

Evaluation of Effectiveness of an Online Self-directed Learning Programme in Biochemistry for First-year Medical Undergraduate Students: A Quasi-experimental Study

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ABSTRACT

Introduction: Self-directed Learning (SDL) has been suggested as a principle of adult learning to promote lifelong learning abilities among students. Though SDL is not a new concept, there is a lack of uniform implementation across the institutions in India. The Competency-based Medical Education (CBME) proposed by the National Medical Commission in 2019 has emphasised SDL for medical students.

Aim: To evaluate the effectiveness of an online, case-based SDL activity in Biochemistry for the first-year MBBS students.

Materials and Methods: This was a quasi-experimental study conducted at Father Muller Medical College, Mangaluru, Karnataka, India from May to July 2021. A purposive sampling technique was used, and 138 first-year MBBS students were enrolled for the research. The topic of lipid metabolism was chosen for SDL. Parallel to the online didactic lectures, a case-based, team-based, online SDL was implemented. Students were provided with case scenarios and were instructed to discuss the case scenarios and find answers to the accompanying questions in allotted groups for 15 days. A three-hour session was held for the presentation of the SDL, followed by a post-test and reflections of students. The data were analysed using Statistical Package for Social Sciences (SPSS) version 25.0. The

significance of the difference in pretest and post-test scores was assessed by paired t-test, and the level of significance was set at a p-value <0.05. Qualitative data were subjected to descriptive statistics, and thematic analysis of reflections was conducted.

Results: The average post-test score of the participants was significantly higher by 99.3% compared to the pretest score (p-value <0.001). On average, 108 out of 138 (78.2%) agreed (agree/strongly agree) that SDL helped them to achieve the learning objectives, 115 (83.3%) agreed that SDL helped them to develop as lifelong learners, 115 (83.3%) agreed that SDL helped them to develop as a health professional, and 83 (60.1%) agreed that enjoyed learning in online mode. The inclination of 110 (79.7%) students to have more SDL sessions in the future shows a behavioural change in favour of SDL. Time constraints and internet connectivity were the main challenges.

Conclusion: SDL was effective and was received positively by the majority of the students. It is the need of the hour to develop lifelong learning and critical thinking among medical students and to make learning interesting with the use of case scenarios. Future research should assess the intermediate and long-term outcomes of case-based SDL on learning, behavioural changes, and its impact on patient care and the health of society.

Keywords: Competency, Critical thinking, Group dynamics, Lifelong learning, Self-learning

INTRODUCTION

The SDL has been defined by Knowles MS as “A process in which a learner takes the initiative, diagnoses their learning needs, creates learning goals, identifies resources for learning, applies appropriate learning strategies, and evaluates their learning outcomes” [1]. Though SDL is not a new concept, there was a lack of uniform implementation across the institutions [2,3]. In SDL, the learner is fully responsible for achieving the learning goals, identifying resources, thinking, and discussing with peers and facilitators. This method of learning is proposed to develop lifelong learning skills among medical students [3,4]. SDL comprises personal attributes of a learner such as self-efficacy, intrinsic motivation, self-assessments, beliefs, learning styles, and ability to set goals and involves the application of critical thinking, self-management, social, communication, research, and analytical skills [5-7]. As the learner takes the initiative and controls the direction of learning in SDL, it is not synonymous with “self-learning,” and the locus of control is “internal” with regard to the learner rather than the “external” as in the case of traditional methods of teaching-learning [7].

Implementation of SDL in the medical course is a challenging task due to lack of preparedness by faculties and students, requirement for various resources, lack of adaptability from teacher-centered

didactic lectures to a more learner-centered method, hesitation, and resistance from faculty to change from the role of teacher to facilitator [2-4]. The online mode has its own inherent limitations [7-9].

Compared to the didactic lectures, SDL drives the learners to build self-learning skills, develop higher-order thinking, learn with peers, and work as a team in a learner-centered active process [3,5]. There is a paucity of studies on the implementation of SDL and evaluation of its effectiveness in the Indian context, especially in the subject of Biochemistry. SDL in an online environment may assist in supporting student learning and performance when direct physical/offline access between teachers and students is not possible, in situations such as the Coronavirus Disease-2019 (COVID-19) pandemic. Most of the didactic teaching sessions were held online as the students were physically away from the institution during the COVID-19 pandemic.

Therefore, the aim of this study was to assess the effectiveness of an online, case-based SDL program of Biochemistry for first-year medical undergraduate students.

MATERIALS AND METHODS

This quasi-experimental study was conducted at Father Muller Medical College, Mangaluru, Karnataka, India over a period of three

months, from May to July 2021, involving first-year MBBS students. This research was conducted after obtaining approval from the Institutional Ethics Committee (approval no. FMIEC/CCM/349/2021) and with voluntary, informed consent from the study participants.

Inclusion criteria: All consenting first-year MBBS students of the institution who were able to attend the online didactic lectures and SDL were included in the study.

Exclusion criteria: Incompletely filled details and students who were not willing to be part of a team were excluded from the study.

Purposive sampling was utilised to recruit the study subjects. Out of the total 148 students who attended the didactic lectures on lipid metabolism and participated in the SDL, 138 students voluntarily consented to be part of the research. Therefore, 138 participants were included in this research. However, all 148 students participated in the SDL and benefited from the program.

Implementation of SDL: As per the undergraduate curriculum provided by the National Medical Council, 5% of the total teaching-learning hours were allocated for the discussion of SDL topics [10]. The faculty of the Department of Biochemistry generated several SDL topics from the chapter on lipid metabolism, involving clinical implications and higher-order thinking. Both didactic lectures and SDL sessions were held online. The didactic lectures on lipid metabolism were scheduled online according to the institution's teaching program, aligning with the competencies specified by the National Medical Council [10]. Case scenarios provided for SDL were not discussed in the didactic lectures.

In the initial class on lipid metabolism, the facilitators explained the SDL method and administered a pretest to the students. Five case scenarios related to lipid metabolism (primary carnitine deficiency, medium-chain acyl-CoA dehydrogenase deficiency, Gaucher's disease, familial

hypercholesterolemia, and type I dyslipoproteinemia) were provided to the students. These case scenarios were accompanied by questions on probable diagnosis, biochemical and genetic basis, reasoning for clinical manifestations, and laboratory tests.

The students were divided into 15 batches. They were asked to search for learning resources, work individually and as a group to formulate answers for the questions in the provided case scenarios. There was regular student-student and student-facilitator communication online.

The facilitators compiled the cases, briefed the students on the SDL process, guided them in SDL whenever requested, moderated the presentation session, clarified the learners' doubts, and finally provided the students with learning material containing key answers and explanations for the cases.

Assessment of SDL: During this synchronous SDL presentation session, a member who was picked by the group presented the learning achieved (in the form of answers to the questions related to the case scenarios) as a PowerPoint presentation on an online platform. The facilitators moderated this three-hour session. Due to time constraints, one group was picked for the presentation of a case, with two other teams picked for reacting and providing inputs. Finally, participation of all groups was ensured. The facilitators only gave their inputs on the learning achieved and provided required clarifications.

The assessment of reaction and learning was done using the Kirkpatrick model at two levels [11]. Reactions: Level 1 of the Kirkpatrick model assessed the reactions of learners. Themes identified from the responses to open-ended questions included exploring resources, the learning process, basic-clinical correlation, higher-order thinking, teamwork and communication, creativity, confidence, time allotted, and the role of facilitators. Detailed thematic analysis is presented in [Table/Fig-1].

Questions asked	Theme	Responses from students
1) What went well this method of learning?	Exploring resources	"Being able to go through articles and understand the information"; "We were able to dig deeper into the subject and also make use of various online research platforms which helped in finding answers to our questions"; "We got to learn from many sources other than the textbook"; "Exploring something out of our text books"; "Getting used to reading research articles"; "We did research in depth about the topics; The individual research that we did helped us gain a lot of knowledge".
	Learning process	"Got to learn many new things in a different way"; "Interactive learning"; "It was very interesting"; "we were bored of usual online class".
	Basic-clinical correlation and higher order of thinking	"I was able to correlate basic science with clinical findings of diseases"; "required high thinking level and correlation"; "Got a better understanding of the topics"; "The case topics were very interesting"; "The SDL encouraged us to critically analyse the case and using various resources like textbooks, research papers, other similar case studies"; "The type of questions asked promoted higher order of thinking"; "clinical cases helped us in finding current diagnostic methods and correlating our textbook material with their clinical applications".
	Team work and communication	"Team work helped in learning"; "It was fun to discuss the case with our peers and have group discussions"; "We also learned how to work as a team and coordinate to complete the work"; "All of us in the group worked hard with team spirit"; "We got to know many points from others as well as our group members"; "Everyone had to put in efforts to collect data and make the presentation so we got to learn a lot of information"; "Participation of everyone"; "The fact that you were able to analyse and discuss with your peers the various case scenarios is something I loved."; "Given the pandemic and circumstances around us, this was an amazing way to interact with batchmates and also understand things from their perspective and work together as a team"; "Coordination in the team was very good. We actually learnt much more by sharing the topics into smaller and later letting know the different point of views of different person"; "It was nice to work as a team during lockdown and isolation"; "It helped us work on our communication skills and teamwork".
	Creativity	"We had fun studying and making powerpoints"; "It helped us show our creativity".
	Confidence	"SDL increased self-confidence"; "We could learn something on our own public speaking"; "bring us out of our shell, to courageously present in front of people".
	Time allotted for SDL	"Appreciate the time slot given for us to prepare ourselves for this activity, It was so sufficient"; "That we were given a good amount of time to do our own studying depending on our personal schedules and discover the answers on our own".
	Role of facilitators and the presentation session	"That we were divided into 1 presenting and 2 supporting groups was the best"; "Discussions after each case presentation were the best".
2) What could have been done better to improve conduct of SDL?	Presentation of SDL	"More time could have been given for presentation"; "Each group could be allowed to present each case rather than picking the group for each case"; "Probably a little more interaction involving a lot of members"; "If a SDL is to be conducted next time new people could get a chance to present"; "Not all the participants will know all the answers, at least by asking them question they get to know what they don't know"; "If it was held like a debate session it would be fun"; "More opportunities for debate and countering from members other than the three main assigned groups"; "Instead of one 3 hour session, we could have done it in 3 one hour sessions, increase in duration people tend to lose interest"; "Maybe made more interactive".
	Facilitators	"One teacher could have been allotted to each group to moderate the learning instead of two teachers as overall facilitators"; "If we were given a basic idea about where to search for the information we could save a lot of time as many of us have no idea about this"; "Maybe teachers could've given more input about the cases".
	Team	"Instead of making the groups roll number wise, we could have groups assigned randomly"; "we could have been allowed to choose groups on our own"; "smaller groups would be better".

3) What are the challenges and limitations of online SDL as per your experience? (Mention whatever challenges you faced or whatever limitations you felt)	Access to internet and network availability	"Network and internet issues affected the online learning and interactions"; "The video calls get connected in online sometimes".
	Demerits of online mode	"Interactions were not as effective as offline"; "lack of face to face interaction with teammates and teachers"; "Concentrating for long sessions using an electronic screen"; "It is very difficult to discuss online as all don't participate".
	Availability of learning resources	"Inability to access resources online especially some research papers"; "lack of access to material present in our college library as students were out of the campus".
	Time factor	"Time constraint for SDL along with other learning programs of three subjects in first year MBBS".
	Team work	Opinion of group leaders: "Challenging to make all the group members participate in the discussion. Since few members of the group were not actively participating, forcing them to participate was very challenging task"; "The time we could spend together as group was very limited".
	Personal issues	"One student's house getting flooded"; "family members suffering from COVID"; "It is hard for everyone to coordinate at a specific due to personal reasons".

[Table/Fig-1]: Assessment of SDL as per Kirkpatrick Level-1: thematic analysis of the reactions from students.

Responses of learners to "what could have been done better?" included more time allotted for learning, more interactions in the team, the opportunity for more students to do presentations, having a debate, expecting more inputs from facilitators, and involving a greater number of facilitators. Access to the internet and network availability, online interactions not being as effective as offline/physical, time constraints, and personal issues were also detailed in [Table/Fig-1].

Additionally, a five-point Likert Scale with options of "Strongly Disagree", "Disagree", "Neutral", "Agree", and "Strongly Agree" was used for statements on achieving learning objectives, lifelong learning and the physician of the future, professionalism, involvement in learning, and feedback on the online mode of learning.

Learning was assessed by a pretest and post-test with 15 multiple-choice questions of higher order thinking (reasoning, diagnosis, calculation, biochemical, and molecular basis). There were 15 multiple-choice questions in the pretest/post-test, and each question carried one mark. Students were graded based on performance in the pretest and post-test as follows: excellent (>90% score), very good (76-90% score), good (61-75% score), satisfactory (51-60% score), average (41-50% score), and below average (<=40% score).

The percentage change in the post-test was calculated using the following formula:

Percentage change in post-test=(Difference in the number of students who answered the question correctly in pretest and post-test/Number of students who answered the question correctly in pretest)×100.

STATISTICAL ANALYSIS

The data was analysed using SPSS version 25.0. The scores of students in the pretest and post-test were expressed as mean±SD.

Theme	Responses	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. Achieving learning objectives	The pre briefing helped me to work on my SDL	0	1 (0.73%)	28 (20.29%)	72 (52.17%)	37 (26.81%)
	Didactic lectures on lipid metabolism provided the basic foundation for my SDL participation	2 (1.45)	1 (0.73)	29 (21.01)	71 (51.45)	35 (25.36)
	SDL helped me to set my learning objectives based on the given competencies	1 (0.73)	2 (1.45)	27 (19.56)	71 (51.45)	37 (26.81)
	Because of this SDL I was able to achieve the competencies required as per competency based medical education	1 (0.73)	2 (1.45)	29 (21.01)	75 (54.35)	31 (22.46)
	SDL helped me to gain new clinical knowledge	1 (0.73)	1 (0.73)	12 (8.70)	62 (44.92)	62 (44.92)
	SDL has enabled me to correlate basic science knowledge with clinical application in diagnosis and management of diseases	1 (0.73)	0	11 (7.97)	75 (54.35)	51 (36.95)
2. Life Long learner and physician of future	SDL project helped me to gain better insights of patient care with the help of appropriate diagnostic tests and I felt empowered for decision making	1 (0.73)	0	33 (23.9)	56 (40.58)	48 (34.78)
	This SDL project has helped in my development as a life-long learner	0	2 (1.45)	21 (15.21)	51 (36.95)	64 (46.38)
	I will use SDL as a physician in future	1 (0.73)	2 (1.45)	29 (21.01)	61 (44.20)	45 (32.61)
	I am more confident in using evidence based practice for patient care	1 (0.73)	2 (1.45)	24 (17.39)	67 (48.55)	44 (31.88)
	I have become more efficient in identifying the learning resources for improving my knowledge in clinical Biochemistry	1 (0.73)	1 (0.73)	27 (19.56)	81 (58.69)	28 (20.29)

The significance of the difference scores was assessed by paired t-test. The comparison of the percentage of students who answered correctly in the pretest and post-test for each question and the reflections were presented as descriptive statistics. The reactions were subjected to thematic analysis.

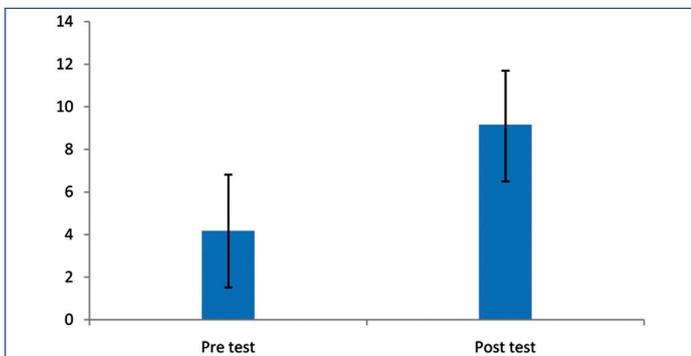
RESULTS

108 out of 138 (78.2%) agreed (agree/strongly agree) that SDL helped them to achieve the learning objectives, 115 (83.3%) agreed that SDL helped them to develop as lifelong learners, 115 (83.3%) agreed that SDL helped them to develop as a health professional, and 83 (60.1%) agreed that enjoyed learning in online mode. The inclination of 110 (79%) students for having more SDL sessions in the future shows a behavioural change in favour of SDL. When students were asked to reflect on the online mode of SDL compared to offline and other methods of teaching and learning, 78 (56.5%) either agreed or strongly agreed that the online mode of SDL is feasible. Feedback on whether the "online mode of SDL is as effective as offline" showed that 54 (39.1%) agreed or strongly agreed, 43 (31.1%) disagreed or strongly disagreed, and 41 (29.7%) showed neutral stance. 73 agreed or strongly agreed that online SDL is a better option compared to other online teaching learning methods (like didactic lectures/small group discussion) [Table/Fig-2].

Learning: As shown in [Table/Fig-3], the average post-test score of the participants was significantly higher compared to the pretest (p -value <0.001). When assessing the number of students who answered the questions correctly in the pretest and post-test, for each question, the number was higher in the post-test than in the pretest. Grading of students based on the score showed that the number of students in the "excellent," "very good," and "good" categories was zero in the pretest, while 52.9% of the students (73 out of 138) were

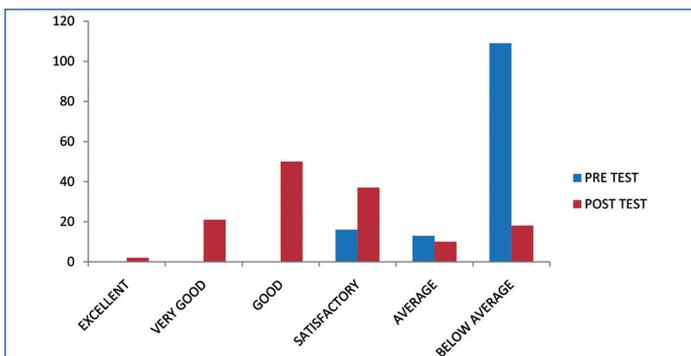
3. Professionalism	I have spent adequate and appropriate time in SDL	1 (0.73)	0	43 (31.16)	56 (40.58)	38 (27.54)
	I have learnt time management skills due to my involvement in SDL	0	2 (1.45)	21 (15.21)	62 (44.93)	53 (38.41)
	All the members of my group have contributed significantly to the SDL process	1 (0.73)	2 (1.45)	28 (20.29)	61 (44.20)	46 (33.33)
	My teammates helped in the learning	1 (0.73)	2 (1.45)	24 (17.39)	66 (47.83)	45 (32.61)
	I learnt how to work in a team	1 (0.73)	1 (0.73)	27 (19.56)	66 (47.83)	43 (31.16)
	Working in a team improved my communication skills	1 (0.73)	0	43 (31.16)	56 (40.58)	38 (27.54)
	This SDL project helped me to develop me as a health professional (integrity, ethics, right attitude and interpersonal relations)	0	2 (1.45)	21 (15.21)	62 (44.93)	53 (38.41)
4. Involvement in learning	The learning environment was comfortable	1 (0.73)	2 (1.45)	28 (20.29)	64 (46.38)	43 (31.16)
	I enjoyed learning by online SDL mode	0 (0)	9 (6.52)	46 (33.33)	49 (35.5)	34 (24.64)
	I was very much involved and engaged myself-in the SDL	1 (0.73)	3 (2.17)	21 (15.21)	76 (55.07)	37 (26.81)
	I gained confidence in my learning and acquisition of skills by SDL	1 (0.73)	2 (1.45)	22 (15.94)	74 (53.62)	39 (28.26)
	SDL prompted me to develop higher order thinking	1 (0.73)	2 (1.45)	17 (12.31)	78 (56.52)	40 (28.99)
	SDL was more learner-centred and active learning than didactic lectures	1 (0.73)	2 (1.45)	15 (10.87)	74 (53.62)	46 (33.33)
	The pretest/post-test questions involved higher order of thinking (reasoning) than just recall type	1 (0.73)	5 (3.62)	17 (12.31)	67 (48.55)	48 (34.78)
	Debriefing by the facilitators provided valuable feedback on my learning	1 (0.73)	1 (0.73)	21 (15.22)	73 (52.9)	42 (30.43)
5. Online mode of learning	Online mode of learning was feasible	1 (0.73)	6 (4.35)	53 (38.41)	60 (43.48)	18 (13.04)
	Online mode of SDL is as effective as offline mode	11 (7.97)	32 (23.19)	41 (29.71)	37 (26.81)	17 (12.32)
	Online mode of acquiring the reasoning and communication skills by SDL was effective	1 (0.73)	5 (3.62)	52 (37.68)	55 (39.85)	25 (18.11)
	In the present context of pandemic, online SDL is a better option compared to other online teaching learning methods (like didactic lectures/small group discussion)	7 (5.07)	14 (10.14)	44 (31.88)	58 (42.03)	15 (10.87)
	I would like to have more SDL sessions in future	2 (1.45)	4 (2.90)	22 (15.94)	58 (42.03)	52 (37.68)

[Table/Fig-2]: Reflections of students on the SDL program (Responses are indicated as number; % of respondents is given in paranthesis) - Achieving Learning Objectives (Level 1- Kirkpatrick Model); n=138.



[Table/Fig-3]: Average scores of the students in pretest and post-test (pretest score= 4.17±2.65; post score= 9.16±2.54; significance of difference p-value <0.001.

in these categories in the post-test [Table/Fig-4]. On average, the number of students who answered correctly increased by 99.3% in the post-test compared to the pretest [Table/Fig-5].



[Table/Fig-4]: Number of students who scored excellent (>90%), very good (76-90%), good (61-75%), satisfactory (51-60%), average (41-50%) and below average (<=40%) in pretest and post-test- Comparison (X-axis: grades; Y-axis: number of students).

Question theme	Number of students who answered correctly		Change in post-test in comparison to post-test (number of students who answered correctly is compared)*
	Pretest	Post-test	
Case Report of Lecithin Cholesterol Acyl Transferase (LCAT) Deficiency and question on the enzyme activity and co-factors	62 (44.9%)	71 (51.4%)	+14.52%
Identifying the enzymes of carnitine biosynthesis	46 (33.6%)	83 (60.6%)	+80.44%
Identifying a disorder which is not a lysosomal storage disorder	63 (45.2%)	117 (84.9%)	+85.71%
Atherogenic lipoprotein phenotype	66 (47.8%)	92 (66.7%)	+39.39%
Biochemical basis of use of Miglustat in treating Gaucher's disease	81 (59.1%)	95 (72.1%)	+17.28%
Mechanism of action of Clofibrate	61 (44.7%)	69 (50%)	+13.11%
Reason for hyperlipoproteinemia in Apo CII Deficiency	52 (37.8%)	97 (70.5%)	+86.54%
Categorisation of plasma LDL cholesterol levels as per the National Cholesterol education Programme Adult Treatment Programmell (NCEP ATP III) criteria	29 (21.4%)	45 (32.6%)	+55.2%
Molecular basis of Familial hypercholesterolemia	72 (52.1%)	92 (66.9%)	+27.8%
Calculation of LDL-Cholesterol by Friedwald's formula	10 (7.2%)	72 (52%)	+620%
Reason for milky serum in a patient with Type I hyperlipoproteinemia	49 (35.6%)	85 (61.3%)	+73.5%
Giving the probable diagnosis based on clinical and laboratory findings (Fabry's disease)	66 (47.9%)	95 (69.1%)	+43.9%

Reasoning for Hypoglycaemia in Medium Chain Acyl CoA Dehydrogenase Deficiency	48 (34.9%)	90 (65.2%)	+64.4%
Reasoning for Hyperammonaemia in Medium Chain Acyl CoA Dehydrogenase Deficiency	17 (12.3%)	44 (32.1%)	+158.8%
Probable diagnosis based on clinical and laboratory findings (Primary Carnitine Deficiency)	44 (31.9%)	92 (66.7%)	+109.1%
	Average of percentage changes in all questions (comparison of number students who answered correctly in post-test with pretest)		+99.3%

[Table/Fig-5]: Analysis of correct responses for each question.

DISCUSSION

Online, case-based SDL received positive reactions from the majority of the students, and they showed a favourable attitude toward more such sessions of SDL in the future. The effectiveness of SDL was evident through significantly improved learning of the topic of lipid metabolism, as demonstrated by the pretest/post-test results.

The learners' reactions demonstrated their perception of SDL as a method for in-depth learning and resource exploration, promoting confidence, creativity, teamwork, coordination, and basic science-clinical correlation, despite challenges, mainly related to internet connectivity. Previously, Hill M et al., used a team-based SDL method in Microbiology for first-year medical undergraduates and observed a positive response from students and faculty regarding its implementation [6]. Similar observations of positive reactions from learners have been reported in previous studies [2,4].

It was observed that the majority of the students either "strongly agreed" or "agreed" that SDL helped them achieve the learning objectives, identify appropriate learning resources, correlate basic science with clinical practice, develop as lifelong learners, work in a team, develop professionally, create a good learning environment, and enjoy learning. Notably, 87% of the study participants agreed or strongly agreed that SDL is more interactive and learner-centered than didactic lectures, and 85.5% agreed or strongly agreed that SDL promotes higher-order thinking. Similar observations favouring SDL were seen in previous studies [2,4,6]. However, there are research studies reporting that didactic lectures are more effective in gaining knowledge than SDL [8].

The comparison of pretest and post-scores indicates improved knowledge among the students regarding inborn disorders of lipid metabolism. The observation that 53% (73 out of 138) of students scored in the grades of "good to excellent" (>60% score) in the post-test, compared to no students in these categories in the pretest, indicates significant learning that took place through SDL. Previous authors have reported similar observations of improved test scores after SDL [2,12].

SDL in the subject of Biochemistry has been rarely reported by researchers, and present study had the unique distinction of using five case scenarios with questions requiring higher-order thinking. A previous study by Agrawal P and Verma N reported using a case on "Heme Degradation and Jaundice" to allow students to set the learning objectives in groups of 30 students each, with contact sessions over a period of five days followed by discussion of the topic in small group teaching sessions [13]. The authors observed that the overall performance of the students regarding core and clinical aspects of the topic improved considerably after the discussion [13].

The enthusiastic participation of students in SDL, with lots of positive inputs, encourages us to undertake more SDL programs in the future. This study had the uniqueness of using an online mode for SDL in a situation where only online teaching and learning were possible due to the prevailing lockdown imposed in the country. The learners set their learning objectives themselves, searched for learning sources on their own, and derived the required details from these resources. Facilitators were in the background, observing the activity and intervening only to coordinate the group activities. SDL, as a philosophy of adult learning and as the process of building a lifelong learner in medical undergraduates, was facilitated by us.

Limitation(s)

The major limitation was the time constraints involved in allowing all the groups to present all five cases, as the only option in the current context of the COVID-19 pandemic was the online platform. However, attempts to overcome these limitations were made by arranging a presentation session, trying to involve as many students as possible during the presentations, and having frequent interactions with them online. Although efforts were made to safeguard all principles of SDL, some directions had to be given to the students, and a few interventions were required as they were in the process of evolving as "self-directed learners".

CONCLUSION(S)

Online, case-based SDL was effectively implemented for the topic of lipid metabolism in the subject of Biochemistry. Learners showed positive reactions and demonstrated improved learning. SDL is the need of the hour to create interest in learning among medical students and to develop lifelong learners. In the present context of medical education, "teachers" need to take the position of "facilitators" to develop competent physicians of the future.

REFERENCES

- [1] Knowles MS. Self-directed learning. Englewood Cliffs, NJ: Prentice Hall Regents; 1975.
- [2] Ginzburg SB, Santen SA, Schwartzstein RM. Self-directed learning: A new look at an old concept. *Med Sci Educ.* 2021;31(1):229-30.
- [3] Devi S, Bhat KS, Ramya SR, Ravichandran K, Kanungo R. Self-directed learning go enhance active learning among the 2nd year undergraduate medical students in Microbiology: An experimental study. *J Curr Sci Med.* 2016;2(2):80-83.
- [4] Premkumar K, Vinod E, Sathishkumar S, Pulimood AB, Umafulam V, Samuel PP, et al. Self-directed learning readiness of Indian medical students: A mixed method study. *BMC Med Educ.* 2018;18(1):134. <https://doi.org/10.1186/s12909-018-1244-9>.
- [5] Patra S, Khan AM, Upadhyay MK, Sharma R, Rajoura OP, Bhasin SK. Module to facilitate self-directed learning among medical undergraduates: Development and implementation. *J Edu Health Promot.* 2020;9:231. Available from: <https://www.jehp.net/text.asp?2020/9/1/231/296377>.
- [6] Hill M, Peters M, Salvaggio M, Vinnedge J, Darden A. Implementation and evaluation of a self-directed learning activity for first-year medical students. *Med Educ Online.* 2020;25(1):1717780. Doi: 10.1080/10872981.2020.1717780.
- [7] Anshu, Gupta P, Singh T. The concept of self-directed learning: Implications for practice in the undergraduate curriculum. *Indian Pediatr.* 2022;59(4):331-38.
- [8] Maloney S, Tai JHM, Paynter S, Lo K, Lic D. Self-directed online learning modules: Students' behaviours and experiences. *Pharmacy.* 2013;1(1):08-15. <https://doi.org/10.3390/pharmacy1010008>.
- [9] Chaudhuri A, Paul S, Mondal T, Goswami A. A comparative study of telemedicine-assisted teaching classes and flipped classroom-assisted self-directed learning sessions during COVID-19 pandemic among first MBBS students in Burdwan Medical College: A pilot study. *Med J DY Patil Vidyapeeth.* 2020;13(6):608-14.
- [10] Medical Council of India. Competency based Undergraduate curriculum for the Indian Medical Graduate. 2018:1. Retrieved from: <https://www.nmc.org.in/wp-content/uploads/2020/01/UG-Curriculum-Vol-1.pdf>, accessed on 1st May 2021.
- [11] Kirkpatrick DL. Techniques for evaluation training programs. *J Am Soc Training Dir.* 1959;13:21-26.

- [12] Pai K, Rao KR, Punja D, Kamath A. The effectiveness of Self-directed Learning (SDL) for teaching physiology to first-year medical students. *Austral Med J.* 2014;7(11):448-53.
- [13] Agrawal P, Verma N. Prediscussion and post discussion assessment scores in a self-directed learning module implemented in the department of biochemistry. *Indian J Med Spec.* 2020;11(2):81-84.

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