DOI: 10.7860/JCDR/2022/53110.15857

Original Article

Biochemistry Section

An Interventional Study on the Impact of Pictorial Primed Lecture Session towards the Performance at Lower and Higher Cognitive Domain Levels among 1st Year Medical Undergraduates

K GUNANITHI[1], S SAKTHIDASAN[2]

ABSTRACT

Introduction: Lectures play a major role in teaching large group of learners in a medical institution. Priming involves familiarising students with background information on the cognitive content just before its actual delivery during lecture sessions. Considering the monotonous textual lectures of present day medical education, there is always a need for making the lecture sessions interactive at the same time improving the performance of the learners at the cognitive level.

Aim: To assess the performance of 1st year medical undergraduates at lower and higher cognitive domain levels after pictorial concept priming before lecture session.

Materials and Methods: The present study was an educational interventional study and a prospective cohort design, the study was conducted during March to April 2019 in Department of Biochemistry, Melmaruvathur Adhiparasakthi Institute of Medical Sciences (MAPIMS) Tamil Nadu, India, as a part of Advance Course in Medical Education (ACME) 2018B Project work. With sample size suggestion made using universal sampling techniques, 120 Phase I medical undergraduates of both sexes aged 17-21 years were enrolled into the study who were divided into two groups, randomised, cohort-60 and control-60 students. The lecture delivery was on glycolysis pathway for both groups with cohort alone being primed using standardised polygonal pictorial concepts during priming session before lectures. Cognitive performance assessment after lecture being made using validated Multiple Choice Question (MCQ) questionnaire which included five lower cognitive level questions at recalling aspects and five higher cognitive level questions at creating aspects and total attainable cognitive performance score at 10. Scores obtained were tabulated and statistical analysis was done using Independent sample t-test for mean score comparisons and relative risk estimation at lower and higher cognitive domain levels using Statistical Package for the Social Sciences (SPSS) version 18.0.

Results: The results of the present study showed that cohort group who were primed with pictorial concepts had significantly higher mean score at total cognitive performance score (7.03±1.37) than the control group (6.15±1.83) at (t=-2.98, p=0.003) and significantly higher mean score at higher cognitive performance score (3.75±1.14) than the control group (3.20±1.33) at (t=-2.42, p=0.01) who were not primed with pictorial concepts. However, the results obtained at the lower cognitive performance scores which although shows a higher score among cohort group with mean value (3.28±1.09) when compared to control group with mean value (2.95±1.01), the mean difference obtained remains insignificant (t=-1.73, p=0.08). Exposure outcome relative risk estimation on priming exposure to outcome (50% total cognitive score) showed primed group which is RR=1.567 (0.895-2.744).

Conclusion: The study concludes that priming sessions using pictures have a significant impact on improving the cognitive performance of the learners when delivered during lecture sessions in a medical college. Adding to the conclusion, the impact of the pictorial priming sessions is even more on the higher level cognitive performance, which includes evaluating and creating aspects of the knowledge domain. This reiterates the role of the importance of dual added benefits of pictures and priming during teaching cognitive domain aspects of lecture sessions in medical institutions.

Keywords: Blooms taxonomy, Image based learning, Large group teaching, Learning domains

INTRODUCTION

Lectures play a major role in teaching large group of learners in a medical institution. It has stood the test of times since its inception years ago, even till today. Though, there are merits on the part of lectures in imparting knowledge domain, so are the limitations of the conventional lectures which deliver monotonous textual contents making the learners disinterested during sessions. This surely affects the cognitive performance level of the learners [1]. The short attention span of a lecture session is an important factor in having an impact on the performance of the learners. The average attention time for a lecture is around 10-15 minutes while the average lectures session in medical schools clock at 45 minutes. Logically, two thirds of the lecture session times are not attentive for learner community on the whole. So, there is always a need for making the lecture sessions interactive at the same time improving the performance of the learners at the cognitive level, especially at the higher levels of cognitive domain [2].

Priming involves familiarising students with background information on the cognitive content before its actual delivery during lecture sessions. Many experts have noted that priming improves the performance of the students in learning. Furthermore, memory for pictures may be better than for words in priming [3]. The study design is to test, the null hypothesis statement that priming using picture concepts before a lecture session has no impact on the performance of learners at different cognitive levels. Though, lectures are an ideal teaching learning method for imparting cognitive content, there is a constant need for increasing attention span of lecture sessions,

for performance improvement of learners at higher cognitive levels, for overcoming the difficulties in learning pathways and conceptual understanding of chemical structures in biochemistry during lecture sessions [4]. But there is a lack of educational studies on priming during lecture sessions in medical education literature which paves the need for the present study.

In a medical school, 1st year medical undergraduates are the most vulnerable population who are on the cross roads of transition from general school learning to medical college learning. This process of transition needs a lot of attention in improving the teaching learning methods making it interactive and at the same time improving their performance outcomes. Subjects like biochemistry which are an intrinsic part of 1st year undergraduate curriculum is full of structures and pathways which are not only difficult to learn but even more difficult to comprehend, which double burdens the 1st year medical undergraduate's transitional phase. The justification of the need to include only phase I students lies in the participant appropriateness for the content like biochemistry, avoidance of content bias and observer bias if many phases are involved along with avoidance of repetition bias and response bias as other phase medical graduates might already be aware of the content knowledge. The present study will also further the knowledge on the medical graduate's transition phase learning which is a bottleneck moment that not only decides the future of the professional but also the fate of the patient community on the whole. So, the study was aimed at assessing the performance of 1st year medical undergraduates at lower and higher cognitive domain levels after pictorial concept priming before lecture session.

MATERIALS AND METHODS

An educational interventional study and a prospective cohort design, the study was conducted under the project requirement of ACME 2018B batch Project work under Medical Council of India (MCI) nodal center, National Faculty Development Programme, Christian Medical College Vellore, Tamil Nadu, India. Institutional Ethical Committee (IEC) approval was obtained before actual conduct of the study {Ref No.:MAPIMS/IEC/52/2019/ 113(02)2019}. The period of study was during March-April 2019 in Department of Biochemistry, Melmaruvathur Adhiparasakthi Institute of Medical Sciences and Research, Melmaruvathur, Tamil Nadu, India. Informed consent was obtained from all learner participants before the conduct of the study.

Sample size: Considering the lack of prior similar studies, the sample size for the study was suggested by the institutional statistician using universal sampling techniques with a minimum sample size of 30.

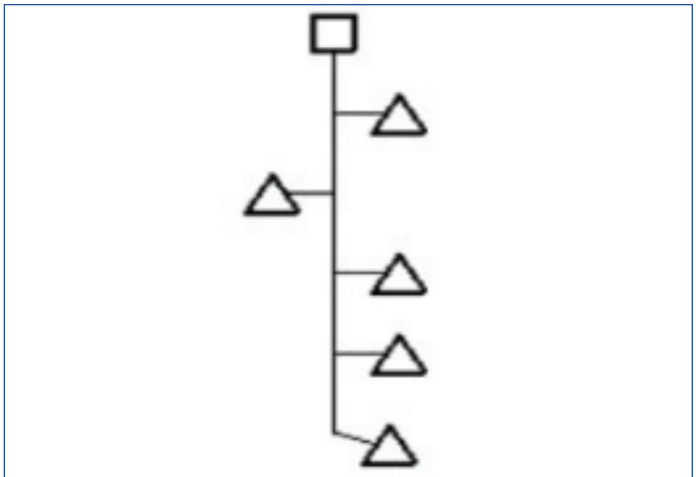
Inclusion criteria: The eligibility criteria for both the cohort and control group were Phase I medical undergraduates. Both the groups being age and sex matched.

Exclusion criteria: Student not welling to participate in the study were excluded.

Study Procedure

Out of the eligible, 150 Phase I medical undergraduates, the total number of study participants enrolled into the study included 120 Phase I medical undergraduate students of the medical college. The participants were divided into two groups, randomised, cohort-60 and control-60 students of both sexes aged 17-21 years.

Lecture content preparation and delivery: The lecture delivery for the both the groups were on the topic of glycolysis pathway on the same day by the same lecturer [5]. The lecture delivery for the control group was done using only the standardised textual content of the topic detailing the steps of the glycolysis pathway by conventional powerpoint presentations using standardised textual contents with total duration of the lecture approximately 30 minutes. The lecture delivery for the cohort group was primed with standardised polygonal pictorial concepts (pictured reasoning of steps) as illustrated in [Table/Fig-1] followed by the standardised textual content of the topic detailing the steps of the glycolysis pathway using same conventional powerpoint presentations with total duration of the lecture approximately 45 minutes (with priming session close to 15 minutes) [6]. The only difference being the session using pictorial concepts as a priming to the lecture for the cohort group and not for the control group.



[Table/Fig-1]: Standardised polygon picture model of glucose used during priming part of lecture session on glycolysis. Source: Bonafe CFS et al., [6].

Questionnaire validation: The performance assessment method of the cognitive domain levels for both the control and cohort groups were done immediately after the content delivery [2]. MCQ were selected as the assessment method with questions being prepared using standard contents [5]. The questionnaire was validated for the content appropriateness using validity framework by Thomsen AS et al., for the relevance of the test content to different cognitive domain aspects by five individual subject experts of the institution on a scale (0-Irrelevant to 5-Highly relevant) which was assessed by reliability analysis for relevance using cronbach's alpha= 0.872 {95% C.I (0.602-0.985)} before being presented for assessment [7].

Assessment: The validated MCQ selected for the performance assessment included 10 questions in total at two different levels (Five lower cognitive level questions were at recalling and understanding level of cognitive domain of revised blooms taxonomy) and (Five higher cognitive level questions were at evaluating and creating level of cognitive domain of revised blooms taxonomy) related to the lecture delivered on glycolysis pathway. The learners from both the groups were given the validated MCQ Questionnaire at the end of their sessions with total duration of performance assessment at 15 minutes. The performance of the learners were assessed manually by the investigators with total attainable lower level cognitive score at 5, total attainable higher level cognitive score at 5, and total attainable overall cognitive score at 10.

STATISTICAL ANALYSIS

The scores of all the participants including both the control and the cohort group were tabulated in SPSS file and the statistical analysis was done by Independent sample t-test as test of significance for mean difference at the lower cognitive level score, higher cognitive level score and total cognitive score and relative risk ratio estimation by cross tabs using SPSS software version 18.0.

RESULTS

The baseline demographic characteristics of both the groups (cases and controls) which includes age (years), sex {N(%)}, Male:Female ratio along with test statistics and p-value (as applicable) are described in [Table/Fig-2]. There was no statistically significant difference noted among the demographics (age, sex) between the two groups.

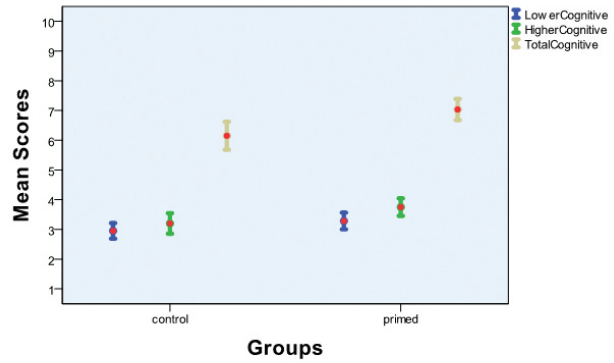
Demographic	Cases	Controls	Test statistics	p-value
Age (years)	17.8±0.75	17.7±0.64	t-value=-0.780	0.437
Male {n (%)}	42 (70%)	36 (60%)	χ^2=1.319	0.251
Female {n (%)}	18 (30%)	24 (40%)		
Sex ratio {Male:Female}	2.3:1	1.5:1		

[Table/Fig-2]: Demographic data of both controls (n=60) and primed cohort (n=60). p-value ≤0.05 is significant; Quantitative variables between two groups were compared using Independent sample t-test (t-value) and Qualitative variables using Pearson Chi-square test ($\in^2$)

The mean score comparisons of both the groups (at the lower cognitive level, at the higher cognitive level, and at the total score) is shown in [Table/Fig-3] and illustrated for visual comparison with colour codes in the [Table-Fig-4] as box plot comparison.

Groups	1 (Control)	2 (Cohort)	t statistic*	p-value
Mean score at lower cognitive domain level (max:5)	2.95±1.01	3.28±1.09	-1.73	0.08^{NS}
Mean score at higher cognitive domain level (max:5)	3.20±1.33	3.75±1.14	-2.42	0.01†
Mean total cognitive domain score (max:10)	6.15±1.83	7.03±1.37	-2.98	0.003†

[Table/Fig-3]: Mean score comparisons of both the groups (Group 1-Control and Group 2- Primed Cohort group) at the lower, higher and total cognitive domain levels along with t statistic and p-value.
*t-statistic and p-value calculated using Independent sample t-test; †p≤0.05 is considered significant; NS: Not Significant



X axis - Groups [Group 1 - Control & Group 2 - Primed Cohort]

Y axis - Mean Cognitive Performance scores [Color codes : Blue - Lower cognitive level; Green - Higher cognitive level; Orange - Total cognitive level

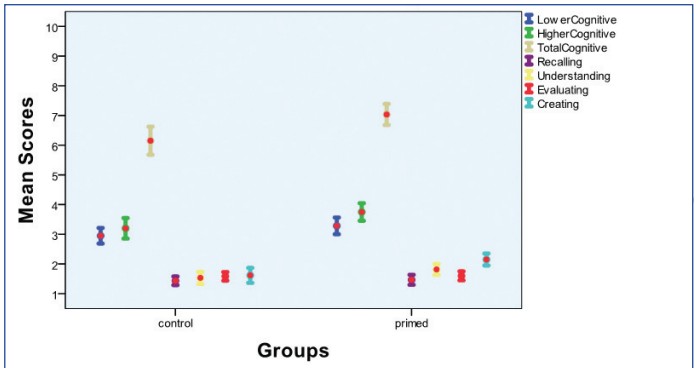
[Table/Fig-4]: Box plot showing comparison of both the groups at lower, higher and cognitive performance levels.

The mean score comparisons of both the groups at the individual lower and higher cognitive domain level (Recalling, understanding, evaluating, creating) scores is shown in [Table/Fig-5] and illustrated for visual comparison with colour codes in the [Table-Fig-6] as box plot comparison.

Exposure outcome association on priming exposure to outcome (50% total cognitive score) between the two groups (control and primed cohort group) is illustrated in [Table/Fig-7].

Groups	1 (Control)	2 (Cohort)	t statistic*	p-value
Mean score at recalling level (max:2)	1.43±0.563	1.47±0.65	-0.300	0.765^{NS}
Mean score at understanding level (max:3)	1.53±0.791	1.8±0.725	-2.046	0.043†
Mean score at evaluating level (max:2)	1.58±0.561	1.60±0.588	-0.159	0.874^{NS}
Mean score at creating level (max:3)	1.62±0.976	2.15±0.777	-3.311	0.001†

[Table/Fig-5]: Mean score comparisons of both the groups (Group 1-Control and Group 2-Primed Cohort group) at the individual cognitive domain levels along with t statistic and p-value.
*t statistic and p-value calculated using Independent sample t-test. †p≤0.05 is considered significant; NS: Not Significant



X axis - Groups [Group 1 - Control & Group 2 - Primed Cohort]

Y axis - Mean Cognitive Performance scores [Color codes : Blue - Lower cognitive level; Green - Higher cognitive level; Grey - Total cognitive level; Purple - Recalling level; Yellow - Understanding level; Red - Evaluating level; Blue - Creating level]

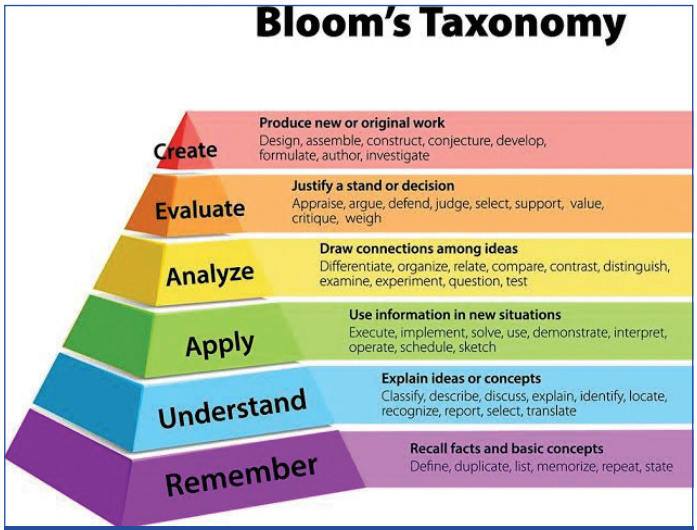
[Table/Fig-6]: Box plot showing comparison of both the groups at individual lower, Higher and cognitive domian levels.

Outcome	Risk estimate	95% Confidence interval	
		Lower	Upper
Odds ratio for result (50% score) (Pass/Fail)	0.446	0.181	1.102
For control (Not Primed) group	0.700	0.490	0.999
For primed group	1.567*	0.895	2.744

[Table/Fig-7]: Association on priming exposure to outcome (50% total cognitive score) for both control group and primed group.
* RR>1 Significant exposure outcome association

DISCUSSION

Among the three learning domains [2], the cognitive domain plays a major role in medical education. It helps in attaining the goal of competency based medical education curriculum, which ultimately creates a fully competent Indian medical graduate to serve the patient community. Blooms taxonomy of cognitive domain levels underwent a change by Anderson et al., which is still followed [2]. There are six levels in the cognitive pyramid which includes remembering and understanding at the base (lower cognitive level), applying and analysing at the middle, evaluating and creating at the top (higher cognitive level) of the cognitive pyramid [Table-Fig-8].



[Table/Fig-8]: Revised blooms taxonomy showing different levels of cognitive domains. Source: Anderson et al., [2].

As there is always a constant need for the present medical graduate to perform well at the cognitive domain, so is the importance towards their performance at the higher levels, which the present study has addressed and thereby helps in determining their competent abilities in being an independent physician in future.

Priming introduces the content to the learner before actual process of learning [8]. It acts as a facilitating zone for the learners as a preparation towards learning experience which has the ability to reduce the

content difficulty levels [9]. It reduces anxiety towards learning the content from the learner's point of view, which helps in smooth and gradual transition to learning the content. Though, zpriming might appear to have some repetitiveness of the content, this repetition also helps in consolidating the learned content to the permanent memory, which has the potential to increase the performance of the learner both at the lower and higher cognitive level.

The results of the present study showed that cohort group who were primed with pictorial concepts had significantly higher mean score at total cognitive performance score (7.03±1.37) than the control group (6.15±1.83) at (t=-2.98, p=0.003) who were not primed with pictorial concepts. The study results showed a significant mean difference between the two groups at the total cognitive level scores highlights the importance of priming during lecture sessions. Though, there are studies which shows that priming was not demonstrated to be a statistically superior educational method [10], the present study was in line with few convincing educational literature studies like Rathore BB et al., which showed the mean marks scored by primed students were significantly higher than unprimed students (p=0.0037) [11]. The hypothesis behind priming improving cognitive performances is supported by studies like Martin A and Chao LL, and Bargh JA et al., [12,13]. Martin A and Chao LL, suggest the organisation of brain networks based on associations with prior experiences by priming [12]. Bargh JA et al., suggests the role of visualising subconscious goal achievement in working memory towards performance improvement [13].

Pictures play a major part of visual learning in the present medical education, especially in today's technologically driven society. But on the contrary, most of the lectures in today's educational atmosphere is mostly of the oral and text content, especially in medical schools and so are the use of pictures which are underexplored by teaching professionals as suggested by Buckley CA and Waring J [14]. Pictures are an effective way of presenting the multistep process into a single image which drives off the apprehension towards learning the difficult contents. It shows modest improvement in content comprehension as suggested by Schrader PG [15]. Pictures add value when presented with the relevant content for the learners as suggested by Carney RN and Levin JR and has the potential to link with the learning objectives [16]. Banks M suggested the absolute need of independent visual presentation rather than text contents [17]. Furthermore, use of images along with textual content rather than text only presentations which provides a multimedia approach to teaching learning method and provokes learner's interest. The juxta posing of image with textual content removes the redundancy of linear thought process and helps in thought organisation and creativity as proposed by Kinchin IM [18]. On the flipside, the use of images can divert attention from the content unless the images prove to be absolutely relevant in conveying the content delivery. So, the use of pictures in priming should be carefully selected from the tutor's point of view whose academic compentency in creating and using images matters a lot.

The scores obtained from the participants of the present study showing the significant cognitive performance improvement of learners, and more so on the higher cognitive aspects with mean value of cohort group (3.75±1.14) being significantly greater than the control group (3.20±1.33) at (t=-2.42, p=0.01) reiterates the importance of use of pictures in medical teaching practice for improving the learner performance that are presented during priming models. The highlight of the present study is the significance attained at the higher cognitive level scores ($p<0.05$) than at the lower cognitive level scores ($p>0.05$), which suggests a significant positive impact on the learning pathway that additionally confirms the importance of pictures in evaluating and creating aspects of knowledge domain, which is further substantiated by studies like Smilek D which suggests that pictures adds additional improvement in cognitive performance [19].

However, the results obtained at the lower cognitive performance scores which although shows a higher score among cohort group with mean value (3.28±1.09) when compared to control group with mean value (2.95±1.01), the mean difference obtained remains insignificant (t=-1.73, p=0.08). The prior knowledge of the learner's content would have masked the effects of the significance, which the study did not accounted for and moreover the recalling and evaluating aspects of lower and higher cognitive domain levels needs more textual repetition rather than concepting through pictures. This does not undermine the importance of pictures in critical anslysis and creativity aspects of the knowledge domain which plays a pivotal role in a medical graduate career.

On intricate analysis of the present study at the individual cognitive domain levels, the results showed a higher significant scores at understanding (1.8± 0.725 vs 1.53±0.791) and creating (2.15±0.777 vs 1.62±0.976) levels for primed cohort group (p=0.043, p=0.001) respectively when compared to control group. While at the recalling level (1.47±0.65 vs 1.43±0.563) and evaluating level (1.60±0.588 vs 1.58±0.561) the scores for primed group were higher without any significance (p=0.765,p=0.874) respectively when compared to controls. In general, the participants performed better at higher domain levels of both the lower and higher cognitive pyramids.This is supported by studies like Padilla LM et al., which confirms the cognitive creative decision making capabilities being supported by visualisations that which undermines the performance at the understanding and creating domain levels [20]. Adding to the results, the exposure outcome association on priming exposure to outcome (50% total cognitive score) which showed a higher outcome numbers (51:9) in primed group when compared to non primed group (43:17) and the relative risk estimate of primed group (RR>1) is R=1.567 (0.895-2.744), which translates to the primed group getting a 50% total cognitive score stands at 1.567 times (56% increase) more when compared to non primed group. While the relative risk of non primed group (RR<1) is R=0.700 (0.490-0.999) which translates to the non primed group getting a 50% total cognitive score stands at 0.700 times (30% decrease) less when compared to primed group. This further substantiates the role of priming and pictures in dual added advantage to cognitive performance improvement.

On a caution note, the performance assessment done for the present study was formative type. The assessment being done on the same day which is surely an impact mostly on the immediate type of memory has both benefits and limitations. The benefits being the direct outcome measure of the session without being influenced by additional referential learning from textbooks or other references and avoidance of peer influence bias. The other benefits include avoidance of memory fades which is a possibility in case of delayed summative type assessment. The limitations includes the inability to assess consolidated memory, where time duration is a major factor and a prime need for passing on the summative type assessments. Yet, the assessment in the present study is a reflection of providing a strong basement towards the final examination phases. Furthermore, the present study focused on only the concept of glycolysis, a breakdown pathway of glucose in the subject of biochemistry. Since the contents are appropriate for only the sample population like phase I medical undergraduates, the present study does not account for other phase medical undergraduates who might need possibly different contents at different levels which would end up in content bias and moreover the same content can be assessed using different level of questioning which would end up in question related bias. In view of avoidance of these bias one concept one sample method is based in the present study. The present study method on one concept is possibly a model template for other different concepts in different streams of medicine.

Apart from this, several possible bias areas in the present study includes the content bias, content delivery bias, question bias, response bias, repeat bias, peer influence bias, parallel and after

learning bias. The content bias is accounted by selection of appropriate contents (biochemistry) for the particular phase (Phase I Medical Undergraduates) and by avoiding other phase medical graduates from inclusion into the study. This further accounts for the response bias and repeat bias as other phase medical undergraduates have already learnt the content during their previous years of learning. The content delivery bias was eliminated by involving the same lecturer and same method of delivery as per study protocol. Question bias was accounted by changing the order of question numbers to be answered by the participants. The peer influence bias, parallel learning and after learning bias was accounted by the assessment being conducted immediately after the content delivery as it avoids time delay and referential additional learning that might influence the content acquisition. The limitation of not being able to compute sample size for the present study is accounted by trying to involve the whole population of the institution. It is further superseeded by the delicate and intricate detailing into the bias considerations which is boosted by the use of randomisation, standardised and validated contents and validated assessment techniques.

To summarise, the present study not only supports the dual coding theory which proposes the role of pictures in addition to texts for improving the learning process, it also emphasises the sequence to dual coding with picture codes as priming to be followed by textual codes. It further confirms the benefits of different loops of memory pathways being activated through different modes leaving memory traces, which surely can have impact towards cognitive performance improvement.

Limitation(s)

The study was not followed-up by crossing over of learners between the groups which would have summed up the justifications resulted from the study. Technical limitations includes pictorial misidentification of the contents was a practical possibility as the polygon model used were not the routine learning way used in conventional lectures. Multipronged assessment would have added meaning to the higher cognitive level performance than with MCQs alone. Statistical limitations include the lack of appropriate sample size calculation considering the lack of previous literature studies and considering a large sample size of similar phase studies needs multi-institutional participation which found hurdles at various levels. And above all, the participants of the study were only phase I medical undergraduates, the inclusion of the learners from other phases would have given an overall picture among medical learner community on the whole.

CONCLUSION(S)

The study concludes that priming sessions using pictures have a significant impact on improving the cognitive performance of the learners when delivered during lecture sessions in a medical college. Adding to the conclusion, the impact of the pictorial priming sessions is even more on the higher level cognitive performance, which includes, evaluating and creating aspects of the knowledge domain. This reiterates the role of the importance of dual added benefits of pictures and priming during teaching cognitive domain aspects of lecture sessions. Yet what is intriguing is the insignificance obtained in the present study at the remembering and recalling aspects of the lower cognitive domain levels which carves the road for future discussions and elaborate learner research studies on a large population in finding the role of picture priming as a part of performance improvement in medical schools.

REFERENCES

[1] Bradbury NA. Attention span during lectures: 8 seconds, 10 minutes or more. Advances in Physiology Education. 2016;40(4):509-13.
[2] Anderson, Lorin W, David R, Krathwohl, Benjamin Samuel Bloom. A Taxonomy for Learning, Teaching and Assessing:A Revision of Bloom's taxonomy of Educational objectives. 17th Edition. New York: Longman, 2001.
[3] Norris EM. The constructive use of images in medical teaching: A literature review. J R Soc Med Sh Rep. 2012;3(1):33.
[4] Taskin V, Bernholt S. Students' understanding of chemical formulae: A review of empirical research. Int J Sci Educ. 2014;3(6):157-85.
[5] Nelson, CoxDL, Glycolysis MM. Lehninger Principles of Biochemistry. WH Freeman. New York. 6th edition, 2013;14:543-63.
[6] Bonafe CFS, Bispo JAC, de Jesus MB. The polygonal model- A simple representation of biomolecules as a tool for teaching metabolism. Biochemistry and Molecular Biology Education. 2017;46(1):66-75.
[7] Thomsen AS, Subhi Y, Kiilgaard JF, la Cour M, Konge L. Update on simulation based surgical training and assessment in ophthalmology: A systematic review. Ophthalmolog. 2015;122(6):1111-30e.1.
[8] Cook A. Priming as a teaching strategy. Cl Int for students. 2016;4:6-43.
[9] Stuart E, Hanson JL, Dudas RA. The right stuff: Priming students to focus on pertinent information during clinical encounters. Pediatrics. 2019;144(1):20191311.
[10] Rose E, Jhun P, Baluzy M, Hauck A, Huang J, Wagner J, et al. Flipping the classroom in medical student education: Does priming work. West J Emerg Med. 2018;19(1):93-100.
[11] Rathore BB, Mehta B, Singh S. Implementation and evaluation of priming as a teaching-learning tool for enhancing physiology learning among medical undergraduates. Indian Journal of Physiology and Pharmacology. 2019;63(1):37-41.
[12] Martin A, Chao LL. Semantic memory and the brain. Structure and processes. Current Opinion in Neurobiology. 2001;11(2):194-201.
[13] Bargh JA, Lee-Chai A, BarndollarK, Gollwitzer PM, Trötsche IR. The automated will: Non conscious activation and pursuit of behavioural goals. Journal of Personality and Social Psychology. 2001;81(6):1014-27.
[14] Buckley CA, Waring J. Using diagrams to support the research process: Examples from grounded theory. Qualitative Research. 2013;13(2):148-72.
[15] Schrader PG. Does multimedia theory apply to all students? The impact of multimedia presentations on science learning. Journal of Learning and Teaching in Digital Age. 2016;1:32-46.
[16] Carney RN, Levin JR. Pictorial illustrations still improve students' learning from text. Educational Psychology Review. 2002;14(1):05-26.
[17] Banks M. Visual methods for social research. American Journal of Qualitative Research. 2018;2(2):143-44.
[18] Kinchin IM. Visualising powerful knowledge to develop the expert student. Sense publishers. Rotterdam. 2016;2:15-34.
[19] Smilek D. Synesthetic colour experiences influence memory. Psychol Sci. 2002;13(6):548-52.
[20] Padilla LM, Creem-Regehr SH, Hegarty M, Stefanucci JK. Decision making with visualisations: A cognitive framework across disciplines. Cogn Res PrincImplic. 2018;3:29.

PARTICULARS OF CONTRIBUTORS:
1. Associate Professor, Department of Biochemistry, Melmaruvathur Adhiparasakthi Institute of Medical Sciences and Research [Affiliated to The Tamil Nadu Dr. M.G.R Medical University, Chennai], Melmaruvathur, Tamil Nadu, India.
2. Professor, Department of Biochemistry, Melmaruvathur Adhiparasakthi Institute of Medical Sciences and Research [Affiliated to The Tamil Nadu Dr. M.G.R Medical University, Chennai], Melmaruvathur, Tamil Nadu, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. K Gunanithi,
104, Malligai Block, Invicon SSP Flats, Krishna Nagar, 6th Street, West Tambaram, Chennai-600045, Tamil Nadu, India.
E-mail: gunamededu@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Nov 05, 2021
- Manual Googling: Dec 09, 2021
- iThenticate Software: Dec 22, 2021 (19%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Nov 01, 2021**
Date of Peer Review: **Nov 29, 2021**
Date of Acceptance: **Dec 10, 2021**
Date of Publishing: **Jan 01, 2022**