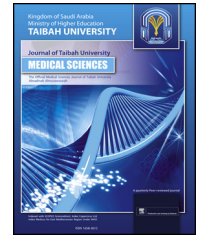




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Educational Article

## Importance of vertical integration in teaching and assessment of physiological concepts



Nazish Rafique, FCPS

Department of Physiology, College of Medicine, University of Dammam, Dammam, Kingdom of Saudi Arabia

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### المخلص

**أهداف البحث:** في ظل النظام القائم للمناهج الجامعية، تم تدريس علم وظائف الأعضاء بالطريقة التقليدية غير المعتمدة على الحالات. يهدف هذا البحث لوضع وتنفيذ منهج وحدة الجهاز التنفسي يعتمد على الدمج الرأسي المتكامل للتعليم، والتقييم باستخدام منهجيات متعددة للتدريس. كما أنه يهدف إلى مقارنة نتائج التكامل الرأسي لتدريس وحدة الجهاز التنفسي مع الطريقة التقليدية للتدريس تمهيدا لتقييم جدوى وأهمية التكامل الرأسي.

**طرق البحث:** أنهى فريق تدريس وحدة الجهاز التنفسي الحالات السريرية، والمواضيع، والأهداف ذات الصلة، واستراتيجيات التعلم، والجدول وأدوات التقييم. وتم العرض والموافقة على هذه الوحدة من قبل مجمع أعضاء هيئة التدريس بقسم علم وظائف الأعضاء. وتم استخدام استراتيجيات متعددة للتعليم. تمت مقارنة نتائج الاختبار لوحدة الجهاز التنفسي المتكاملة رأسيًا مع نتائج الطريقة التقليدية للوحدة التمهيديّة لنفس المجموعة من الطلبة. كما وزعت استبانات لجمع ردود فعل الطلبة في نهاية الوحدة.

**النتائج:** أجاب 99% من الطلبة بأن النهج المتكامل يجعل التعلم والفهم أسهل. كما أعرب 90% من الطلبة عن أملهم أن تكون طريقة التدريس هذه مفيدة لهم مستقبلا في السنوات السريرية، وفضل 92% من الطلبة استمرار النهج المتكامل في المستقبل. تشير مقارنة النتائج بأن نسبة النجاح ومتوسط النتيجة (89% و 61.5) كانت أعلى بوحدة الجهاز التنفسي المتكاملة رأسيًا بالمقارنة بالوحدة التمهيديّة غير المعتمدة على الحالات (70% و 61.5).

**الاستنتاجات:** بناء على التغذية الراجعة من الطلبة يمكن أن نستنتج بأن تدريس علم وظائف الأعضاء بواسطة النهج المتكامل رأسيًا، يمكن أن يكون أفضل من الطريقة التقليدية غير المعتمدة على الحالات. حيث أنها تعزز اهتمام الطلبة وتسهل التعلم الهادف والعميق. لكن هناك حاجة المزيد من الدراسات لمعرفة

التأثيرات وأهمية استبدال منهج علم وظائف الأعضاء التقليدي بالمناهج المتكاملة رأسيًا.

**الكلمات المفتاحية:** علم وظائف الجهاز التنفسي؛ المحاضرات التفاعلية باستخدام حالة محاكاة؛ السيناريوهات

### Abstract

**Objectives:** Under the existing system of undergraduate curriculum, physiology teaching was done in a traditional non-case based manner. The objective of this research was to develop and implement a respiratory module which would incorporate vertically integrated learning and assessment using multiple teaching methodologies.

**Methods:** A respiratory modular team finalized the clinical cases, themes, relevant objectives, learning strategies, time table and assessment tools. The exam results of this Vertically Integrated Respiratory Module were compared with the results of traditionally delivered Introductory Module for the same group of students. Students' feedback questionnaire was also administered at the end of module.

**Results:** 99% of the students responded that integrated approach makes learning and understanding easy. 90% of the students hoped that this mode of teaching would be helpful to them in future clinical years and 92% of the students favored the continuation of this integrated approach in future. Comparison of the results indicated that the passing percentage and the mean score (89% and 61.5) was higher in the Vertically Integrated Respiratory Module as compared to the non case based Introductory Module (70% and 61.5).

**Conclusion:** Based on the students feedback we may conclude that teaching physiology via vertically

Corresponding address: Assistant Professor, Department of Physiology, College of Medicine, University of Dammam, PO Box 2114, 31451, Kingdom of Saudi Arabia.

E-mail: nazishrafique@hotmail.com, nryahmed@ud.edu.sa

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integrated approach may be superior than traditional non case based teaching, because it enhances students interest and facilitates meaningful and deep learning.

**Keywords:** Case scenarios; Case stimulated interactive lectures; Respiratory physiology

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## Introduction

Medical education is changing rapidly, with more than half of American medical schools engaged in curricular reform.<sup>1,2</sup> The need for integration has been advocated in many reports on medical education. Many of these modifications focus on implementing horizontal and/or vertical curricular integration.<sup>3</sup>

Vertical integration is defined as the integration between the clinical and basic science sections of the curriculum. It can occur throughout the curriculum with the basic medical and clinical sciences beginning together in the early years of the curriculum and continuing until the later years. More emphasis may be placed on the basic medical sciences in the earlier years and on clinical sciences and the practice of medicine in the later years.<sup>4</sup>

Introduction of vertical integration may be considered as one of the major reforms to prepare better physicians for the next century.<sup>5</sup> Vertical integration between basic sciences and clinical medicine has been found to stimulate profound rather than superficial learning, and thereby results in better understanding of important biomedical principles.<sup>6</sup> Vertical integration improves motivation, enhances deep learning, prepares for lifelong learning, facilitates curricular reforms, enhances clinician's reflections on scientific practice and enhances scientists reflections on clinical application and research.<sup>7</sup>

Although the move towards vertical integration is gathering momentum world-wide. The process of change will be relatively difficult in institutions with established curricula mainly, because it needs to change the mindset of the faculty. Vertical integration brings more relevance and excitement in learning. To involve clinicians in preparation of basic medical science modules and vice versa is vital to develop vertical integration.<sup>8</sup> Negative faculty attitudes can present a significant barrier to integration and an open line of communication between basic science and clinical disciplines may combat the perception that basic sciences are irrelevant to clinical practice and encourage vertical integration.<sup>9</sup>

Vertically integrated learning is the need of the hour. In recent years such curricula have been employed by faculties of many medical schools throughout the world.<sup>4, 6,19,20,21</sup> WHO supports the integration of outcome and competency based strategies and student centered approaches in learning process.<sup>10</sup> Medical education has also been changing rapidly in Saudi Arabia and most of the medical colleges are now shifting towards innovative, integrated and problem based programs.<sup>11</sup> So our aim was to design and implement a vertically integrated respiratory module for teaching physiology in a modified way to the second

year MBBS class at University of Dammam. This was an effort to eliminate the sharp boundaries between basic and clinical sciences in undergraduate teaching in Kingdom of Saudi Arabia.

## Materials and Methods

### *Module designing*

#### *Team formulation*

For the efficient delivery of the module a respiratory team was formed. Team was headed by a team leader and included highly relevant and dedicated team members. The entire faculty was oriented to the process of implementing integrated curriculum, and a series of the faculty development programmes were conducted in order to train the faculty to accept the evolving challenges in medical education. The learning objectives, clinical cases, themes, learning strategies, time table and assessment tools for the module were finalized after several meetings and discussions amongst the team members.

#### *Designing the clinical scenarios*

Construction of well-designed cases/problems that drive meaningful learning was considered crucial as these are the starting point for students' learning activities that largely impact on the quality of student learning. Attempts were made to ensure the vertical integration of the different topics of respiratory system. Clinical scenarios, covering most of the objectives related to respiratory physiology were designed after various meetings between the chairman of the department, and the team of respiratory module. While formulating these case scenarios special consideration was given to the Dolmans seven principles of effective case design, which include: relevance to the context of future professional practice, integration of basic and clinical concepts, stimulation of self-directed learning by encouraging students to generate learning issues and conduct literature searches.<sup>12</sup>

### *Module implementation*

#### *Teaching methods*

Case based learning was incorporated in lectures and small group discussions in a modified way to improve students understanding, and to motivate them toward self-directed study. Following learning methodologies were used.

#### *Case stimulated interactive lectures*

This approach consisted of introduction of the case scenario at the beginning of the Lecture [Table 1], which provided opportunities for authentic, integrated problems to drive relevant learning and reduce the burden of factual information. Basic idea was to integrate basic and clinical concepts and help the students in understanding the pathophysiological basis of various respiratory disorders. Emphasis was given on the physiological mechanisms rather than on diagnosis and treatment.

At the end of each lecture the students were given pre-designed high quality vertically integrated Short Answer questions(SAQs), which helped them in their self assessment [Figure 1].

### Small group discussion

Students were divided into groups of 8–10. They were provided with the predesigned cases/questions which were intended for enhancing self-motivation, active life-long learning, critical thinking, professional behaviors, effective communication and collaborative team-work approaches of students.

An important aim of these Sessions was to shift the students from the teacher centered towards the student centered learning. Before the beginning of the module some of the important guidelines derived from “Thoughts on Self-Directed Learning in Medical Schools” were given to the facilitators, as: Facilitate do not teach, encourage students to learn on their own, turn questions back to students. Help the students to stay on track, ensure equal participation, and keep track of student performance.<sup>13</sup> In summary the role of the facilitator is to act as a silent guardian, not a source of primary information.

At the end Assessment of students participation was done by using a form. Aggregate score of these forms was an important component of the final assessment.

**Table 1: Example of a case scenario used in one of the case stimulated interactive lectures.**

#### Clinical case (Pneumothorax)

This case was used as a stimulus at the beginning of the lecture

A young adult man known to have chronic obstructive pulmonary disease was brought to hospital with sudden aggravation of his breathlessness. Examination of his chest revealed completely absent chest movement and breathing sounds on the right side of the chest. In addition, a resonant note on percussion was felt on the right side of the chest. Chest X ray revealed completely collapsed right lung. On the basis of examination and investigations he was diagnosed as a case of pneumothorax. This patient was observed in hospital with serial X rays (weekly) which showed the lungs to gradually expand with time.

#### Objectives (Mechanics of ventilation)

- Study the importance of pressure considerations in ventilation.
- Describe the changes in atmospheric pressure, intraalveolar pressure and intrapleural pressure in ventilation and state their typical magnitudes during the respiratory cycle.
- Understand the effects of the forces that hold the lungs and the thoracic wall in tight apposition
- Understand the importance and mechanism of development of transmural pressure gradient.
- Analyze the role of intrapleural fluid cohesiveness in stretching the lungs.

An interactive discussion between the students and the facilitator was focused to correlate the objectives of the lecture with the case scenario resulting in deep and meaningful learning

#### Questions for self assessment

These questions were provided to the students at the end of the lecture for their self assessment.

- Explain the physiological basis of lung collapse in this patient.
- If you stand at the feet of this patient and look at his chest, what would be the position of the right side of the chest compared to left side and why?
- What is the force that gradually expanded his lung?

### Developing integrated MCQs

Efforts were done by members of respiratory team to design and employ objective rather than subjective assessment techniques. Emphasis was given to use the assessment tools that assess the higher levels of cognition, such as understanding, comprehension, interpretation, analysis and decision-making skills rather than simple recall of knowledge.

A blueprint for the assessment was developed, in which categorization of each objective was done on base of Miller’s pyramid.<sup>14</sup> End of module assessment included 80% MCQS and 20% Short essay questions.

Workshop was arranged as a part of faculty development program to train the faculty to develop vertically integrated MCQs in early years. A template was used from NBME<sup>15</sup> which incorporated case scenario-based MCQS. Sessions of departmental meeting were arranged for Peer reviewing and final vetting of MCQS, most of the MCQS were refined after modifications and those rejected by the faculty forum were not used in the examination.

### Students feedback

All cohorts (104, second year medical students in the 2009/10 academic year at University of Damman), were exposed to the same respiratory module, teaching modalities, materials and evaluation tools, and had a limited prior knowledge of respiratory physiology. At the end of the module a feed back questionnaire was filled by the students and a total of 90 questionnaires were returned by students. Detailed explanation of questionnaire was presented to the students, and the students were informed that they have to answer this questionnaire by keeping Traditional Introductory module as a comparison. Since it was an anonymous questionnaire, written informed consent was not obtained and response to questionnaire was implied as verbal consent. This questionnaire addressed the issues related to vertical integration, module organization, delivery and teaching methodologies. The questionnaire also had a free comment section for narrative by the students. The free comments were later on analyzed by the Respiratory team. Tutor evaluation forms were also analyzed.

### Data analysis

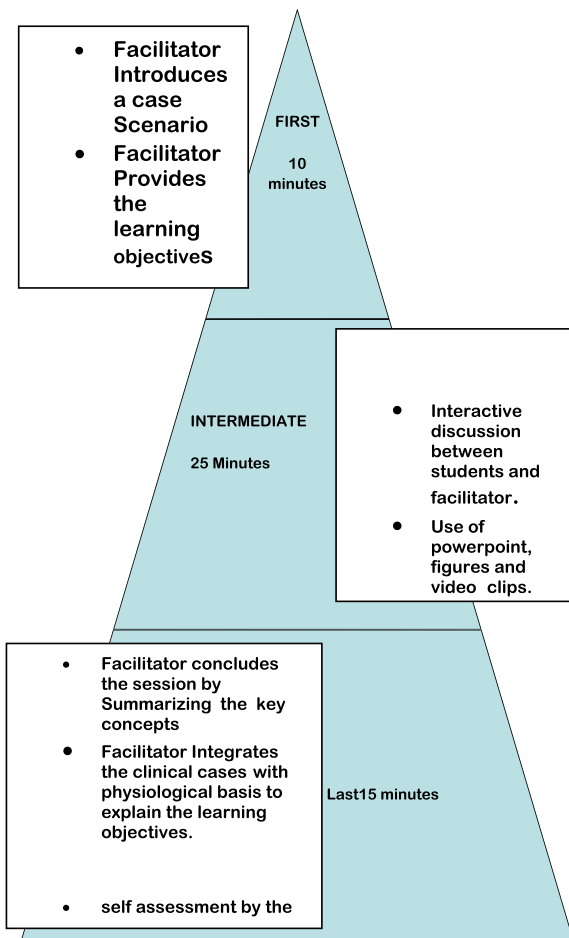
Students feedback questionnaire used a five-point Likert-type scale, data was entered into an Excel spreadsheet. Mean responses were calculated for all evaluation questions.

Comparison of the results between the traditionally delivered introductory module and vertically integrated delivered respiratory module was done by *t*-test. *P* value  $\leq$  was considered to be statistically significant.

Open-ended comments were analyzed qualitatively to explore the content of commentaries, compare and contrast students perceived strengths and weaknesses of the module and the cases in terms of relevance and stimulation.

### Results

85% of the students agreed that teaching physiological concepts in integration with clinical scenarios is a better approach than traditional teaching. 99% of the students



**Figure 1:** Time distribution, pattern and goals of case stimulated interactive lectures.

responded that integrated approach makes learning and understanding easy. 76% of the students agreed that this mode of teaching and assessment motivated their critical thinking. 90 % of the students hoped that this mode of teaching would be helpful to them in future clinical years [Table 1], and 92% of the students favored the continuation of this integrated approach in future. The students were also satisfied with the teaching methodology and commented positively about it (Tables 2 and 3). The students responses about the module organization and delivery are summarized in Table 4. 85% of the students agreed that the Module was well organized

**Table 3: Students feedback on teaching methods.**

|                                      | Agree + SA | Disagree + SD | Uncertain |
|--------------------------------------|------------|---------------|-----------|
| Case stimulated interactive lectures | 83%        | 7%            | 10%       |
| Small group discussion               | 74%        | 18%           | 8%        |

Values are students responses in percentages

and 89% of the students found this module interesting. Open comments and suggestions of the students are summarized in Table 5.

The importance of vertical integration was also highlighted in the students results. The Passing percentage in the exam was 60%.

89 out of the 100 students passed and 11 failed in this vertically integrated Respiratory module. Mean percent score was 68.5, whereas internal consistency and reliability (Cronbach’s alpha/KR21) of this Exam was found to be 0.76.

Whereas, in the results of Introductory module, which was taught in a traditional and non case based way 72 out of 102 students passed and 30 failed. And mean percent score was 61.5. Cronbach’s alpha/KR21 of the Exam was found to be 0.72.

We also found a statistically significant difference between the results of these two modules (*P* value < 0.05).

**Discussion**

Students gave a very positive feed back about the module but at the same time also highlighted the areas which need improvement. 85% of the students responded that teaching physiological concepts in integration with clinical scenarios is a better approach than traditional teaching and 99% indicated that vertical integration makes learning and understanding easy. Similar results have been quoted by Brynhildsen J etal, feedback from their students and faculty showed that vertically integrated teaching methodology is better than the traditional teaching.<sup>14</sup> Abraham Flexner was also in a strong favor of correlating the knowledge of clinical and basic sciences because it make learning and understanding easy.<sup>16</sup> In a survey involving three teaching hospitals in Australia, the responding staff and faculty

**Table 2: Students Feedback on vertical Integration**

|   | Agree + SA | Disagree + SD | Uncertain |
|---|------------|---------------|-----------|
| Teaching physiological concepts in integration with clinical scenarios is a better approach than the traditional teaching?                      | 85%        | 10%           | 5%        |
| Integrated approach makes learning and understanding easy.  | 99%        | 0%            | 1%        |
| This mode of teaching and assessment motivated your critical thinking?  | 76%        | 11%           | 13%       |
| This mode of teaching would be helpful to you in the future years for better understanding of the clinical concepts ?                           | 90%        | 2%            | 8%        |
| Assessment of physiological knowledge by the use of clinical scenario based questions is a better way of judging the knowledge of the students? | 80%        | 18%           | 2%        |
| This integrated mode of teaching and assessment be continued in future?   | 92%        | 5%            | 3%        |

Values are students responses in percentages.



**Table 4: Students feedback on module organization and delivery.**

|   | Agree + SA | Disagree + SD | Uncertain |
|---|------------|---------------|-----------|
| Module was well organized                                     | 85%        | 5%            | 10%       |
| Facilitators interacted with the students                     | 86%        | 12%           | 2%        |
| Facilitators gave clear explanations and relevant information | 75%        | 12%           | 13%       |
| I find the module interesting                                 | 89%        | 5%            | 6%        |
| Facilitator encouraged participation                          | 66%        | 25%           | 9%        |
| Facilitator encouraged critical thinking                      | 71%        | 20%           | 8%        |

Values are students responses in percentages.

**Table 5: Students suggestions and comments on their likes and dislikes about the module.****Students comments on strengths of the module**

Lectures were interesting and innovative.  
 Facilitators were helpful and cooperative  
 We get an early exposure to the clinical approach, so we start feeling like doctors.  
 We get oriented to the clinical scenarios  
 This module created interest in physiology and we realized that physiology is the root of pathology and medicine.

**Students comments on deficiencies of the module**

Huge content was covered in a short time.  
 Some of the content was irrelevant and unnecessary.  
 Clinical relevance was overemphasized in some sessions.

**Students suggestions for improvement**

High quality study guides should be designed and provided to the students before the beginning of the module.  
 Trimming of unnecessary course must be considered by the faculty.  
 Number of small group discussions should be increased and they should be conducted by the trained faculty members.  
 Horizontal integration should also be started.

Open comments by the students.

strongly support the integration of biomedical sciences into clinical teaching.<sup>17</sup>

In another study the students indicated that integrated teaching improves the performance in clinics.<sup>18</sup> This is in accordance with our results, 90% of our students think that integrated mode of teaching will be helpful to them in the future years for better understanding of the clinical concepts. Vertical integration probably leads to better retention of knowledge and the ability to apply basic science principles in the appropriate clinical context.<sup>6</sup>

89% of our students found this case stimulated and integrated mode of teaching interesting and 99% of them favored its continuation in future. In another study, the results of feedback from students of first year after introducing a vertically integrated learning program in endocrine physiology showed that the students clearly enjoyed the experience of case stimulated learning and perceived that it was valuable.<sup>19</sup> Alam S M et al indicated that an early clinical exposure, use of clinical scenarios and clinical examples in teaching sessions of basic medical sciences generates interest among the learners and help them to see why it is important to learn basic sciences.<sup>8</sup> The studies of Ghosh et al and Sathishkumar S also showed that the students liked the integrated and case stimulated teaching and agreed upon its continuation in future.<sup>19,20</sup>

Most of the course in our module was delivered via the Case Stimulated Interactive Lectures and 83% of the students agreed that this teaching methodology was useful, moreover the students indicated that the lectures provoked critical thinking and were interactive. Similar type of case stimulated lectures and tutorials were used in Department of Physiology, Pramukhswami Medical College India with a very positive response from the student.<sup>21</sup> Brezis M et al also reported that traditional lectures have limited ability to maintain attention and promote changes in behaviour. Active learning, which stimulates the audience to think and participate, may be more effective.<sup>22</sup>

In Open comments many students complained about the content overload and commented that too much course was delivered in a short period of time (Table 5). It has been indicated that to prevent course overload and to enhance the integration between basic and clinical sciences, course content should be created with the involvement of relevant clinicians, e.g. orthopaedic surgeon can help in identifying the content for musculoskeletal module.<sup>8</sup> Some investigators warn that without vertical integration, a medical school curriculum may suffer from content gaps.<sup>23</sup> As vertical integration scrutinizes the educational system critically and ask why a certain area should be included? Whether it is relevant or not? So In future, our team is planning to coordinate with the pulmonologist to rewrite the objectives and cut down the unnecessary course of respiratory physiology in order to deliver the content with context. We are also planning to make high quality study guides which would be available to the students before the start of the module.

Few students indicated that in some sessions clinical relevance was over emphasized due to which the students suffered in grasping some of the basic physiological concepts. Study of Dahle LO mentions that there is a risk that clinical studies direct too much attention from basic sciences. Therefore the clinical examples should be used initially only to motivate efficient learning, and a balance between the basic and clinical sciences should be maintained with more emphasis on basic concepts at preclinical level.<sup>6</sup>

The success of integrated curriculum depends on the implementation of integrated assessment. Having mismatch between teaching/learning strategies and assessment methodologies is an effective recipe for failure of implementation of any curriculum.<sup>24</sup> In order to prevent this mismatch between teaching and assessment, we formulated vertically integrated MCQS and SAQS. 80% of the students were satisfied by this mode of assessment.

80–90% of the students were satisfied with the module delivery and responded that the module was interesting and

facilitators interacted with the students. As the success of any modular delivery depends on the active participation and devotion by the faculty members. Faculty development programs in our department contributed in motivating the faculty and highlighting the importance of integration. As Integration entails a lot of time and work in respect of planning, organization and execution, therefore the teachers have to be deeply involved and enthusiastic.<sup>25</sup> Moreover faculty development is important to ensure high levels of competency in facilitating learning.<sup>26</sup>

Some of the students wrote that in order to gain maximum benefit, one needs to integrate the curriculum both horizontally and vertically. As Harden argues that curricular integration can be viewed as a ladder, with discipline-based teaching ('isolation') at the bottom of the ladder and full integration ('trans-disciplinary teaching') at the top.<sup>27</sup> But Integration throughout the whole curriculum is time-consuming for both teachers and students and various logistic problems hinder during planning, organization and execution.<sup>16</sup> So this first step was taken within the physiology department as a beginning effort before we can start with high level of horizontal and vertical integration.

We suggest that willingness to accept the shortcomings in the curriculum or its implementation and to make the appropriate changes should be an ongoing process.

The idea of vertically integrating the respiratory module in physiology was well received by the students and faculty so our conclusion is this that teaching physiology via vertically integrated approach may be superior than traditional non case based teaching, because it enhances students interest and facilitates meaningful and deep learning . But further studies are needed to find out the effects and importance of replacement of Traditional Physiology curriculum via vertically integrated curriculum".

### Study limitations

In order to have an ideal comparison between the two learning and teaching methodologies the class should be split into two groups and the same course should be delivered to one group in a traditional way and to the other group in a vertically integrated way. At the end both the groups should be exposed to the same assessment approach. But due to logistic and administrative issues we were not able to implement this methodology.

So we selected the same group of 102 Students of University of Dammam of 2nd Year MBBS class and exposed them to two different modules via two different teaching methodologies. But the duration of the course, number of lectures, Tutor delivering the course and number of MCQS in the end of module exam were kept same for both the modules.

So in future we recommend an ideal comparison by splitting the same class into two groups and the same course should be delivered to one group in a traditional way and to the other group in a vertically integrated way. This will help us to analyze that either it is better to teach Physiology curriculum via vertically Integrated Methodology.

### Conflict of interest

The authors have no conflict of interest to declare.

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