Curricular Integration of Physiology

Using an integrated teaching approach to facilitate student achievement of the learning outcomes in a preclinical medical curriculum in India

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INTRODUCTION

It is a matter of fact that today most education institutions around the world have adopted the philosophy of outcome-based education (OBE). OBE means focusing and organizing everything in an educational system around what is essential for the students to be able to do successfully at the end of their learning period. In OBE, the curriculum design begins with a clear picture of what students must be able to do, demonstrate, and need to know, and then organizing the content, teaching, and assessment to make sure the intended learning eventually happens (33). The outcomes are the explicit statements indicating the culminating demonstration of abilities the student will be able to demonstrate at the end of the learning period (14, 33). In the context of institutions offering medical education, the competencies possessed by the doctors coming out of such schools become the outcome (13, 14, 33). Hence the curriculum should be designed in such a way that it includes the components targeted specifically at achieving such outcomes (12).

It is preferable to motivate students to think as doctors from the day they enter medical school. Discipline-based or isolated teaching approach in medical education attracts the criticism that it generally results in fragmentation of learning and that students fail to see the relevance of basic sciences applied to clinical practice (11, 15). This leads to the contemplation of an alternate approach, which could look at the required competencies or outcomes in a holistic way and will be able to inculcate them among the students. Integrated teaching gains importance from the above perspective in medical education, as basic science learning is placed in the context of clinical practice and is considered to be more meaningful and relevant by the students (25).

Integration is organizing contents based on their interdependencies and interrelations so as to unify the subject matter, which is taught independently and in isolation (16). An integrated medical curriculum, therefore, helps the graduates to put together the learned facts to get the whole picture of the medical program and adopt a holistic approach while treating a patient (21). Integrated teaching is believed to develop critical thinking, self-learning ability, deep learning, and clinical problem-solving skills (5, 17, 37). The reports from several medical schools demonstrate the effectiveness of an integrated curriculum in relation to acquiring knowledge (6, 18, 31, 36). There are challenges in implementing an integrated curriculum, as it involves a shift from the present curriculum as per
the literature. Scheduling conflicts, limited resources, and resistance from faculty members, students, and their parents were major difficulties in implementing an integrated curriculum (29). Hence, in this study, an attempt has been made to develop a module for integrated teaching, which could be implemented in the discipline-based curriculum without involving too much deviation from the existing model, yet achieving integration. The studies on integrated curriculum available from India have mainly evaluated the perception and knowledge of the students who experienced the integrated curriculum (10, 18, 19). However, there is a dearth of reporting on the evaluation of other outcomes from India, which calls for a systematic evaluation of outcomes. Therefore, in this study, evaluation of outcomes, such as integrated knowledge, critical thinking skills, deep learning, and self-directed learning (SDL) skills, besides gathering the reaction of the students, was carried out.

**MATERIALS AND METHODS**

Melaka Manipal Medical College (MMMC), Manipal Campus, Manipal Academy of Higher Education, Manipal, India, offers the undergraduate medical program [Bachelor of Medicine and Bachelor of Surgery (MBBS)] as a twin campus program with MMMC, Malaysia. **Phase 1** of the program is conducted at Manipal, followed by **phase 2** in Malaysia. Subjects taught in the first year include anatomy, physiology, and biochemistry. During the second year, students learn pathology, pharmacology, microbiology, and forensic medicine. After completing the second year successfully, students undergo 6 mo of clinical training in Manipal before proceeding to **phase 2** at Malaysia.

The whole first-year curriculum is divided into four blocks (teaching unit), and each block is 10 wk in duration. The topics that are taught in every block are as follows:

**Block 1**: Basic concepts, skin, muscle, bone, joints, and blood

**Block 2**: Cardiovascular, respiratory, gastrointestinal, hepatobiliary system, and nutrition

**Block 3**: Endocrine, reproductive system, kidney, and electrolytes

**Block 4**: Central nervous system, special senses, and molecular biology

Integrated teaching was conducted in the first 4 wk of the third block of the first-year (September 2013 cohort, n = 234) MBBS program. The discipline-based curriculum was in practice in the institution. As the students were new to the medical curriculum and needed time to adjust to the curriculum, the third block of the first year was chosen for the implementation of the module. Moreover, students have previously reported that the second and fourth blocks are most challenging, and we determined they would not be the ideal location for a curriculum pilot study.

Objectives for conducting integrated teaching were identified as follows:

- To impart integrated knowledge of organ structure, body functions, and their regulation, pathophysiology, and mechanism of disease processes
- To improve deep learning, SDL, and critical thinking skills

Integrated teaching was conducted in the form of temporal coordination of anatomy, physiology, and biochemistry with the correlation of learned topics to clinical settings. Topics for integrated teaching were chosen from the endocrine system. The content was organized around the organ system. The module consisted of lecture classes, case-based learning, anatomy dissection classes, and laboratory-based learning sessions. Moreover, the SDL sessions were also included, wherein the students were given the topics with learning objectives well in advance. Students were expected to study the topics on their own and attend the sessions. During the sessions, they were required to present and discuss the topics in small groups under the supervision of a facilitator.

Faculty members from the Anatomy, Physiology, Biochemistry, and Medicine Departments participated in the process. Topics from anatomy included the structure of the gland, blood supply, nerve supply, and lymphatic drainage of the gland, and biochemistry consisted of the normal range, synthesis, and transportation of hormones. Physiology topics comprised concepts such as actions of the hormones and regulation of the secretions of the gland. Clinicians discussed the pathophysiology of the diseases with the basis for different clinical features, diagnosis, and treatment integrating with aspects learned in first-year subjects through lecture classes, which included case discussions. The scheduling was done in such a way that the topics within the subjects or disciplines that are interrelated occur during the same week (Table 1). Other topics that were not integrated were reorganized to preserve the continuity and completeness with a smooth flow and delivered with lecture classes, SDL sessions, case-based learning, anatomy dissection classes, and laboratory-based learning sessions without temporal and vertical integration.

Kirkpatrick’s evaluation model was used to evaluate the integrated module. It consists of four levels, which are reaction, learning, behavior, and results (20). In this study, evaluation was conducted at the level of reaction and learning.

A questionnaire with 14 items was developed to elicit students’ reaction to the integrated teaching-learning process. A 5-point Likert scale (5 = strongly agree and 1 = strongly disagree) was used to score these items. Content validation of the questionnaire was done by experts in medical education, and, later, the questionnaire was administered to the students. Internal consistency was calculated using Cronbach’s alpha. Additionally, two focus group discussions with students were conducted to obtain qualitative data.

A question paper with case vignettes and multiple-choice questions from anatomy, physiology, and biochemistry, to test students’ integrated knowledge and critical thinking, was developed to assess the students’ learning. The question paper consisted of questions from both integrated and nonintegrated topics and was reviewed by subject experts. A sample question is provided in Table 2. Using the above-mentioned question paper, the integrated test was administered to the students at the end of the block.

A Revised Two Factor Study Process Questionnaire (R-SPQ-2F) (4) and Self-Directed Learning Readiness Scale (SDLRS) (8) were administered at the beginning (pretest) and end (posttest) of the third block to find the change in students’ learning approaches and SDL readiness. As the third block included both integrated and nonintegrated topics, the learning approaches and SDL readiness of the previous cohort (March 2013 cohort) students were analyzed to find whether the change was really due to integration. R-SPQ-2F has 20 items grouped under 2 scales: surface approach (10 items) and deep approach (10 items). A 5-point scale (5 = always, 4 = frequently, 3 = one-half of the time, 2 = sometimes, and 1 = never or only rarely) was used to score the items. SDLRS is a prevalidated questionnaire containing 29 items in a 5-point Likert scale (5 = strongly agree to 1 = strongly disagree) grouped under 3 scales: self-management (10 items), desire for learning (9 items), and self-control (10 items).

Dundee Ready Education Environment Measure (DREEM) inventory was used to collect information regarding the educational environment (26). The inventory contains 50 statements grouped under 5 subscales: students’ perceptions of learning (12 items), students’ perceptions of teachers (11 items), students’ academic self-perception (8 items), students’ perceptions of atmosphere (12 items), and students’ social self-perceptions (7 items). Each DREEM item was scored 0–4, with scores of 4, 3, 2, 1, and 0 assigned for strongly agree, agree, uncertain, disagree, and strongly disagree, respectively.

**Statistical analysis.** The data collected through the newly developed perception questionnaire were analyzed for frequency. R-SPQ-2F, SDLRS, and DREEM inventory were analyzed using the mean.
Table 1. Integrated teaching module

| Expected Outcomes                                                                 | Week | Topic                      | Learning Objectives                                                                 | Departments Participated                           | Teaching-Learning Activities | Assessment     |
|-----------------------------------------------------------------------------------|------|----------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------|------------------------------|----------------|
| Students will be able to:                                                         | 1    | Introduction to endocrinology | ● Define hormone<br>● Mention the characteristic features of a hormone<br>● Describe the classification of hormones<br>● Describe the transport of hormones<br>● Describe the mechanism of action of hormones<br>● Describe the up and downregulation of receptors | Physiology and Biochemistry                         | Didactic lecture              | Integrated test |
| ● Apply integrated knowledge of basic science across disciplines to explain patients’ signs and symptoms<br>● Demonstrate critical thinking skills based on the integrated knowledge to solve medical problems<br>● Demonstrate deep learning while solving medical problems using integrated knowledge<br>● Demonstrate SDL skills in assimilating new medical information | 2    | Pancreas                   | ● Describe the structure, blood supply, nerve supply and lymphatic drainage of pancreas<br>● Describe insulin structure, biosynthesis, receptor and its functioning, role of insulin in cellular glucose uptake<br>● Describe effects of insulin<br>● Describe the regulation of insulin secretion<br>● Describe the cause, classification, clinical features, basis for metabolic alterations, and laboratory investigations of diabetes mellitus | Anatomy, Physiology, and Biochemistry                | Didactic lecture Dissection CBL Laboratory-based learning |
| 3 Thyroid gland                                                                   |      |                            | ● Describe functional anatomy of thyroid gland<br>● Describe thyroid hormone synthesis, release and inhibitors<br>● Describe transport and mechanism of action<br>● Describe the actions of thyroid hormone<br>● Describe the regulation of secretion<br>● Describe the cause and clinical features of hyperthyroidism<br>● Describe the cause and clinical features of hypothyroidism<br>● Describe thyroid function tests<br>● Describe the treatment for hypo- and hyperthyroidism | Physiology, Biochemistry, and Medicine               | Didactic lecture Dissection CBL Laboratory-based learning |
| 4 Adrenal gland                                                                   |      |                            | ● Describe the position, structure, relations, blood supply, nerve supply and lymphatic drainage of adrenal gland<br>● Describe the transport of adrenocortical hormones<br>● Explain the synthesis and mechanism of action of aldosterone, cortisol, testosterone, and its active form<br>● Explain the actions of adrenocortical hormones<br>● Explain the regulation of cortisol and aldosterone<br>● Explain the secondary effects of excess mineralocorticoids<br>● Describe the regulation of aldosterone secretion<br>● Describe the cause and clinical features of Conni’s syndrome<br>● Describe the cause and clinical features of Addison’s disease<br>● Describe congenital adrenal hyperplasia<br>● Describe adrenal function tests<br>● Describe the treatment for altered secretions of adrenal gland | Anatomy, Physiology, Biochemistry, and Medicine      | Didactic lecture Dissection CBL Laboratory-based learning |

CBL, case-based learning; SDL, self-directed learning.

total score and standard deviation (SD). Pre- and post-R-SPQ-2F and SDLRS data were compared using independent samples t test. Assessment scores were expressed as means (SD) separately for integrated and nonintegrated topics, and later they were compared using paired t test. A P value < 0.05 was taken as significant. Qualitative data were analyzed separately by two investigators using constant comparative analysis (35). Themes in the comments were identified and coded, and comments were assigned to themes.
Table 2. Sample question

Neha, a 26-yr-old woman with recent tiredness and difficulty in concentrating had experienced a decline in memory over the last several months. She also noted decreased frequency of bowel movements and an increased tendency to gain weight. She felt chilled without a light sweater, even in warm weather. Neha consulted her physician, and on physical examination her pulse rate was found to be 54 beats per minute and her blood pressure was 108/78 mmHg. The physician noticed a lump on the anterior side of her neck. He also observed that Neha had a slightly puffy face, and her skin had a yellowish tint. Her eyebrows were sparse, especially at the lateral margins.

For each statement given below, state whether it is true or false:
1. The patient most probably suffers from hyperthyroidism
2. The weight gain of the patient is due to increased BMR
3. The yellowish tint of the skin is due to jaundice
4. Her pulse rate is normal

BMR, basal metabolic rate.

Ethical approval. Permission from the Institutional Ethics Committee of Kasturba Medical College and Hospital, Manipal Academy of Higher Education, Manipal, was obtained before the study was conducted (IEC 255/2012).

RESULTS

The average score obtained by the students (n = 232) in the integrated test was 86% on topics from integrated teaching, whereas it was 82% on topics taught in a nonintegrated approach. Although the difference in the scores was small, it was statistically significant (P < 0.001).

More than 85% of the students responded to the questionnaires. Internal consistency, Cronbach’s alpha of the newly developed perception questionnaire, was 0.929. Analysis of the data collected through the questionnaire showed that, for all items, the majority of the students had given positive answers (Table 3). There was a significant increase in the deep approach of the students in the posttest compared with the pretest (Table 4). Although the analysis of data of previous cohort students showed an increase in the deep approach, it was not significant. It also showed an increase in the preference of students for the surface approach.

Table 5 shows students’ opinions about their SDL readiness. In the posttest, there was a significant increase in scores in all three subscales of SDLRS compared with in the pretest. However, SDL readiness of the students of the previous cohort, who were not exposed to integrated teaching, did not show a notable change. Table 6 shows the perception of students about the educational environment, and the total mean score was found to be 131/200.

The following themes emerged from analysis of focus group discussions conducted with the students about the integrated teaching.

Benefits. Students commented that integrated teaching made the learning easier and helped them to understand the topics in a better way. Moreover, the approach helped them to establish correlation among the subjects they had learned. Students also stated that the integration could save them time and effort needed for their study, as they learned the topics in an integrated way and not in isolation. Furthermore, topics taught with case scenarios helped them to improve critical thinking skills. The following quotes are examples of students’ comments:

“I love this way of teaching method. It made learning process easier.”
“Integrated teaching definitely gives a better understanding and correlation.”
“Study once and cover all the topics. So, save time.”

Suggestions for improvement. Some students expressed their desire to learn more about treating the patient from clinicians as a part of integrated teaching. They also expressed that integrated teaching should be continued and extended to all topics. The quotes below support these findings:

“Integrated teaching should be done for every topic every single block whenever possible.”
“II think it is better if the clinicians tell us more about how to treat the patient.”

DISCUSSION

The OBE in its structure and composition has to facilitate achievement of outcomes by the students and hence needs to be equipped with appropriate curricular components, which are selected based on the expected outcomes (12, 14, 33). Therefore, it becomes necessary to examine whether the selected curricular components are facilitating the attainment of outcomes. Reports are available about the evaluation of outcomes of integrated teaching conducted in western countries in which

Table 3. Perception of students on integrated teaching

| Items                                                                 | Cumulative Score |
|-----------------------------------------------------------------------|------------------|
| Motivated me to learn the topic                                       | 85.3 (175)       |
| Improved the understanding of the topic                              | 94.6 (194)       |
| Helped to gain an in-depth knowledge about the topic                  | 91.2 (187)       |
| Stimulated my interest in the topic                                  | 79.5 (163)       |
| Stimulated my critical thinking about the topic                       | 83.9 (172)       |
| Helped to enhance my reasoning skills                                | 88.3 (181)       |
| Helped me to perceive the topic better, in a real-life situation      | 89.7 (184)       |
| Helped me to give much attention to the topic                         | 87.3 (179)       |
| I hope will help me to prepare better for the examination             | 91.7 (188)       |
| Helped me to understand the interrelations among the basic science subjects | 93.2 (191)       |
| Helped me to relate basic science subjects in clinical contexts in a better way. | 91.2 (187)       |
| Helped me to appreciate the role/importance of basic science subjects in clinical practice | 90.7 (186)       |
| Helped me to learn the topic as a whole/get a holistic view of the topic | 88.8 (182)       |
| Discussion by the clinician helped me to understand the topic better. | 82 (168)         |

Values are in % (with n, no. of students, in parentheses). n = 205 Students who responded to the questionnaires.

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medical schools admit graduates (34, 39). But, in the Indian context, the students who just completed the 12th standard (equivalent to grade 12) and are still in their adolescence get admitted to medical schools. Moreover, it was observed that the performance of the students of previous cohorts of MBBS at MMMC was not up to expectations when the questions requiring integrated knowledge were asked. Hence, a systematic in-depth evaluation of the outcomes becomes very important in the Indian scenario.

In the present study, an organ-based model of integrated teaching was developed and implemented in the first-year curriculum of MBBS, which was predominantly delivered through lecture classes. The evaluation of the module revealed that integrated teaching facilitated in achieving the outcomes by the students, including integrated knowledge.

Integrated teaching was well received by the students, which was evident by their affirmative answers for the perception questionnaire (Table 3). Similar observations were noted in other published articles from India (19, 36). Integrated teaching helped to improve the students’ perception of clinical relevance of the topic, which was also observed in the earlier studies (10, 19, 36). The assessment of integrated knowledge and critical thinking skills was done through a test, which had questions assessing integrated knowledge and critical thinking skills, in the form of case vignettes. Generally, questions from different subjects, i.e., anatomy and physiology, were given separately to test students’ knowledge gain through the integrated teaching (18, 36). In the present study, a unified question paper was administered that had items in the form of multiple-choice questions drawn from three subjects, namely, anatomy, physiology, and biochemistry. The test had both the integrated and nonintegrated topics. In the integrated topic, the students’ average score was significantly higher than the score in the nonintegrated topics, which showed that they could acquire integrated knowledge and critical thinking skills. We think it most likely that this effect is attributed to the integrated teaching intervention, although other contributions, such as unconscious selection bias of examination questions, cannot be ruled out in the research design. However, students have acknowledged that integrated teaching stimulated their critical thinking and gave a holistic view of the topic (Table 3).

Learning approaches are considered by the researchers as one of the main factors for success in higher education (27). Students adopting a surface approach are usually rote learners. They limit themselves to recall level or factual knowledge and are able to reproduce the material using a superficial level of understanding. They are focused on meeting the basic requirements for completing the course rather than developing a higher level of cognition and interest in the course, whereas students adopting a deep learning approach are motivated by their interest in the topic (3, 23). These students exhibit an ability to relate their prior knowledge to the new knowledge and application of acquired theoretical concepts to everyday experience (23). Doctors with a deep approach are more likely to develop a habit of life-long learning and have a higher tendency for academic progression by pursuing postgraduate training than those who limit themselves to the surface approach (24). Deep learning is one of the key merits of integrated teaching (17). Researchers from the United Arab Emirates found that the students who were into the integrated curriculum exhibited the deep approach more compared with the surface approach (22). In the present study, the students were deep learners, and there was a significant increase in their deep approach as they experienced the integrated teaching (Table 4). However, the students who were not exposed to integrated teaching did not show a significant increase in the deep approach. It is reported that students are more interested and motivated to learn a given subject if they can relate the concepts studied in basic science subjects to the clinical subjects (16, 36). Also, interest in the subject matter enhances the

Table 4. Total mean score of students adopting deep and surface approach at the commencement and end of first-year Bachelor of Medicine and Bachelor of Surgery program at Melaka Manipal Medical College

| R-SPQ-2F (Subscales) | September 2013 Cohort | March 2013 Cohort |
|-----------------------|-----------------------|-------------------|
| Pretest               |                       |                   |
| DA (maximum score 50) | 29.66 (6.39)          | 31.88 (6.38)      |
| SA (maximum score 50) | 26.94 (7.97)          | 24.25 (7.07)      |
| Posttest              |                       |                   |
| DA (maximum score 50) | 32.52 (6.78)*         | 32.42 (6.51)      |
| SA (maximum score 50) | 26.43 (7.95)          | 25.71 (6.71)      |

Values are means (SD). September 2013 cohort: n = 208 students; March 2013 cohort: n = 156 (pretest) and 146 (posttest) students. R-SPQ-2F; Revised Two Factor Study Process Questionnaire; DA, deep approach; SA, surface approach. *Significant, posttest vs. pretest, P < 0.001.

Table 5. Total mean score of students in self-directed learning readiness at the commencement and end of first-year Bachelor of Medicine and Bachelor of Surgery program at Melaka Manipal Medical College

| SDLRS (Subscales) | September 2013 Cohort | March 2013 Cohort |
|-------------------|-----------------------|-------------------|
| Pretest           |                       |                   |
| 1 (maximum score 50) | 33.24 (5.4)          | 34.89 (5.84)      |
| 2 (maximum score 45) | 34.3 (4.13)          | 36.47 (4.49)      |
| 3 (maximum score 50) | 37.07 (4.87)         | 39.94 (4.46)      |
| Total (maximum score 145) | 104.61 (11.81) | 111.30 (12.39)    |
| Posttest          |                       |                   |
| 1 (maximum score 50) | 35.82 (5.08)*        | 35.67 (5.81)      |
| 2 (maximum score 45) | 35.64 (4.16)*        | 35.92 (4.51)      |
| 3 (maximum score 50) | 39.03 (4.67)*        | 40.09 (4.7)       |
| Total (maximum score 145) | 111.39 (11.47)* | 111.68 (12.39)    |

Values are means (SD). September 2013 cohort: n = 208 students; March 2013 cohort: n = 157 (pretest) and 149 (posttest) students. Subscale 1, self-management; subscale 2, desire for learning; subscale 3, self-control. *Significant, posttest vs. pretest, P < 0.001.

Table 6. Perception of first-year Bachelor of Medicine and Bachelor of Surgery students regarding the educational environment at Melaka Manipal Medical College

| DREEM Subscales | Mean (SD) |
|-----------------|-----------|
| SPL (maximum score 48) | 31.58 (5.15) |
| SPT (maximum score 44) | 30.06 (4.32) |
| SASP (maximum score 32) | 20.41 (3.8) |
| SPA (maximum score 48) | 31.62 (5.59) |
| SSSP (maximum score 28) | 17.11 (3.62) |
| Total (maximum score 200) | 130.77 (17.6) |

n = 213 Students. DREEM, Dundee Ready Education Environment Measure; SASP, student academic self-perception; SPA, student perception of atmosphere; SPL, student perception of learning; SPT, student perception of teacher; SSSP, student social self-perception.
deep approach (9). In the present study, students were made to learn the related concepts from the three subjects in the same week; they were thereby given an opportunity to establish the relationship among the contents of first-year subjects. Furthermore, clinicians explicitly discussed the relevance of these topics to clinical practice in addition to suitable case discussions. This collectively might have enhanced their interest in the topic and hence contributed to improvement of their deep learning.

Integration helps in the development of the SDL skills (17). For example, problem-based learning (PBL) has been shown to be an effective technique to enhance integration of learning (1), and Vyas et al. (36) used assessment of PBL to evaluate SDL skill development in students. Davis and Harden (7) mention lack of trained facilitators as a challenge for conducting PBL sessions. As the number of students increases, a proportionate increase in faculty members, infrastructure, and better planning are required. In the present study, the integrated teaching module was developed without using PBL, which could be easily implemented in such situations. SDL sessions were part of the module, although the assessment was not done during the sessions. Thus SDLRS was used, which is a validated tool to measure the readiness for SDL, i.e., the degree to which an individual possesses the abilities, attitudes, and personality characteristics necessary for SDL (38). A study conducted in Gulf Medical College revealed that SDL readiness of the students who experienced integrated teaching was lower than for those in the traditional curriculum (30). But, in the present study, students who experienced the integrated teaching showed a significant increase in SDL readiness from pretest to posttest; others did not (Table 5). This substantiates the utility of the integrated teaching module in achieving the outcomes.

Study of the educational environment is important during curriculum revision (32). This gains importance, as a conducive educational environment is essential for student learning (2). In the present study, analysis of the DREEM scores indicated a conducive educational environment, similar to an earlier study conducted in Iran (28).

Challenges encountered. The implementation of integrated teaching had challenges. The planning of integrated teaching across departments was time consuming and involved negotiation with the faculty members. Moreover, a lot of time was invested in the development of the question paper for an integrated model, as it required inputs from all the departments participating in the process. In horizontal integration, the faculty members of the Anatomy Department could not participate in all weeks, as they taught those topics in other blocks. Consulting clinicians and getting their slots for vertical integration was a difficult task due to their busy schedule. During the second week of the integrated teaching module, there was an unexpected holiday, which required rescheduling of the classes. Besides, a clinician’s talk on diabetes mellitus did not happen because of an emergency in the hospital, which required the clinician’s presence.

Limitations. Feedback from the faculty members on the integrated teaching was not taken. This was mainly because the study was conducted only in one block. Moreover, only a small number of faculty members were involved in the process, and the task was mainly coordinated by the researchers. Also, the impact of integrated teaching on integrated knowledge gain through pre- and posttests could not be ascertained due to the time constraint. Hence, an integrated test that included the questions from the topics covered in the integrated teaching module, as well as from the topics delivered in the nonintegrated way, was conducted.

Conclusions. Evaluation of the integrated teaching module showed that it was well accepted by the students. Also, they could gain integrated knowledge through integrated teaching. Furthermore, the integrated teaching approach increased deep learning, enhanced SDL readiness, and enabled application of the knowledge of basic science in the clinical context.

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DISCLOSURES

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

AUTHOR CONTRIBUTIONS

A.V., V.D., R.R., R.R.A., V.P., and S.U. conceived and designed research; A.V., V.D., R.R., R.R.A. and V.P. performed experiments; A.V., V.D., R.R., R.R.A., V.P., and S.U. interpreted results of experiments; A.V. prepared figures; A.V. drafted manuscript; A.V., V.D., R.R., R.R.A., V.P., and S.U. edited and revised manuscript; A.V., V.D., R.R., R.R.A., V.P., and S.U. approved final version of manuscript.

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