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Original Article

Measuring the Effectiveness of Faculty Feedback on the use of an active integrated instructional pedagogy for the embryology course

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الملخص

أهداف البحث: إن طرق التدريس التقليدية ليست بالكفاءة المرجوة بسبب عدم قدرتها على تعزيز التعلم النشط. وإن اعتبار المشاركة النشطة من قبل المتعلمين يساعد على تعزيز التجربة التعليمية. بالإضافة إلى ذلك، فقد ثبت أن التغذية الراجعة البناءة تحفز على التعلم النشط. تهدف هذه الدراسة إلى قياس تأثير التدخلات باستخدام التعلم النشط والتغذية الراجعة على الأداء الأكاديمي لطلاب الطب.

طرق البحث: أُجريت هذه الدراسة الاستطلاعية متعددة المراحل على طلاب الطب في منهج علم الأجنة من خلال التعلم السلبي (٩٠ طالبا)، والتعلم المتكامل النشط (٨٠ طالبا)، وأخيرا بالتعلم النشط مع التغذية الراجعة الفاعلة (٨٥ طالبا) على مدى ثلاث سنوات متتالية. وقد تمت مقارنة درجات الطلاب خلال التقييمات المستمرة والختامية مع الدرجات النهائية. بالإضافة إلى ذلك، تم تحليل آراء الطلاب باستخدام استبانة.

النتائج: شارك في هذا البحث ٢٥٥ طالبا. أظهرت آراء الطلاب اختلافات ملحوظة. وكان هناك اتجاه إيجابي نحو التدخلات من خلال التعلم النشط والتغذية الراجعة. زادت المشاركة النشطة للطلاب من ٢٤٪ إلى ٦٩٪ وأخيرا إلى ٧٢٪ خلال ثلاث سنوات. وكان لديهم الدافع لحضور المحاضرات كما اتضح من مشاركة ٢٨٪ و٧٠٪ و٨٢٪ على التوالي. كما كانت هناك زيادة كبيرة في الدرجات الأكاديمية خلال الثلاث سنوات.

الاستنتاجات: تؤكد هذه الدراسة فاعلية التعلم النشط والتغذية الراجعة على الأداء الأكاديمي لطلاب الطب. وبالتالي يمكن إدراج نهج تعليمي للتعلم المتكامل النشط متبوعا بالتغذية الراجعة في المناهج الطبية.

الكلمات المفتاحية: التغذية الراجعة؛ التعلم المتكامل النشط؛ علم الأجنة؛ طلاب الطب؛ الأداء الأكاديمي

Abstract

Objectives: Didactic time-honoured teaching pedagogies carry a low educational impact due to their inability to foster active learning. Active participation from learners is considered to enhance their learning experience. Furthermore, constructive feedback has been found to facilitate active learning. This study aims to measure the impact of interventions via the use of active learning and feedback on the academic performance of medical students.

Methods: We conducted an observational multi-stage prospective study of the medical students undertaking embryology courses via passive learning (90 students), active integrated learning (80 students), and finally, with active learning and effective feedback (85 students) over three successive years. The students' grades in the formative and summative assessments were compared with their end-of-course grades. Additionally, the students' perceptions about the courses were analysed using a self-constructed questionnaire.

Results: A total of 255 students participated in this research. The observed frequencies of the students' responses showed significant variations in their responses to all the statements (X^2, $p < 0.0001$). There was a positive trend towards the interventions carried out via active learning as well as feedback. Students' active participation increased from 24% to 69%, and finally to 72% across three years. Furthermore, students were motivated to attend sessions, as can be seen in the participation rates of 28%, 70%, and 82%, respectively. There was a significant improvement in academic grades across the three years (p values of 0.000, 0.000, and 0.006, respectively).

Conclusion: This study validates the effectiveness of active learning and feedback on the academic

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performance of medical students. It is possible for an educational approach of active integrated learning followed by feedback to be embedded in the medical curricula.

Keywords: Academic performance; Active integrated learning; Embryology; Feedback; Medical students

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Introduction

In medical education, an appropriate selection of teaching and learning pedagogy plays a vital role in the active learning of learners.[1,2] Instructors often deliver complex material in a format that does not translate to the desired active engagement recommended by educators, theorists, and psychologists.[3] Learning is no longer followed by an apprenticeship model where the learners will not get adequate knowledge by just listening to teachers, memorizing pre-packaged information, and rote memorizing. The learners must reflect on their experiences and must apply their experiences to their real practices.[4] In order to improve the impact of learning, the National Board of Medical Education and the International Association for Medical Science Educators have underpinned the importance of active learning in the medical field.[5] Active learning, an educational method to engage students in the learning process, covers a plethora of teaching and learning strategies such as workplace-based education,[6] peer assisted learning,[7] experiential learning, small group learning, and use of technology including audience response,[8] vlogs, gaming, and social media.[9] The instructional strategies of active learning include a broad variety of activities that share the common element of 'involving students in doing things and thinking about the things they are doing'.[10] Despite the pivotal role active learning has played among the neo-millennial generation, there is limited research available on the mechanisms that can help embed the different teaching strategies necessary to enable active learning in medical education.

As the experience of shifting from a traditional lecture-based teaching to an active strategy can be intimidating to students, formative assessment can be offered as an attractive solution to ensure the continuity of active learning. The formative assessment provides information to the teaching faculty and learners about their performances and achievements with regard to achieving their learning goals and objectives.[11] Students would be able to know what knowledge and skills they have gained, how close they are to achieving their goals, and what they are required to accomplish in the subsequent phase.[12] At this step, providing an objective and specific effective feedback is an essential skill that the tutors must master to get the best out of this instructive process.[13–15] Feedback is one of the most influential instruments that the teachers can practice to improve the students' learning.[16] Medical teachers should provide facilitative feedback that is directed towards the development of meta-cognition and social learning.[17] Hattie and Timperley have proposed a model of feedback that identifies four levels: (1) feedback about the task – 'right or wrong answers', (2) feedback about the processing of the task, (3) feedback about self-regulation – 'self-evaluation', and (4) feedback about the student as a person. The phase in which the feedback is focused influences its effectiveness.[18]

Embryology remains to be a valuable part of the medical curriculum. Students, anatomy tutors, and medical educators should be following a proactive approach when it comes to finding the learning opportunities for teaching embryology courses.[19,20] Although educators find it hard to incorporate embryology course in the congested schedules of medical curricula, it remains crucial for students to help them comprehend the basic concepts of human development and developmental disorders.[20,21] It has been suggested that the teaching of embryology using clinical scenarios can increase its relevance and interest among learners.[22] Incorporation of new teaching methods in embryology courses is necessary to increase students' motivation and their desire to learn.[21,23–26]

There is scarcity in information about the effectiveness of immediate feedback in embryology courses that can enhance the active learning of medical students. As a result, we took up this study with the primary objective of determining the impact of providing feedback and active learning on the academic performance of students during an integrated embryology course.

Materials and Methods

Study settings

This study was carried out at the College of Medicine (CoM), University of Sharjah (UoS), United Arab Emirates. The MBBS program of the CoM is delivered via an integrated, problem-based learning (PBL), student-centred and systematic curriculum. The program contains three phases, that is, phase one (foundation year), phase two (pre-clinical), and phase three (clinical). While phase two embraces the basic sciences units, phase three covers all the clinical clerkships. The first semester of 2nd year MBBS curriculum at the CoM consists of cardiovascular, respiratory, and endocrine units. The cardiovascular system is taught over five weeks and includes basic sciences within the integrated PBL system, which is followed by a formative exam in anatomy, histology, and embryology. Traditionally, embryology unit is taught as a part of the integrated multi-disciplinary organ system modules along with the histology and gross anatomy units under the umbrella of anatomical sciences teaching.

Study design

In our study, we recruited 2nd year students having the embryology course as part of the MBBS program during the three academic years of 2016–2019. A convenient sampling technique was used to include students in this research. The students unwilling to participate in this research were excluded from this study. All the students were informed about the nature and significance of the research and a

written consent was taken from them for their participation in this study. During the academic year of 2016–2017, the cardiovascular unit's embryology sessions were taught in a traditional lecture-based format.

Active integrated learning approach

During 2017–2018, an active learning approach was added in the embryology unit, which, in addition to the didactic lectures, included presentations made by the students for their peers. The students were divided into groups (10 students in each group) and each group was assigned to an instructor. All the groups were instructed to make a 10-min slideshow presentation about one of the heart's congenital anomalies. Detailed instructions were given about the specific cardiac anomaly with its embryological basis and expected pathophysiological changes in the circulation. Students were encouraged to include illustrative diagrams and relevant radiology images in plain X-rays, CTs, and MRIs. Two students from each group presented the assigned topic to the entire batch and a tutor facilitated group discussions. The students were requested to fill out a questionnaire that recorded their perceptions and opinions about this educational activity.

Active integrated learning approach with feedback

During the following academic year of 2018–2019, further improvements were made to the learning system to enable more active learning with an effective feedback strategy. The sessions encompassed resource sessions carried out faculty and presentations made by students, which were followed by an immediate feedback session led by a panel of faculty to enhance the active learning of students. The faculty panel included an anatomist, a pathologist, and a cardiologist. They attended the students' presentations and monitored the student groups to ensure that each educational activity achieved its learning objectives while also maintaining the group dynamics. Immediate and constructive feedback was provided to each group by the faculty members in the form of an unbiased reflection of events with logical connections. During the feedback session, a faculty member would reflect on the event by shedding light on the students' achievements and shortcomings. Then, the students were invited to describe their perspectives. Finally, the faculty panel would summarize the accomplishment of goals, the areas that need improvement, and a brief roadmap on how to achieve such objectives.

The evaluation of the students' learning of the embryology course was carried out via the use of formative and summative assessments, and the use of their total grades to assess the students' overall performance. The quantitative evaluation of the students' responses to the interventions was performed by using a self-administered questionnaire during an anonymous survey. The creation of questionnaire was a product of an intense review of the available literature. Following this, the tool was adjusted to meet the local context after piloting with 20 students and 10 faculty members. The questions were developed to explore the students' perceptions of the active learning process in the working groups and to measure the faculty feedback about the effectiveness of intervention. The items in the questionnaire were based on a Likert-type rating paradigm, wherein the participants were required to answer their degree of agreement or disagreement on a five-point scale (1 = strongly disagree, 5 = strongly agree).

Statistical analysis

The questionnaire and students' grades were entered in the statistical package of the Social Services (SPSS) software version 22 for statistical analysis. The descriptive analysis was carried out through the use of frequency distribution charts. Parametric tests (e.g., Analysis of Variance [ANOVA]) were applied to analyse the continuous variables and the formative, summative, and total grades obtained across three years. As all the statements in the survey were arranged in an ordinal scale, inferential statistics were performed via non-parametric tests. The non-parametric chi-square test was applied to analyse the statements made in the Likert scales for passive, active, and active with effective feedback sessions. The chi-square test was applied to explore the differences between the observed frequencies and expected frequencies within each statement. A p value of less than or equal to 0.01 was considered significant.

Results

Out of the 349 invited students, 255 participated in this research. There were 90 students in 2016–2017, 80 in 2017–2018, and 85 in 2018–2019. The results of this study show that 56% of the students were satisfied with the passive learning sessions conducted during the first year of study. This number increased to 85% and 84% in the subsequent years (p 0.000), respectively. The results of the chi-square test (X^2, $p < 0.0001$) showed all the statements to be significant, which reaffirmed that the observed frequencies of the students' responses are statistically significant in comparison to the expected frequencies within each category (Table 1).

Furthermore, there was an increase in the students' motivation to attend sessions, which is reflected in 28%, 70%, and 82% of the students' agreements with the statement in the passive, active, and active with effective feedback sessions, respectively. This pattern reflects a gradual increment in the students' participation, which increased from 24% to 69%, and then to 72% over a duration of three years (Figure 1).

With regard to achieving the learning objectives of each educational activity, only 24% agreed that the passive learning sessions met the prescribed objectives. These agreements rose to 75% for active learning sessions and 92% for active learning with effective feedback sessions. Similarly, 11%, 85% and 93% of the students in the respective years agreed that the corresponding sessions provided a conducive environment for inter- and intra-group discussions (p value 0.000) (Figure 2). Moreover, over this period of three years, while 77% of the students understood the topic in the 1st year and 90% of them in the 2nd year, the percentage of them who understood the topic fell to 80% in the 3rd year. However, this fall was not found to be significant ($p = 0.187$).

Responding to the statements about the small working groups used in active learning with feedback sessions, 75% and 78% of the participants found these sessions to be

Table 1: Responses of the students to passive learning, active learning and active learning with feedback strategies using chi-square test.

Learning strategy	N	Likert Scale (1-strongly disagree to 5-strongly agree)					Agreement % of total	χ^2	*P*-value
		1	2	3	4	5			
Passive learning (2016/2017) (n = 90)									
I enjoyed the whole session	90	0	30	10	40	10	55.56%	30[a]	0.00*
I understood the topic taught	90	4	10	7	29	40	76.67%	55[b]	0.00*
The lecture fulfilled the learning objectives needed	90	8	20	40	12	10	24.44%	38[b]	0.00*
The lecture allowed good students' participation	90	3	19	46	20	2	24.44%	71[b]	0.00*
The lectures motivated the students to attend	90	10	30	25	20	5	27.78%	24[b]	0.00*
Lecture provides environment for inter & intra group discussion	90	0	30	50	10	0	11.11%	27[c]	0.00*
Active learning (2017/2018) (n = 80)									
I enjoyed the whole session	80	0	10	2	38	30	85.00%	42[d]	0.00*
Student Working Groups (SWG)									
SWG enabled better understanding of the topics	80	3	2	3	55	17	90.00%	128[e]	0.00*
SWG enabled better fulfillment of the learning objectives	80	3	7	10	40	20	75.00%	55[e]	0.00*
SWG ensured greater students' participation	80	2	15	8	40	15	68.75%	76[e]	0.00*
SWG helped me to identify my strengths and weaknesses	80	2	16	2	40	20	75.00%	92[e]	0.00*
SWG builds self-esteem through conversations with other students	80	1	5	4	50	20	87.50%	109[e]	0.00*
Presentations (PPT)									
PPT provide environment for inter & intra group discussion	80	0	7	5	44	24	85.00%	111[d]	0.00*
The process increased the motivation to attend	80	2	12	10	27	29	70.00%	152[e]	0.00*
PPT increased enthusiasm for learning in students and instructors	80	0	4	1	55	20	93.75%	119[d]	0.00*
PPT required greater effort on the part of students as compared to traditional teaching methods	80	0	6	4	60	10	87.50%	115[d]	0.00*
The faculty has provided me with specific advice on how to improve my performance	80	0	4	10	36	30	82.50%	134[d]	0.00*
I like to have more such sessions to be organized in the future	80	2	8	2	48	20	85.00%	93[e]	0.00*
Active learning with effective feedback (2018/2019) (n = 85)									
I enjoyed the whole session	85	0	6	8	53	18	83.53%	67[f]	0.00*
Student Working Groups (SWG)									
SWG enabled better understanding of the topics	85	3	9	5	49	19	80.00%	84[g]	0.00*
SWG enabled better fulfillment of the learning objectives	85	0	2	5	58	20	91.76%	93[f]	0.00*
SWG ensured greater students' participation	85	6	10	8	47	14	71.76%	68[g]	0.00*
SWG helped me to identify my strengths and weaknesses	85	6	8	5	50	16	77.65%	87[g]	0.00*
SWG builds self-esteem through conversations with other students	85	2	8	7	53	15	80.00%	100[g]	0.00*
Presentations (PPT)									
PPT provide environment for inter & intra group discussion	85	0	3	3	60	19	92.94%	102[f]	0.00*
The process increased the motivation to attend	85	2	8	5	60	10	82.35%	138[g]	0.00*
PPT increased enthusiasm for learning in students and instructors	85	1	4	7	54	19	85.88%	112[g]	0.00*
PPT required greater effort on the part of students as compared to traditional teaching methods	85	0	2	4	61	18	92.94%	106[f]	0.00*
The faculty has provided me with specific advice on how to improve my performance	85	2	11	5	57	10	78.82%	121[g]	0.00*
I like to have more such sessions to be organized in the future	85	2	14	2	55	12	78.82%	113[g]	0.00*

PPT; powerpoint presentation.

Note: SWG small working groups n: number of students; Likert Scale (1-strongly disagree to 5-strongly agree): 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, and 5 = strongly disagree; The minimum expected cell frequency: a = 22.5, b = 18.0, c = 30.0, d = 20.0, e = 16.0, f = 21.3, g = 17.0; $\chi 2$ = Chi-square test statistics; and* represents p value < 0.01.

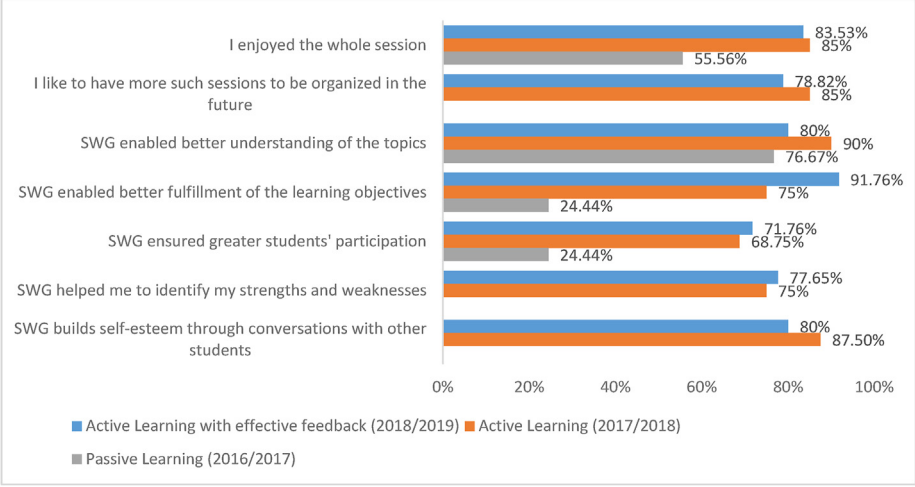

Figure 1: Percentage of students who agreed with the corresponding statements in each learning strategy with focus on the effect of the small working groups.

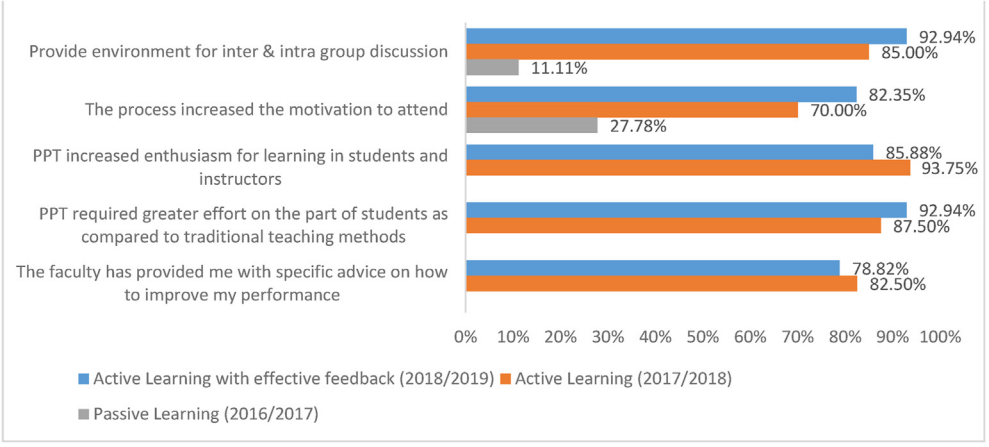

Figure 2: Percentage of students who agreed with the corresponding statement in each learning strategy with focus on the effect of powerpoint presentations.

Table 2: Average, minimum and maximum scores of formative, summative and total grades of students during passive learning, active learning and active learning with feedback.

Teaching strategy	Scores		
	Average score	Minimum score	Maximum score
Passive Learning (2016/2017)			
Formative assessment	50.00%	10.00%	90.00%
Summative assessment	60.92%	30.00%	100.00%
Total Grade	74.49%	57.00%	92.00%
Active learning (2017/2018)			
Formative assessment	52.41%	10.00%	90.00%
Summative assessment	72.53%	30.00%	100.00%
Total Grade	77.84%	57.00%	94.00%
Active learning with effective feedback (2018/2019)			
Formative assessment	70.24%	20.00%	100.00%
Summative assessment	81.41%	50.00%	100.00%
Total Grade	78.31%	59.00%	95.00%

Table 3: Formative, summative, and total grades of the students during passive learning, active learning and active learning with feedback using ANOVA analysis.

Statistics	Formative Assessment	Summative Assessment	Total Grade
Average	57.54%	71.62%	77.88%
Between group			
Sum of squares	20178.44	16881.19	683.59
Mean Squares	10089.22	8440.60	341.80
Within group			
Sum of squares	78313.37	5383.79	15796.00
Mean Squares	324.95	223.38	65.54
F statistics	31.04	37.78	5.21
p-value	0.000*	0.000*	0.006*

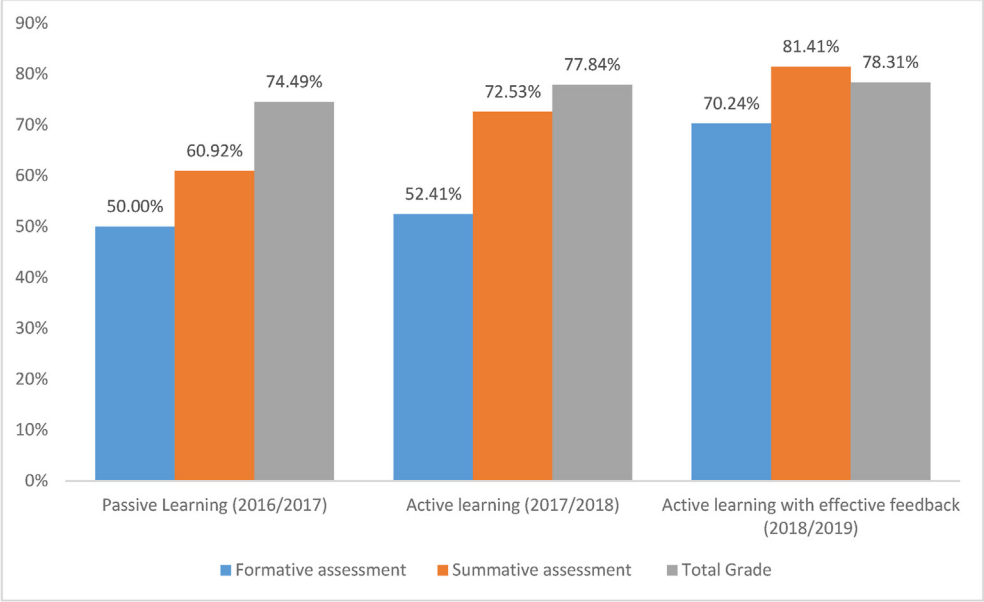

Figure 3: Average scores of formative, summative and total grades of the students using three learning strategies.

helpful in identifying their strengths and weaknesses (Table 2). Moreover, the students pointed out that both the active learning sessions required a greater effort than that required for traditional teaching methods. Although, 88% of the students agreed that the small working groups in the active learning sessions helped them build their self-esteem. This value dipped down to 80% in the following year.

Results of ANOVA analysis of formative, summative and total grades showed a significant increase across three years, with the *p* values being 0.000, 0.000, and 0.006, respectively (Table 3). Interestingly, higher academic grades were reported across the formative and summative assessments, and to a lesser degree with regard to total grades, which sheds light on the importance of having active learning with effective feedback (Table 3 and Figure 3).

Discussion

Our study provides insights on the impact of active learning using immediate feedback in a selected cohort of medical students in embryology courses. The academic performance and the active engagement of students were remarkably enhanced by the educational intervention where the students were empowered to present their learning experiences under direct supervision. Lastly, the impact of small group teaching was significant, as reflected in the students' responses and their satisfaction with the educational reforms in this study.

Active learning pedagogies have proved to be one of the key strategies to be employed in teaching. It makes students feel more in charge of their learning and makes it more relevant and meaningful.[27–29] Our study results have shown active learning sessions to be significantly more enjoyable with there being an increase in the motivation of students. This is reflected in the students' agreement with the questionnaire statements and the students' participation over the three years period. In the study by Cavanagh et al., the researchers have indicated that students appreciated a mix of the conventional lecturing and collaborative learning responsibilities, especially the diversity of activities, the opportunities for small-group and whole–class interactions, and the authenticity of their

responsibilities.[30] Likewise, they have reported that a high degree of interactivity promotes extensive advances in learning.[31] The authors have argued that a movement beyond traditional lecturing and towards more applied techniques and small-group pedagogy may be a way forward to promote teaching perfection.[31] Switching from an instructor-centred to a learner-centred format led to there being a significant improvement in the students' performances.

In our study, the active learning strand in the embryology sessions has been perceived to contribute toward a better understanding of the topic and help the students achieve the desired course objectives. Having carried out a meta-analysis, Freeman et al. have suggested active learning to be one of the core topics in the current day medical education and have considered it to result in an improved students' performance and better learning outcomes.[27] Similarly, Gross and colleagues have reported active learning to have a positive and measurable impact on students' academic performance.[32] Several other studies have successfully proven or confirmed the impact of active learning and feedback on medical students' engagement and academic performance.[33–35]

Researchers have indicated learning to not be related to teaching hours and there to be a weak correlation between classroom attendance and course grades.[36,37] In our study, getting the students to present their work in small groups guaranteed greater student participation. This strategy remarkably increased the students' motivation, as illustrated by the agreement rates that increased from 28% in the first year to 82% in the third year. Literature has shown that learner-centred education strategies tend to yield better self-reported engagement on the part of students.[38,39] Christopher Uhl has rightly stated that students' engagement 'is the power to transform classrooms from tedious, lifeless places to alive, authentic relationship-rich environments'.[39]

Another crucial dimension of our study was to determine the synergistic impact of providing effective feedback on students' learning and analyse the students' perceptions about this intervention. The provision of effective and specific feedback served to enhance students' collaboration and engagement, which was statistically significant. Furthermore, motivation (with the rate of agreement rising from 24% in the first year to 72% in the third year when effective feedback was added), satisfaction, and a successful achievement of the learning objectives were observed in the third year of intervention. Additionally, effective feedback was associated with higher grades and has been perceived well by the learners as it helped reduce the gaps in their learning. Likewise, a large number of reports have shown that effective feedback was associated with a better academic performance and giving proper feedback was associated with a better achievement of learning outcomes,[40–44] for it offered a two-dimensional advantage to both the students and faculty.[45]

In our study, the students were remarkably motivated as they favoured active learning over the traditional instructor-oriented apprenticeship approach of teaching. Interestingly, more than 70% of the students proposed that the new teaching strategy provided them with an insight on their strengths and weaknesses. Perhaps the use of traditional lectures and other forms of faculty-centred teaching should be questioned in the light of the enormous volume of evidence that goes with active learning, and our results are no different in this regard.

Study limitations

This study sample is too small to draw major conclusions. Similar cohort studies with larger groups of medical as well as health sciences schools are essential to validate the findings of our study.

Conclusion

This study validates the effectiveness of constructive feedback with regard to the academic performance in the embryology course. Active learning through an integrated educational pedagogy significantly improves academic performance. A diverse educational approach of active integrated learning followed by faculty feedback can be embedded into medical curricula.

Source of funding

This research did not receive any specific grant from the funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

The authors have no conflicts of interest to declare.

Ethical approval

The research was approved by the Research Ethical Committee of the University of Sharjah (REC/27/10/15/43).

Informed consent

A written informed consent was obtained from all of the study participants.

Authors' contributions

MAE conceptualized the main research topic, supervised and conducted the research, and collected and analysed the initial data. SYG performed advanced data analysis, reviewed the initial and final draft, and enriched the literature review. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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