	14.4 (1.9) vs. 13.2 (4.4)	1.2
Time 3 vs. Time 4	13.2 (4.4) vs. 10.8 (3.0)	2.4

Note. Mean rubric scores and mean absolute difference scores for responses' content application (16=full demonstration of content application; 0=no demonstration of content application) at Time 1 (integrated foundational exam), Time 2 (mid-course MSD exam), Time 3 (mid-course aphasia exam), & Time 4 (integrated case application final. Stars signal a significant difference in performance between the assessments at differing time points. * $p<.05$, ** $p<.001$

Discussion

The current study investigated changes in students' CK and CA across a semester of graduate MSD and aphasia courses including integrated instruction and activities. Study findings revealed that both CK improved across the semester, but that CA analysis revealed improvements in CK across the semester from the integrated foundational exam (Time 1) to the integrated case application final (Time 4). While there was a significant improvement in CK from Time 2 to Time 4, and Time 3 to Time 4, there were no significant differences in CA and CK between mid-course MSD (Time 2) and aphasia (Time 3) assessment case questions. This finding may suggest that the knowledge and application of knowledge integrated across the semester did not disproportionately increase in one course area over the other.

Students' CA of content to clinical cases significantly improved from the integrated foundational exam (Time 1) to the final (Time 4). Opportunities to integrate and apply information to clinical cases and practice skills collaboratively with peers across MSD and aphasia courses may have facilitated overall gains in CK and CA. No differences in CA were found between the mid-course MSD and aphasia exam case questions at Times 2 and 3. Data further suggests that application skills from the mid-course aphasia exam (Time 3) to the integrated application final (Time 4) declined, although not significantly. On the other hand, CA declines from Time 2 to Time 4 were significant. These data suggest that students may have experienced challenges with horizontal integration of aphasia and MSD. Prior to time 4, all assessments either examined these disorders' overall neurobasis or considered case information successfully. When students were tasked with differentially diagnosing and making sense of a full patient case history, their performance declined, likely because of the complexity of the task. Perhaps, students required additional time and practical application in the field in order to surpass application scores related to case-based questions that only integrated one disorder type like those at times 2 and 3. Additionally, the similar CA and CK at Times 2 and 3 were expected, given that students were progressing similarly in both Aphasia and MSD. These assessments also occurred within a few days of one another so there was likely minimal time for growth in either area.

Study Limitations

Similar to limitations in the initial pilot study (Vinney & Harvey, 2017), it is not clear whether the integrated curricular features influenced gains in CA and CK from Time 1 to Time 4 or whether the determined gains were simply a result of traditional learning that occurred across the course of the sixteen-week semester. Additionally, while overall improvement occurred from Time 1 to Time 4, application of concepts from time 2 to time 4 declined. It is theorized this likely occurred because students were applying concepts at a much higher level, considering factors of the complex case together, instead of insolation. This difference in performance warrants further investigation. Future research should isolate individual integrative components to examine whether a specific feature of instruction led to the significant growth noted. Investigation of individual integrative components would be further enhanced by including a comparison control group. Further the rubric-based scoring methods required some interpretation of CK and CA mastery by both instructors. Therefore, instructors scored each case together and discussed any disagreements about scoring until agreement was reached, some level of subjectivity may have been introduced into the findings. Additionally, the rubric ranges were designed for course grading, allowing multiple point opportunities for different levels of skills. While this design was helpful for student's scoring and feedback, it may not have been best for research analysis and interpretation. That being said, the researchers consider their methods to be ecologically valid and likely typical for the type of assessment the might be done to examine integrated methods across multiple instructors.

Curricular Integration in Related Fields

The pedagogical methods described here focused on horizontally integrating interrelated disorder content and providing opportunities for vertical integration via clinical case studies. The discussion of implementing integrated curricular methods within CSD is, to the researcher's knowledge, unique to the discipline. While, the use and implementation of integrated curricular models have received little attention in CSD; medicine, dentistry, and other health science disciplines have discussed its potential pros and cons for over 35 years (Cohn, Coster, & Kramer, 2011; Elangovan et al., 2016; Harden, Sowden, & Dunn, 1984; Howard, Steward, Woodall, Kingsley, & Ditmyer, 2009; Husband, Todd, & Fulton, 2014; Lam, Irwin, Chow, & Chen, 2002; Malik & Malik, 2011; Pfeifer, 2018; Rosse, 1974).

Advocates for integrated curricular reform have identified a lack of vertical and horizontal integration during the first two years of medical and dental schools (Howard et al., 2009; Pfeifer, 2018). Scholars suggest that curricular re-design that focuses on both may provide multiple benefits. Specifically, curricular integration may help trainees define and work towards a potential specialty area earlier and with greater certainty, decrease their tuition costs and time in medical/dental schools, and allow them to connect normal bodily functions and disease together immediately by learning about them simultaneously rather than separately (Pfeifer, 2019). Other health science scholars have examined explicitly integrating core skills like evidence-based clinical reasoning and general healthcare and business practices across course sequences, rather than expecting them to be picked up during practica and field experiences (Cohn et al., 2014; Howard et al., 2009).

That being said, much of the literature on curricular integration in the health sciences fields is heavily focused on student or faculty perceptions of these practices; or similar to our research here, supports integrated pedagogical approaches' association with better retention of information and its application within a small segment of a class or a program (Husband et al., 2014; Lam et al., 2002, Pearson & Hubball, 2012; Rosse, 1974). Thus, no data exists to support a fully integrated curriculum's promotion of better clinical practice.

Although there is much work to be done to fully and carefully evaluated and model integrated curriculums in the health sciences, it is worth considering how curricular integration may address challenges in our disciplines. In particular, SLPs' scope of practice continues to widen, despite the relative brevity of SLP graduate programs. As a result, knowledge and skills are often learned on-the-job, after students' degree program has ended. Integration of clinical experiences and disorder-based coursework earlier may set students up to become more competent and prepared clinicians.

Reflection from Instructors' Perspective

The integrated curriculum described here required rigorous curriculum design and coordination between instructors. Specifically, instructors coordinated course scheduling and timing of integrated course content, labs, and assessments across the semester. This kind of close coordination has been described as a challenge in other health sciences disciplines that have attempted integration also, and the time and structure required to facilitate full or partial integration should be considered when attempting to modify curriculum in this way (Cohn et al., 2011; Howard et al., 2009).

Following instructors previous experiences in integrated foundational review, the introduction and implementation of the cross-course integrated curriculum was well-received by the students. While the students found the integrated content challenging, they appreciated learning about integrated foundations, applications, and complex cases from both instructors. Students also, appreciated having joint office hours and opportunities for feedback from both instructors. While the integrated curriculum was a challenge to design and schedule, the gains observed in the student's knowledge and application, as well as the anecdotal difference in skill compared to cohorts that did not receive the cross-course integrated curriculum, is a significant motivator and validation for the instructors to continue this new curriculum design.

Considerations for Curriculum

Findings from this and other integrated projects (Friberg & Harbers, 2016; Vinney & Harvey, 2017), supported an extensive three-year process to implement horizontal and vertical integration

DOI: https://doi.org/10.30707/TLCSD3.2Harvey-Northrup

across the graduate-level SLP curriculum at Illinois State University. Specifically, disorders with similar foundations (i.e. neurologic or developmental) are now introduced together foundationally and are then discussed across the lifespan with integration of cross-course clinical experiences. For example, the curriculum now includes a course focusing on the advanced neurological bases of communication and swallowing disorders followed by an introduction to dysphagia and MSD topical areas. The new curriculum is in its second year of implementation, and further research into the success of its integrated components and student learning outcomes are a major focus of faculty members. Further, SLP curriculum may benefit from integrated concepts across the content areas, including development, aging, and lifespan. From a holistic perspective, this may allow instructors to overtly discuss and apply the same concepts across different content areas. This does not necessarily require a complete curricular revision. However, close communication between instructors will ensure that overlap between course foundations and disorder types is creatively addressed through integrated instruction or explicit discussion within and across courses. Such efforts may also bridge potential knowledge gaps for students who have difficulty examining complex cases with multiple overlapping etiologies resulting in multiple speech and language deficits.

Disclosure Statement
The authors would like to acknowledge funding for this work via two teaching and learning innovation grants from the Center for Teaching and Learning at Illinois State University.

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Appendix A: Clinical Case Response Rubric

CATEGORY	Demonstrated Overall (14-16)	Moderately Demonstrated (10-13)	Marginally demonstrated (6-9)	Not Demonstrated Overall (0-5)
Content Knowledge	Foundational content knowledge is demonstrated in over three-quarters of the case response.	Foundational content knowledge is demonstrated in a half to three-quarters of the case response.	Foundational content knowledge is demonstrated in a quarter to a half of the case response.	Foundational content knowledge is demonstrated in less than a quarter of the case response.
Content Application	Over three-quarters of case information is interpreted correctly and integrated with foundational content knowledge. Over three-quarters of conclusions are accurate.	Half to three quarters of case information is interpreted correctly and integrated with foundational content knowledge. Half to three-quarters of conclusions are accurate.	A quarter to a half of case information is interpreted correctly and integrated with foundational content knowledge. A quarter to a half of conclusions are accurate.	Less than a quarter of case information is interpreted correctly and integrated with foundational content knowledge. Less than a quarter of conclusions are accurate.

Appendix B: Examples of Integrated Lab Components

DOI: https://doi.org/10.30707/TLCSD3.2Harvey-Northrup

Examples for the conversational interview and language screen tasks from Helm-Estabrooks (2004) Appendix 10. A Suggestions for an Informal Exam

1. Conversational Interview
   a. What happented to you?
   b. What problems are you having now?
   c. What did (do) you do for a living?

2. Language Screen
   a. Auditory comprehension skills
      i. Sit up straight.
      ii. Close your eyes.
      iii. Point to the floor and the exit.
   b. Naming skills
      i. What do you call these?
         1. Watch, band, numbers, buckle
   c. Repetition skills
      i. Repeat after me
         1. Pizza, One hundred seventy-two, Happy hippopotamus
   d. Reading skills
      i. Show the following printed words,one at a time, for identification. Indicate to point to body parts:
         1. Nose, cheek, elbow, lungs
   e. Writing skills
      i. Place paper pad in front of patient and give him or her a pen. Indicate object or part and ask patient to write names:
         1. Watch, buckle, jacket, cuff

3. Neurological Examination
   a. Observation of Oral Anatomy
   b. Digital Manipulation
   c. Examination of the Cranial Nerves During Non-speech Activities
      I. Cranial Nerves
         A. Vth (Trigeminal)
         1. “Bite down hard.” Palpate temporalis and masseter muscles.
   d. Reflexes
      1. <u>Palatal Reflex</u> -Stroke the soft palate with a firm Firmly stroke tongue blade or laryngeal mirror down the soft palate from anterior/superior to posterior/inferior (Soft palate should contract bilaterally)
   e. Examination of the Speech Mechanism During Speech Activities
      A. Connected Speech:
         1. Conversation. If you can engage the patient in conversation do so.
         2. Reading. Any standard passage, Rainbow, Grandfather, will do

4. Cognitive Screen

a. Mini-Mental State Examination
b. Montreal Cognitive Assessment

Appendix C: Examples of Mid-Course Application Questions

1. Aphasia Mid-Course Question
    a. You are evaluating a patient using the Bedside Examination Protocol. Upon asking Mr. Smiles to describe "what happened to him?", he begins to speak loudly with many jargon and neologistic words. He begins gesturing towards the door. When you indicate that you don't understand him, he begins to become visibly frustrated. When you attempt to redirect his attention, he repeats the same nonsense words. He is not successful for phonemic, visual, or written cuing. Below is an example of his discourse sample:
        i. "The grapty gone go. Yep, the grapty go. I, yep, droxy, gone go. Let's go grapty. Let's go. I go vroom grapty. Them to. Com'in grapty gone go. "
            1. Based on the information given, what type of language and cognitive subtests would you plan to administer with this patient? Why?
            2. What type of differential diagnosis might you expect? Why?

2. MSD Mid-Course Question
    a. Walter White is a 52 year old male. He accidentally hit the caudal portion of his skull on the corner of the table, while falling back out of a chair in his "lab." Dr. Pinkman, the neurologist, noted that Walter's MRI scans exhibited significant damage to his cerebellum. What types of patient complaints, salient neuromuscular features, and deviant perceptual characteristics might be expected?

Appendix D: Example of an Integrated Case

Patient Chart

Name: Adam Smith

DOB: November 18th, 1956

Date of Evaluation: April 28, 2014

I. Background Information
   a. Current Diagnosis: Myasthenia Gravis
   b. Medical History: Early onset Myasthenia Gravis, Type 1 Diabetes, and Rheumatoid arthritis
   c. Neurological Report: Decreased Acetylcholine receptor antibodies. Chest x-ray clear. CT scan clear. Vital capacity of lungs greatly reduced.
   d. Patient and Family Report: Began displaying problems in June 2000 with drooping eyelids bilaterally and difficulty with arm and leg movements. Patient was a high school music teacher but is now retired. The patient's wife reports "he likes to crochet and play Wii on his good days, but he doesn't like to go to poker night anymore". Additionally, his wife noted the patient has increased difficulty with movement of the Wii controller. Last week, Mrs. Smith noted that he tires easily and has more significant deficits in speaking and swallowing. His wife has reported 8 falls in the last 6 months.
   e. History of swallowing disorder: Started approximately 10 weeks ago. Patient describes coughing frequently after meals.
   f. Presence, type duration, and method of placement of any airway device: N/A
   g. Respiratory status: WNL, rate at rest – 14 breaths per minute, swallows on exhalation, can hold breath for 1,3,5 seconds
   h. Nutritional status:
      i. Current diet: Regular foods
      ii. Liquids: Thin liquids
      iii. List any problems and/or diet restrictions: Patient prefers chopped foods and pudding consistencies.
   i. List current Medications: Prednisone, Mycophenolate, and Azathioprine
   j. Presence, type, duration of placement, adequacy, and complications of oral and non-oral feeding methods: N/A
   k. Physical observations: Generalized weakness and fatigue with activity

II. Motor Speech & Perceptual Examination Observations
   a. Moderate hypernasality
   b. Breathy voice with a consistently wet voice quality
   c. Short phrases
   d. Jaw hangs open at rest
   e. Unable to resist examiner attempt to open/close jaw

f. Reduced lingual and labial ROM
g. Ptosis with drooped eyebrows and eyelids
h. Reduced soft palate movement
i. Reduced loudness
j. Reduced articulatory precision
k. Decreased accuracy & speed for AMRS
l. Tongue fasciculations

III. Language & Cognitive Examination Observations

a. Decreased initiation of conversation
b. Conversational length of 3-4 words
c. Decreased judgment
d. Reduced cognitive flexibility and working memory
e. Decreased planning
f. Increased anxiety and frustration when speaking
g. No anomia present
h. Moderately impaired repetition
i. Auditory comprehension within functional limits