HOW WE TEACH | Generalizable Education Research

Vertical integration of head, neck, and special senses module in undergraduate medical curriculum

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Arain SA, Kumar S, Yaqinuddin A, Meo SA. Vertical integration of head, neck, and special senses module in undergraduate medical curriculum. Adv Physiol Educ 44: 344–349, 2020; doi: 10.1152/advan.00173.2019.—Vertical integration is believed to increase motivation by providing context for the learning. In this quasi-experimental study, cohort I took two horizontally integrated modules: structure and function of head, neck, and special senses in the second year, and pathophysiology and clinical sciences in the third year. Cohort II took a combined, vertically integrated module in the second year. Data from the questionnaire and examination scores were compared. Response rate was 80.1% (125/156) for cohort I and 57.6% (98/170) for cohort II. Response to the statement that vertical integration provides context to basic sciences was mixed with a higher agreement in cohort II (51.5 vs. 37.2%; P = 0.04). Cohort II was least satisfied with the appropriateness of self-study time (52.0 vs. 34.7%; P = 0.01). However, cohort II felt that the basic sciences lectures (90.8 vs. 69.4%; P < 0.01) and the clinical skills sessions (85.7 vs. 62.1%; P < 0.01) were more effective. Cohort II was less satisfied with clinical lectures (80.6 vs. 56.1%; P < 0.01) and was less confident in achieving clinical learning objectives (72.8 vs. 40.8%; P < 0.01). Mean multiple-choice questions and problem-based learning scores were similar. However, the short-answer question score was higher for cohort I [82.48 (SD 14.9) vs. 70.74 (SD 17.9); P < 0.01]. Overall, the idea of early vertical integration had a mixed response. It improved the effectiveness of basic sciences lectures and clinical skills sessions. Achievement of clinical learning outcomes was compromised. A disparity in the module’s duration and curricular content, and students’ ability to grasp clinical concepts and faculty’s expectations are the possible reasons. Increased duration and better communication with clinical faculty may improve early introduction of vertical integration.

The characteristic of the adult learners, in particular relevance to medical education, is their interest in meaningful learning. Thus learning is most effective when the organization of the knowledge matches its application (14). Besides, early clinical exposure increases students’ motivation, provides context for integration of theory with practice, and improves knowledge construction, the clinical reasoning, and acclimation to clinical environment (5, 7). Consequently, traditional curricula comprising distinct discipline-based courses are being replaced by integrated curricula.

Horizontal integration represents integration across the courses taught within the same period, whereas vertical integration is integration across time involving basic and clinical sciences (4). At Alfaisal University, until recently, the entire curriculum was divided into three horizontally integrated phases. Phase I (years 1 and 2) included longitudinal courses on structure and function. Phase II (year 3) consisted of organ system-based modules incorporating preclinical and clinical curricular contents, whereas phase III (years 4 and 5) comprised clinical rotations. Keeping with emerging trends, the curriculum committee decided to integrate phase I and phase II curricular content. Accordingly, the Head, Neck, and Special Senses (HNS 242) module was developed and was offered in the second year of the undergraduate medical curriculum.

At present, horizontal integration of body systems is widely adopted; however, vertical integration is often limited to introducing broader clinical content in earlier years to provide context for the learning of basic sciences (1, 21). Conversely, we included learning outcomes related to the advanced ophthalmology and otolaryngology curricular contents, along with preclinical and basic sciences, and all those learning outcomes were assessed.

The present study compared the perception and performance of the students in the two curricular formats of head, neck, and special senses content.

METHODS

Ethical approval. This study was approved by Institutional Review Board, College of Medicine Alfaisal University, Riyadh, Saudi Arabia (ref. no. ORG/CMB/2014/036), and written, informed consent was obtained from the participants.

Study design. At Alfaisal University College of Medicine, the Bachelor of Medicine-Bachelor of Surgery (MBBS) course is completed in 5 yr in a spiral fashion with a gradual “basic to clinical” shift. In this quasi-experimental study, 326 students were enrolled; 156 in
cohort I and 170 in cohort II. Cohort I was offered two horizontally integrated modules: structure and function of head, neck, and special senses, as part of a longitudinal course in the second year, and pathophysiology and clinical sciences, as a 4-wk-long organ-based module in the third year. Cohort II took a combined, vertically integrated module in the second year. The study design is summarized in Fig. 1.

A multidisciplinary committee developed an organ-based, vertically integrated module [Head, Neck, and Special Senses (HNS 242)] for cohort II. Adopting a constructivist perspective, the committee reviewed learning objectives and devised learning strategies 1) to include clinically relevant concepts of basic sciences omitting structural details; 2) to help students recognize the relevance of basic sciences with pathophysiology and clinical aspects of otolaryngology and ophthalmic disorders; 3) to provide an early clinical experience (2, 3); and 4) to promote small-group learning (19).

The newly made module was offered over 4 wk. Longitudinal anatomic regional themes were identified to run over each week. Clinical cases in the form of problem-based learning (PBL) were introduced on the first day of each week with reporting sessions toward the end of the week, covering major learning objectives related to the weekly themes. PBL sessions were conducted in line with the PBL pedagogy (23). Other learning strategies included lectures and clinical skills sessions. Students were exposed to clinical skills through mannequins, simulated patients, and hospital visits, with focus on adopting the appropriate clinical methods. Basic sciences lectures and PBL sessions were facilitated by trained faculty members from basic and preclinical sciences. Clinical lectures were delivered by the clinical faculty from ophthalmology and otolaryngology.

End-of-module examinations consisted of multiple-choice questions (MCQs) and short-answer questions (SAQs). In SAQs, clinical vignettes were followed by three to four questions based on the clinical data. The questions were open ended but structured, requiring synthesis of the clinical data to create short, focused responses. The responses were graded by matching them with the standard answers. The content of the examination components was based on the table of specifications to ensure validity. Moreover, PBL scores, given by the facilitators through a structured evaluation proforma, contributed as continuous assessment.

Data collection and statistical analysis. Both direct and indirect assessment of student learning was used as the outcome measure. At the end of the module, students from both of the cohorts were requested to fill out a validated self-administered questionnaire consisting of two components: a 5-point Likert scale and open-text comments. Moreover, scores for each examination component (MCQs, SAQs, and PBLs) were obtained from the assessment office. Clinical skills were assessed separately through structured clinical examination (not included in this study).

Likert-scale scores of both of the cohorts were compared. “Strongly agree” and “agree” were taken together to calculate percent agreement for each item on the questionnaire and were compared using chi-square test. Besides, mean scores of the two cohorts for different components of the module examinations were compared using the independent t test. The level of significance was assumed at $P < 0.05$ in all cases. Qualitative data in the form of free-text comments were reviewed and analyzed inductively, and similar comments were grouped as themes. Representative statements are reported for each theme.

RESULTS

A total of 326 students were enrolled across the two modules. In cohort I, 156 students were registered and 125 (80.1%) responded, and, out of 170 students in cohort II, 98 (57.6%) responded. Table 1 depicts and compares students’ ratings based on their Likert-scale scores. Findings are described briefly in the following paragraphs.

Perception of vertical integration. Agreement to the statement that vertical integration provides context to concepts of the basic disciplines was not very high; however, it was significantly higher in cohort II (51.5 vs. 37.2%; $P = 0.04$). In
both of the cohorts, a majority of the students (61.8 vs. 56.7%) agreed to the statement that early patient exposure stimulates learning. Similarly, 56.1% of the students in cohort I and 50% in cohort II agreed that early patient exposure will help perform better in clinical years.

Execution of the module. Although an agreement to the statement that appropriate time was given for self-directed learning was low in both of the groups, it was significantly lower for cohort II (52 vs. 34.7%; P < 0.01). Other statements unfavorably rated by cohort II students were regarding clinical content; lectures were at the student level (66.4 vs. 44.9%; P < 0.01), and emphasis was appropriate (74.4 vs. 54.2%; P < 0.01). Importantly, only 40.8% of the students in cohort II were confident that they had achieved clinical learning objectives effectively, compared with 72.8% of the cohort I students (P < 0.01).

Learning strategies. There was a strong agreement for the effectiveness of PBL in both of the cohorts (Fig. 2). However, 90.8% of students in cohort II felt that the basic sciences lectures helped them to achieve the module learning objectives, compared with 69.4% in cohort I (P < 0.01). Similar results were found with clinical skills sessions, with the higher agreement in cohort II (85.7 vs. 62.1%; P < 0.01). In contrast, a higher number of cohort I students provided positive ratings for clinical lectures (80.6 vs. 56.1%; P < 0.01).

Open-text comments. Eighty-seven students from cohort I and 91 from cohort II offered 848 comments. Indicative comments were summarized combining similar statements and are shown under six emergent themes with their frequencies (Table 2).

Examination grades. Mean MCQ scores [69.85 (SD 12.7) and 69.85 (SD 13.5)] and PBL scores [89.56 (SD 12.3) and 87.02 (SD 16.0)] were similar (Table 3). However, cohort I students scored higher in the SAQ component [82.48 (SD 14.9) vs. 70.74 (SD 17.9); P < 0.01], resulting in their higher final scores. Out of 155 students who took the examination in cohort

![Fig. 2. Students’ agreement for effectiveness of learning strategies. PBLs, problem-based learning sessions. *Percent agreement is significantly different between the two cohorts.](image-url)
Table 2. **Representative statements from the open-comments arranged as recurring themes**

| Themes                             | Indicative Comments                                                                 |
|------------------------------------|-------------------------------------------------------------------------------------|
| The usefulness of vertical integration | Will be too hard for the students to comprehend both basic and clinical sciences at the same time (57/82) | Overall it was hard (34/76)                                                                 |
| Time of implementation             | Never too early to introduce concepts; it is just that the assessment must be fair to the student level (37/80) | Too early to implement integration (46/74)                                              |
| Overall execution                  | Time was fairly distributed between basic and clinical teaching (33/66)                | Good idea, bad organization! (31/71)                                                    |
| Clinical teaching/learning         | Some clinical lectures were beyond the objectives, using too much clinical and surgical details (16/60) | Clinicians really didn’t know what our current level of knowledge was, and clinical lectures were too complex and overwhelming (26/71) |
| Assessment                         | End-of-module examination was fair (31/47)                                           | Examination was too challenging (24/71)                                                  |
| Suggestions to improve             | Increase duration of the module (34/66)                                               | Increase duration of the module (44/78)                                                  |

Values are the no. of similar comments under the theme out of the total no. of comments. Note: Cohort I was instituted the questionnaire, asking their opinion about vertical integration without being exposed. Cohort II was instituted the questionnaire after being exposed to vertical integration.

I, 151 (97.4%) completed the module successfully, whereas, out of 164 students in cohort II, 145 (88.4%) completed the module successfully.

**DISCUSSION**

Notable among the curricular reforms all over the world is the integration of curricular content to ensure a holistic approach and facilitate meaningful learning (4, 22). At Alfaisal University College of Medicine, horizontally integrated head, neck, and special senses curricular content offered in years 2 and 3 was vertically integrated into one module and was offered toward the end of the second year. Relevant learning objectives of the clinical disciplines like ophthalmology and otolaryngology were integrated into the new module.

Overall, there was a mixed response, and students seemed cautious in both of the cohorts to support the idea of vertical integration at this stage in the curriculum. From cohort I, 37.2% of students thought that vertical integration would provide context to the concepts of basic sciences. A significantly higher number of students (51.5%) from cohort II agreed that early vertical integration provided context to understanding concepts of basic disciplines. This apprehension was also apparent in the free-text comments from both of the cohorts. These results are not in agreement with some earlier studies reporting better perception for vertically integrated modules (9, 21). However, unlike our study, Vashe et al. (21), used vertical integration only for contextual learning of basic science disciplines and did not assess clinical content. Similarly, Ghosh and Pandya (9) did not assess advanced clinical concepts in their study. Besides, in the later study, when students were asked whether vertical integration would help them perform better in university examinations, only 36% agreed. On the other hand, students rated vertical integration lower than horizontal integration in other studies, corroborating our findings (12, 13). This finding may be reflective of apprehension, as inexperienced students find it difficult to comprehend and link complicated concepts from different sources (20).

The satisfaction score of cohort II was significantly lower for the content of clinical lectures and module examinations. Besides, fewer students were confident that they achieved clinical learning objectives effectively. A possible reason could be cognitive overload due to the shorter duration of the module affecting perception with unfavorable learning outcomes (8). This possibility is supported by the fact that the students in cohort II showed the least agreement with the statement that there was an appropriate time for self-learning. This finding was further emphasized by the fact that many students suggested, in open-text comments, extending the duration of the module (Table 2). It is known that an appropriate teaching-learning environment requires a balanced workload at the right level with clear objectives (24). Duration of the module for cohort II was kept at 4 wk, as content of the basic sciences was reduced by including only clinically relevant structural details and the fact that only a 4-wk slot was available in the semester time frame.

Moreover, lower satisfaction could be due to a lack of orientation of clinical faculty about the placement of the module. Most of the clinical faculty had been involved in either training of the residents or undergraduate students in advanced semesters. Their interaction with students of year 2, who have limited clinical knowledge, was not an easy task. A large number of students thought the best way to “vertically integrate

Table 3. **Comparison of scores for examination components**

| Examination Components | Cohort I (n = 155) | Cohort II (n = 164) | P Value |
|------------------------|--------------------|---------------------|---------|
| PBL                    | 89.56 (12.3)       | 87.02 (16.0)        | 0.11    |
| MCQs                   | 69.85 (12.7)       | 69.85 (13.5)        | 0.99    |
| SAQs                   | 82.48 (14.9)       | 70.74 (17.9)        | <.01    |

Values are means (SD); n, no. of students. All scores are shown as the mean out of 100. MCQs, multiple-choice questions; PBL, problem-based learning; SAQs, short-answer questions.
the experience” was to, in fact, horizontally address the topics (Table 2). This response from the students possibly reflects their apprehension due to inability to grasp clinical concepts, as they were not integrated with basic science concepts and were delivered before any consolidated basic science concepts. In fact, based on the feedback from Table 2, it seems likely that the clinical faculty was trying to deliver more advanced concepts than what was required for the level of students.

Early exposure to clinical curricular content in cohort II consisted of clinical lectures, PBL, and clinical skills sessions. Both cohorts showed a strong agreement for the effectiveness of PBL sessions. Moreover, cohort II was better satisfied with basic sciences lectures and clinical skills sessions. Introduction to the clinical content might have improved context for the learning of basic sciences and clinical skills. Besides, the clinical skills sessions were well accepted by cohort II students possibly due to a better structure; use of multiple modalities including simulation laboratory, standardized patients and hospital visits and the fact that all the tasks were structured based on detailed checklists (11). For cohort I, clinical skills consisted of hospital rotations only.

Mean MCQ and PBL scores were comparable in both the cohorts. SAQ score was significantly low in cohort II. SAQ consisted of a clinical vignette, followed by questions requiring synthesis of clinical data. Interpretation of clinical data was modeled through discussions based on clinical-case scenarios in PBLs and lectures. It appears that those learning strategies were not sufficient to develop the skill of clinical data interpretation, due to lack of either time or motivation. Thus increasing the duration of block, as well as more extensive data interpretation exercises, especially those involving bed-side interactions, is likely to improve outcome through enhanced motivation and interpretation skills.

Faculty specialized in certain disciplines who participate in the delivery of the integrated curriculum may support content integration to a certain extent, but sometimes their focus, while delivering the integrated content, is more on their related disciplines. It is important to develop a common philosophical understanding for the need of clinical experience at this stage, teaching-learning strategies, and outlining of responsibility. Curriculum reforms involving vertical integration with the participation of the clinical faculty will be enhanced by improved communication between students, basic sciences, and clinical faculty about the learning expectations. Besides, faculty training and careful selection of clinical curricular content, guided by effectively mapped learning objectives, provide a robust basis for successful curriculum integration (5, 10, 13, 15).

**Study limitations.** The quasi-experimental study design is one of the limitations, as students from different cohorts are likely to have a different teaching and learning experience in a changing environment (6). Besides, availability of only a 4-wk slot in the semester time frame for cohort II might have affected the outcome. However, during the study period, the curriculum remained stable, except for the changes mentioned in the METHODS section. Furthermore, data were obtained through a self-administered questionnaire, and results mainly rely on students’ perception. Although this is not considered the most reliable method of information, the students’ perception is indeed an accepted and useful method in measuring the effectiveness of academic innovations. An anonymous survey was used that is more likely to produce candid responses (17, 18). Additionally, students’ perception was supported by their performance in examinations.

The response rate was low in cohort II. We are not aware of the reasons, but it may be reflective of this cohort feeling low due to lack of confidence in achieving clinical learning objectives effectively, as this survey was conducted just after module examination. Furthermore, data collected from cohort I students carry a possibility of recall bias, as they were asked to reflect on their experience with a time lag of about 4 mo. However, the questionnaire was developed using a simple Likert scale, focusing on different components of the module to help students better evoke each element.

**Conclusions.** We conclude that the idea of early vertical integration had a mixed response from both of the cohorts. However, it improved the effectiveness of basic sciences lectures and clinical skills sessions. Achievement of clinical learning outcomes was compromised. A disparity in the duration of module and curricular content, resulting in cognitive overload, and a mismatch between students’ ability to grasp early introduced clinical concepts and expectations of the faculty are the possible reasons. We recommend that early vertical integration can be further improved by 1) effective curriculum mapping to accurately connect learning expectations at all levels; by 2) a careful consideration for the duration of module to allow for internalization of vertically integrated concepts and effective clinical-data interpretation exercises; and 3) enhanced communication with clinical faculty while planning and delivering the reformed curriculum. To gain more insight into the learning from early clinical exposure, further studies should be carried out after incorporating the suggested changes to seek the perception of students and faculty for this form of learning.

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**DISCLAIMERS**

The authors are responsible for the content and writing of this article.

**DISCLOSURES**

No conflicts of interest, financial or otherwise, are declared by the authors.

**AUTHOR CONTRIBUTIONS**

S.A.A. conceived and designed research; S.K. analyzed data; A.Y. interpreted results of experiments; S.K.A. and S.A.M. drafted manuscript; S.A.A., A.Y., and S.A.M. edited and revised manuscript; S.A.A., S.K., A.Y., and S.A.M. approved final version of manuscript.

**REFERENCES**

1. Bandiera G, Kuper A, Mylopoulos M, Whitehead C, Rutetalo M, Kulasegaram K, Woods NN. Back from basics: integration of science and practice in medical education. Med Educ 52: 78–85, 2018. doi: 10.1111/medu.13386.
2. Başak O, Yaphe J, Spiegel W, Wilm S, Carelli F, Metsemakers JF. Early clinical exposure in medical curricula across Europe: an overview. Eur J Gen Pract 15: 4–10, 2009. doi:10.1080/13814780902745930.
3. Bates J, Ellaway RH. Mapping the dark matter of context: a conceptual scoping review. Med Educ 50: 807–816, 2016. doi:10.1111/medu.13034.
4. Brauer DG, Ferguson KJ. The integrated curriculum in medical education: AMEE guide no. 96. Med Teach 37: 312–322, 2015. doi:10.3109/0142159X.2014.970998.
5. Diemers AD, Dolmans DH, van Santen M, van Luijk SJ, Janssen-Noordman AM, Scherpbier AJ. Students’ perceptions of early patient encounters in a PBL curriculum: a first evaluation of the Maastricht experience. *Med Teach* 29: 135–142, 2007. doi:10.1080/01421590601177990.

6. Eccles M, Grimshaw J, Campbell M, Ramsay C. Research designs for studies evaluating the effectiveness of change and improvement strategies. *Qual Saf Health Care* 12: 47–52, 2003. doi:10.1136/qhc.12.1.47.

7. Ferey JE, Bui DT, Townsend D, Sureshkumar P, Carr S, Roberts C. Predictors of confidence in anatomy knowledge for work as a junior doctor: a national survey of Australian medical students. *BMC Med Educ* 18: 174, 2018. doi:10.1186/s12909-018-1280-5.

8. Fraser K, Ma I, Teteris E, Baxter H, Wright B, McLaughlin K. Emotion, cognitive load and learning outcomes during simulation training. *Med Educ* 46: 1055–1062, 2012. doi:10.1111/j.1365-2923.2012.04355.x.

9. Ghosh S, Pandya HV. Implementation of integrated learning program in neurosciences during first year of traditional medical course: perception of students and faculty. *BMC Med Educ* 8: 44, 2008. doi:10.1186/1472-6920-8-44.

10. Khalil MK, Kibble JD. Faculty reflections on the process of building an integrated preclerkship curriculum: a new school perspective. *Adv Physiol Educ* 38: 199–209, 2014. doi:10.1152/advan.00055.2014.

11. Lujan HL, DiCarlo SE. First-year medical students prefer multiple learning styles. *Adv Physiol Educ* 30: 13–16, 2006. doi:10.1152/advan.00045.2005.

12. Postma TC, Bronkhorst L. Second-year dental students’ perceptions about a joint basic science curriculum. *Afr J Health Prof Educ* 7: 199–201, 2015. doi:10.7196/AJHPE.409.

13. Postma TC, White JG. Students’ perceptions of vertical and horizontal integration in a discipline-based dental school. *Eur J Dent Educ* 21: 101–107, 2017. doi:10.1111/eje.12186.

14. Quintero GA, Vergel J, Arredondo M, Ariza MC, Gómez P, Pinzon-Barrios AM. Integrated Medical Curriculum: Advantages and Disadvantages. *J Med Educ Curric Dev* 3: JMECD.S18920, 2016. doi:10.4137/JMECD.S18920.

15. Reinke NB. Promoting student engagement and academic achievement in first-year anatomy and physiology courses. *Adv Physiol Educ* 43: 443–450, 2019. doi:10.1152/advan.00205.2018.

16. Shaﬁ R, Quadri KH, Ahmed W, Mahmud SN, Iqbal M. Experience with a theme-based integrated renal module for a second-year MBBS class. *Adv Physiol Educ* 34: 15–19, 2010. doi:10.1152/advan.00069.2009.

17. Tavakol M, Sandars J. Quantitative and qualitative methods in medical education research: AMEE guide no. 90: part I. *Med Teach* 36: 746–756, 2014. doi:10.3109/0142159X.2014.915298.

18. Tavakol M, Sandars J. Quantitative and qualitative methods in medical education research: AMEE guide no. 90: part II. *Med Teach* 36: 838–848, 2014. doi:10.3109/0142159X.2014.915297.

19. Thistlethwaite JE, Davies D, Ekeocha S, Kidd JM, MacDougall C, Matthews P, Purkis J, Clay D. The effectiveness of case-based learning in health professional education. A BEME systematic review: BEME guide no. 23. *Med Teach* 34: e421–e444, 2012. doi:10.3109/0142159X.2012.680939.

20. van Merriënboer JJ, Clark RE, De Croock MB. Blueprints for complex learning: the 4C/ID-model. *Educ Technol Res Dev* 50: 39–61, 2002. doi:10.1007/BF02504993.

21. Vashisht Devi V, Rao R, Abraham RR, Pallath V, Umakanth S. Using an integrated teaching approach to facilitate student achievement of the learning outcomes in a preclinical medical curriculum in India. *Adv Physiol Educ* 43: 522–528, 2019. doi:10.1152/advan.00067.2019.

22. Verma M. Early clinical exposure: new paradigm in medical and dental education. *Contemp Clin Dent* 7: 287–288, 2016. doi:10.4103/0976-237X.188536.

23. Wood DF. Problem based learning. *BMJ* 326: 328–330, 2003. doi:10.1136/bmj.326.7384.328.

24. Yusuf S, Yildirim Z. Investigation of interaction, online support, course structure and flexibility as the contributing factors to students’ satisfaction in an online certificate program. *J Educ Technol Soc* 11: 51–65, 2008.