DOI: 10.7860/JCDR/2023/63836.18401

Original Article

Education Section

Computer-Assisted Learning versus Conventional Methods for Pathology Tutorials: A Longitudinal Interventional Study

KALYAN KHAN[1], RUPSHA DUTTA PAL[2], SUBRATA BHATTACHARJEE[3], RAJASREE CHAKRABARTY[4], SABITA SAHA[5]

ABSTRACT

Introduction: One of the important objectives of undergraduate pathology teaching is to enable the student to correlate the normal and altered morphology of different organ systems in common diseases. The conventional chalk and board method of tutorials for imparting this training is not free of disadvantages. Computer-Assisted Learning (CAL) is the trend of the day worldwide.

Aim: The present study aimed to compare the effectiveness of CAL with the conventional method for pathology tutorials, with special emphasis on the retention of knowledge in students.

Materials and Methods: The present study was a longitudinal interventional study involving 110 students of the second Professional MBBS batch of the Department of Pathology at North Bengal Medical College, Darjeeling, a rural area Medical College, for a period of six months from December 2017 to June 2018. The students were divided into an intervention group taught by the CAL method and a control group taught by the chalk and board method. On the day of teaching and one month after that, assessment was done by histopathology slide spotting. Focus Group Discussion (FGD) and a pre-tested and validated questionnaire completion were also undertaken. Paired t-test was used for comparison in both groups.

Results: Those instructed by the CAL Method scored significantly higher than the control group students in both Spotting-1 and Spotting-2. In Spotting-1, the average score of group A (interventional group) and group B (control group) students was 71.11±27.67 (SD) and 38.89±24.75, respectively (p-value 0.01). In Spotting-2, the average score of group A and group B students was 67.78±28.52 (SD) and 29.44±28.85 (SD), respectively (p-value-0.01).

Conclusion: The present study concluded that the CAL method is acceptable to both students and facilitators. It resulted in a significantly improved performance of students in the diagnosis of histopathology slides assessed immediately after teaching and one month after teaching. Hence, CAL also assists in the retention and recall of information.

Keywords: e-learning, Histopathology, Medical education

INTRODUCTION

In undergraduate pathology training, understanding disease processes and their clinical significance is achieved when students are able to correlate the normal and altered morphology of different organ systems in common diseases [1,2]. One of the important constraints in achieving this teaching objective is the limited availability of effective teaching hours [3,4]. Hence, most universities recommend teaching systemic pathology in tutorial classes aided by the demonstration of specimens and histopathology slides. In the pathology departments of most medical colleges, the conventional method of teaching utilising the chalk and board is used for tutorials. However, this conventional teaching method has certain disadvantages [5,6]. It requires the involvement of a significant number of faculty members and increases laboratory time. Additionally, the lack of standardisation of teaching is a result of inter-teacher variation in teaching skills [7].

The incorporation of various electronic devices in pathology teaching schedules is a current trend worldwide [5,8]. Basic electronic devices such as digital cameras, personal computers, and data projectors are now part of teaching resources even in resource-deprived teaching hospitals, including those in developing countries. CAL is defined as the use of any computer software to deliver or facilitate a learning experience [9,10].

CAL has been incorporated in medical education as a whole and has been implemented in different diagnostic and clinical subjects as well [11-13]. The recent COVID-19 related restrictive teaching and learning environment has further prompted the promotion of e-learning for obvious reasons [14]. The improvement in the retention of knowledge among medical students remains a perennial challenge faced by stakeholders in medical education [15-17]. Despite an extensive search of published literature, not a single study was found that assessed the effectiveness of CAL in increasing the retention of knowledge in MBBS students specifically in pathology tutorials.

The aim of the present study was to compare the effectiveness of CAL against the conventional chalk and board method in pathology tutorials, with a special emphasis on the retention of knowledge in students.

MATERIALS AND METHODS

The present study was a longitudinal interventional study with one control and one intervention arm involving students of the second professional MBBS 4th semester batch of the Department of Pathology at North Bengal Medical College, Darjeeling, a rural area Medical College. The study spanned a period of six months from December 2017 to June 2018. Approval from the Institutional Ethics Committee was obtained (Certificate no. PCM/2015-2016/413 dated 29.9.2015). The study was conducted as a separate schedule according to administrative instructions without affecting the academic progress of the participating students. Informed Consent was obtained from each student. The two groups of students were interchanged and instructed using the opposite teaching method after collecting the necessary data. Absolute confidentiality was maintained regarding participants' individual performance data.

Sample size: A pilot study was conducted with two groups of 10 students each, which showed a higher mean post-teaching score in students taught by the CAL method (95±13 SD) compared to those taught by the conventional chalk and board method of teaching (85±22 SD).

Pilot Study

CAL Method (n_1=10)	**Conventional Method** (n_2=10)
Mean 95±13 (m_1±SD_1)	Mean 85±22 (m_2±SD_2)

The sample size formula used was: $n=\frac{(Z_{1-\alpha/2}+Z_{(1-\beta)}^{2})\times 2S^{2}}{d^{2}}$

The value of $(Z_{1-\alpha/2})$ at a 5% level of significance is 1.96.

The value of $(Z_{1-\beta})$ at 80% power is 0.84.

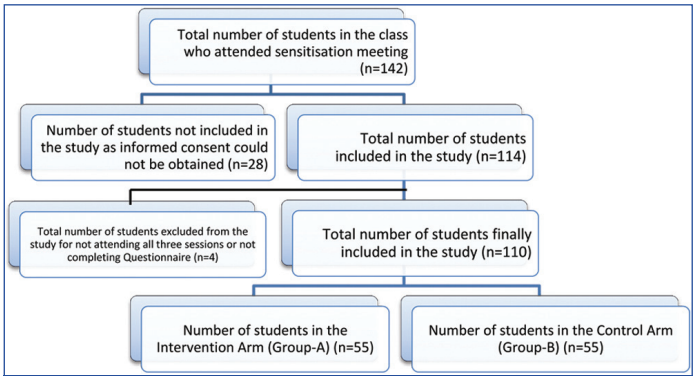
The sample size derived for one group is 51, and the total sample size is 51×2=102.

The second professional MBBS batch consisted of 142 students. Using sealed envelopes containing numbered slips generated by random numbers, all willing students (n=114) from whom informed consent could be obtained were randomly assigned to the two study arms, Group A and Group B, the intervention group and the control group, respectively.

Inclusion criteria: Students from whom informed consent was obtained and those who were present during the sensitisation meeting, both the initial teaching session, and the subsequent evaluation session after one month were included in the study.

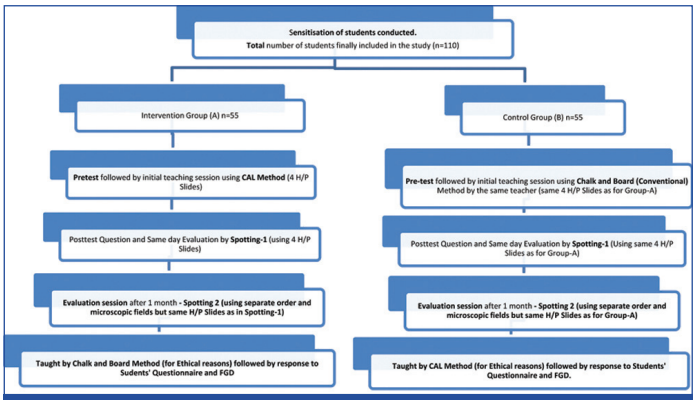
Exclusion criteria: Students unwilling to participate in the study and those who did not complete the questionnaire meant for students were excluded from the study.

After applying the inclusion and exclusion criteria, 55 students in each batch, a total of 110 students, were finally included in the study, and 32 students were excluded [Table/Fig-1].



[Table/Fig-1]: Flow chart showing enrolment of students in intervention and control arms.

The present study was conducted in three phases: 1) Sensitisation and preparation phase; 2) Intervention and data collection phase; 3) Data analysis phase [Table/Fig-2].



[Table/Fig-2]: Flow diagram of study procedure followed.

Sensitisation and preparation phase: An in-house sensitisation meeting involving students and faculty members was organised to apprise them of the study procedure details. The two groups were instructed to attend separate sessions on different dates.

The digital microphotographs of the histopathology slides within the students' syllabus were stored on a personal computer. These digital photographs were obtained from the same departmental teaching slides used for teaching and evaluating the students. The histopathology slides included:

- Acute appendicitis (acute inflammation)
- Tuberculous lymphadenitis (chronic granulomatous inflammation)
- Fibroadenoma (benign neoplastic condition)
- Adenocarcinoma of the large intestine (malignant neoplastic condition)

For each pathological condition, one low-power (10X) and two high-power (40X) microphotographs were selected for the teaching session.

The study tools used included Haematoxylin and Eosin (H&E) stained histopathology slides, a trinocular microscope (Olympus CH20i self-illuminating), a digital camera (Canon EOS 90D Digital SLR) with a lens adapter (Olympus OM/EOS), a personal computer (Quad-core processor, 4 GHz CPU, 16 GB RAM, SSD, with GPU and EOS Utility Software), PowerPoint (Microsoft) presentations, a multimedia projector (Epson EH-TW750 Full HD 1920x1080 px), and monocular microscopes (Labomed CxE LED 40X-1000X).

Intervention and data collection phase: Students in group A (intervention group) were instructed on identifying and understanding the histopathology slides leading to their diagnosis using the multimedia projector and the stored microphotographs on the computer. The instruction was provided by a basic pathology teacher who usually conducts tutorials. The format used was a PowerPoint presentation with multimedia projection. The same teacher instructed the same content to the students in group B (control group) using the conventional chalk and board method typically employed in routine classes. The time taken by the teacher for discussion in both methods was recorded. Pre-test and post-test questionnaires were given to the students in both groups before and after the first teaching session.

Non punitive evaluation of accuracy (using spotting slips) was conducted for each student in both groups to identify the histopathology slides under the uniocular microscope without moving the microscopic field. This evaluation, known as slide spotting, took place on the same day as the first teaching session (Spotting-1).

The two groups of students underwent the same evaluation process with the same slides after one month (Spotting-2) to assess the value of the new method in retention and recall of information. On that day itself, the groups were interchanged, and the opposite method was instructed by the same facilitator.

Data collection was done through pre-tested, validated pre-tests, post-tests, spotting questions, semistructured questionnaires with graded responses and open-ended sections, and FGDs for the two groups of students, as well as the facilitators. Pretesting was done through informal, individual-based expert reviews of draft questionnaires and cognitive interviews with participants such as students and faculty members. The pre-test and post-test questions consisted of the same four basic theoretical recall-based Multiple Choice Questions (MCQs), one for each of the four histopathology slides that were discussed. Each question carried 25 marks, making the total 100 marks. In Spotting-1, students were asked to diagnose those four histopathology slides by observing the focused field under the monocular microscope. They had to write two identifying features in favour of the diagnosis observed in the focused microscopic field for each slide. The assessment method of students' performance in Spotting-2 was the same as Spotting-1, based on the same four histopathology slides, and carried a total of 100 marks. The difference was in the order and microscopic field focused on the same four histopathology slides used in Spotting-1.

After the groups were interchanged, the students of both groups were asked to respond individually to a set of questions and participate in FGDs to evaluate the acceptability of CAL in pathology tutorials. Faculty members of the Department of Pathology also responded to a different set of questions and participated in separate FGDs. The questionnaire was designed to assess perceptions regarding the acceptability and utility of teaching methods.

During the data analysis phase, probable confounding factors such as the percentage of marks obtained in 10+2 (Higher Secondary) and 1st professional MBBS examinations were taken care of and matched between the two groups of students. The parameters studied for comparing the effectiveness of the teaching methods were students' performance in the post-test, Spotting-1, and Spotting-2 sessions.

STATISTICAL ANALYSIS

The data collected was recorded in an MS Excel sheet and analysed using frequency distribution, descriptive statistics, paired t-test, and the software tools Epi Info 7 and SPSS version 20.0, both developed by Chicago, Inc., located in Ili, USA. A p-value of <0.05 was considered statistically significant.

RESULTS

The mean age of the students in Group A was 20.07±0.95 (SD) years, ranging from 18 to 22 years. Similarly, the mean age of the students in Group B was 19.84±0.88 (SD) years, also ranging from 18 to 22 years. The difference in mean ages between the two groups of students was insignificant (p-value 0.25), making them comparable [Table/Fig-3].

Confounding factors	Group A		Group B		Significance
	Mean	SD	Mean	SD	p-value
Age (in years)	20.07	0.95	19.84	0.88	0.25
Marks obtained in HS (%)	80.95	6.43	84.07	6.97	0.07
Marks obtained in 1st Prof (%)	66.20	3.88	66.23	4.94	0.97
Marks obtained in pre-test (%)	45.00	23.60	40.56	26.80	0.41

[Table/Fig-3]: Matching of confounding factors.
Paired t-test applied (Significance: p-value <0.05)

Out of the total study population of 110 students, 75 were male and 35 were female. In Group A, there were 41 male students (74.5%) and 14 female students (25.5%). In Group B, there were 34 male students (61.8%) and 21 female students (38.2%). The difference in gender distribution between the two groups was not significant, with a p-value >0.05.

Both groups of students completed their 10+2 (Higher Secondary) examination between 2012 and 2014. The mean percentage of marks obtained in this examination by students in Group A was 80.95%±6.43 (SD), ranging from 65.8% to 92%. For students in Group B, the mean percentage of marks was 84.07%±6.97 (SD), ranging from 67% to 95.6%. The difference in mean percentages between the two groups was insignificant (p-value 0.07), indicating comparability [Table/Fig-3].

Regarding the 1st Professional MBBS examination, the mean percentage of marks obtained by students in Group A was 66.20%±3.88 (SD), ranging from 58 to 76%. For Group B, the mean percentage of marks was 66.23%±4.94 (SD), ranging from 58% to 75.6%. The difference in mean percentages between the two groups was insignificant (p-value 0.97), suggesting that they were comparable or matched [Table/Fig-3].

Consequently, the age, gender, and previous academic performances of the students in the intervention and control groups were comparable and matched.

In terms of the Pre-test, the mean percentage of marks obtained by students in Group A was 45.00%±23.60 (SD), ranging from 0% to 100%. Similarly, for students in Group B, the mean percentage was 40.56%±26.80 (SD), also ranging from 0% to 100%. The difference in mean percentages between the two groups was insignificant (p-value 0.41) [Table/Fig-3].

In the post-test, students in Group A scored an average percentage of 93.89±15.22 (SD) and ranged from 50% to 100%, while students in Group B scored 90.56%±14.39 (SD) with a range of 75% to 100%. The difference was significant with a p-value of 0.06 [Table/Fig-4].

	Group A		Group B		Significance
	Mean	Std. Deviation	Mean	Std. Deviation	p-value
Pre-test	45.00	23.60	40.56	26.80	0.41
Post-test	93.89	15.22	90.56	14.39	0.04
Change from pre-test to post-test	48.89	27.98	50.00	28.20	0.06

[Table/Fig-4]: Performances of students of both the groups in pre and post-test.
Paired t-test applied (Significance: p-value <0.05)

The time taken by the same teacher to teach Group A and Group B using the same four histopathology slides was 35 minutes and 50 minutes, respectively. This difference was mainly due to the teacher needing to draw the figures of the histopathology slides on the board [Table/Fig-5,6].

[Table/Fig-5]: Teaching of Group A students by CAL method.
[Table/Fig-6]: Teaching of Group B students by conventional chalk and board method. (Images from left to right)

The mean score of students in the intervention group (Group A) for the first spotting (Spotting-1) on the day of teaching was 71.11±27.67 (SD). The average score of the control group (Group B) for Spotting-1 was 38.89±24.75. It was observed that students in the intervention group scored significantly higher than those in the control group, with a p-value <0.05 [Table/Fig-7].

	Group A		Group B		Significance
	Mean	Std. Deviation	Mean	Std. Deviation	p-value
Spotting-1	71.11	27.67	38.89	24.75	0.01
Spotting-2	67.78	28.52	29.44	28.85	0.01

[Table/Fig-7]: Performance of students of both the groups in Spotting-1 and Spotting-2.
Paired t-test applied (Significance: p-value <0.05)

After one month, both groups of students were asked to spot the same four histopathology slides again (Spotting-2), with different fields of focus and in a different order compared to Spotting-1. The methods used were kept the same as for Spotting-1. The mean score of students in the intervention group (Group A) for Spotting-2 was 67.78±28.52 (SD). The average score of the control group (Group B) for Spotting-2 was 29.44±28.85 (SD). Once again, it was observed that students in the intervention group scored significantly higher than those in the control group, with a p-value <0.05 [Table/Fig-7].

From the questionnaires and FGD, the following significant points were noted:

The majority (92.8%) of faculty members agreed that the CAL method is more convenient for demonstrating to students, explaining the pathogenesis, and reaching a diagnosis. However, in response to the open-ended question and FGD, 75% of faculties opined that the use of schematic animations would be beneficial in teaching the pathogenesis in a better way.

Twelve out of the 14 faculty members (85.7%) thought that the conventional method was more time consuming compared to the CAL method for demonstrating the same content to the students in tutorials.

Most of the facilitators (71.4%) (n=14) disagreed with the notion that the CAL method was more cumbersome in terms of content preparation, use of electronic gadgets, or demonstrating histopathology contents. However, during the FGD, it was revealed that faculties who were not comfortable with using electronic gadgets sought help from junior faculties.

The faculty members unanimously agreed that some slides, such as tuberculous lymphadenitis and large intestinal adenocarcinoma, required more than the three projected images for better understanding.

Out of 55 students in Group A, forty-nine (89.1%) strongly agreed that the CAL method helped them understand the topic easily. Additionally, 81.8% of the students found it easier to remember the diagnostic features of histopathology slides. However, in Group B, 69.1% (n=55) of the students (compared to only 27.2% (n=55) in Group A) felt that preparing the practical notebook was easier for them. They mentioned that during chalk and board teaching, the teacher drew schematic diagrams that they could reproduce easily in their notebooks. In the FGD, students expressed that CAL helped them visualise the microscopic details of the histopathology sections under the microscope, enabling them to match them with their observations during time-bound slide spotting.

In the open-ended section of the questionnaire, three senior faculty members wrote, "Detailed explanation of well-prepared PowerPoint slides, rather than just reading from them, would make a difference." During the FGD, one student stated, "It would have been better if normal histology was also taught in Anatomy using the CAL method." This suggestion was unanimously supported by other students.

DISCUSSION

Pathology is a fundamental subject in medical education, providing the scientific foundation for understanding human disease processes and bridging the gap between preclinical and clinical subjects. In India, the traditional approach to teaching pathology involves didactic lectures using the chalk and board method, while morphological changes are observed through monocular microscope examination of histopathology slides [6,18]. Currently, the introduction of new techniques and equipment tailored to specific educational purposes is a significant trend and challenge in pathology teaching [7,19]. Over the past two decades, there have been numerous positive reports on the acceptance of novel teaching-learning methods, including CAL, by both students and faculty members in pathology education [1,3,7].

In the present study, a total of 110 students were divided into control and intervention groups. Statistical analysis demonstrated that the two groups were well-matched in terms of age, gender, scores in the Higher Secondary (10+2) Examination, and percentage of marks obtained in the 1st professional MBBS examination [Table/Fig-3]. Since the study population belonged to the same batch of the college, it is presumed that they had similar scores in the medical entrance examination, which may account for these comparable parameters. The mean pre-test scores of group A and group B students were 45.00%±23.60 (SD) and 40.56±26.80 (SD), respectively, which were also comparable (p-value 0.41). Since all these confounding factors were statistically matched between the two groups, it can be concluded that the difference in students' performance was influenced by the CAL teaching method.

The average post-test score percentage of group A students was 93.89±15.22 (SD), while that of group B students was 90.56%±14.39 (SD), and the difference was statistically significant (p-value <0.05) [Table/Fig-4].

The mean scores of group A students in Spotting-1 and Spotting-2 were 71.11±27.67 (SD) and 67.78±28.52 (SD), respectively, while those of group B students were 38.89±24.75 and 29.44±28.85 (SD). The difference in scores between the two groups in both spotting sessions was highly significant with a p-value <0.05 [Table/Fig-7].

No similar study assessing students' performance following the CAL teaching method in Pathology was found in the published literature.

However, in a study involving computer science students at the ICS level, Kausar T et al., found a significant improvement in the post-experiment test scores of both the intervention and control groups. They reported a significant lead of CAL (+77) compared to conventional learning (+21) [20]. The gain in analysis and synthesis skills reported in the post-test evaluation by CAL was 146% higher. They also reported an 80% increase in the evaluation skills of students in the experimental group, validating the extraordinary significance of the CAL teaching method.

Kausar T et al., further commented that CAL provided additional benefits, such as increased relevance of learning, expectations for success, general satisfaction, heightened motivation, and improved retention of information [20].

The statistically significant higher mean scores of the intervention group students (67.78±28.52 SD) compared to Group B students (29.44±28.85 SD) in Spotting-2 of the study corroborate these remarks.

Another study by Bhat SP et al., reported a significant improvement in students' performance with Case Based Learning (CBL), another novel method similar to CAL, compared to didactic lectures (p <0.001) [18]. This was based on the mean scores of students in pre- and post-tests. The mean score reported before implementing CBL in Group A with anaemia cases was 8.31, and after CBL in Group B with jaundice cases was 13.44 (p=0.001) [18]. These findings align with the present study.

Downing SW commented on the numerous benefits of using multimedia instead of traditional microscopes and microscope slide collections [21]. These benefits include faster access and review of specific histological images (compared to finding a structure on a glass slide), a significant reduction in the required laboratory time for students to learn the same amount of information, ease of tutoring on a large monitor screen (compared to discussing a histological structure through a microscope eyepiece), encouragement of group study (which is difficult with one-on-one microscope work), and a decrease in the number of faculty needed to cover a typical histology laboratory session [21].

Kumar RK et al., from the Department of Pathology, University of New South Wales, Sydney, Australia, believe that the use of high-quality learning resources such as virtual slides can ensure that microscopic examination of tissues remains both meaningful and interesting [22].

Collier Ebenezer SO stated that instruction supplemented by properly designed Computer-Assisted Instruction (CAI) is more effective. Computer-assisted instruction can play an important role in classrooms and laboratory work, not as a substitute for other activities, but as an additional tool [23].

In a study conducted on CAI and the traditional method of instruction, Mahmood MK examined the effect of computer-assisted instruction on student achievement in general science compared to the traditional method of instruction. The results revealed that the experimental group outperformed the control group in all achievement areas, including overall performance, cognitive domain levels, and type of content. Students reported liking the CAI Program, benefiting from it, and considering it a better mode of instruction than the traditional method [24].

According to Spiro RJ et al., tutorials are designed to introduce unfamiliar subject matter. The format of a computer tutorial, along with drill and practice, is most successful in improving knowledge and comprehension levels according to Bloom's taxonomy [25].

CAL has also been reported to play a significant role in the teaching of diverse medical subjects such as pharmacology [9,11], radiology [13], rheumatology [26], surgery [27], neuroanatomy, and neurosurgery [12,28].

One of the prime importance of undergraduate pathology as a subject is its need for understanding the clinical subjects taught in subsequent years. Hence, retaining the information gathered during pathology training becomes important for the further development of clinical understanding in students [1]. van Merriënboer JJG and Sweller J commented that, according to cognitive load theory, improved instructional design in teaching minimises demands on students' working memory, thereby improving retention of knowledge [29].

In the present study, 81.8% of students strongly agreed that the CAL method helped them remember the histopathological features easily, and 89.1% of students found CAL helpful for understanding the study contents. In a recent study conducted among Indian undergraduate Pathology students, Nishal A et al., concluded that 87% of the students experienced longer retention of the topic when instructed by the novel CBL method. However, their study only reported students' perception regarding the retention of the topic [6]. The present study emphasises the role of CAL in significantly improving scores in students due to better retention of knowledge.

Limitation(s)

The present study involved students from a single academic setup. It was conducted only in the Department of Pathology and was conducted prior to the introduction of Competency-Based Medical Education (CBME). There was a chance of discussion among students from the two groups, leading to the exchange of knowledge, which could not be avoided.

CONCLUSION(S)

The present study concluded that the CAL method for pathology tutorials is acceptable to both students and facilitators due to its significant perceived advantages over the conventional chalk and board method. The CAL method resulted in significantly improved performance of students in the diagnosis of histopathology slides assessed just after teaching and one month after teaching, as it helps in better understanding, retention, and recall of information.

REFERENCES

[1] Yadav V, Kumar V, Shrimal R, Deshmukh AV. The need of modifying current undergraduate curriculum in pathology subject from student's perspective. Med J DY Patil Vidyapeeth. 2022;15:37-42.
[2] Domizio P. The changing role of pathology in the undergraduate curriculum. In: Hall PA, Wright NA, editors. Understanding Disease: A Centenary Celebration of the Pathological Society. London: Wiley; 2006. Pp. 137-52.
[3] Vijayan P, Ponniah A. A survey study based on undergraduate medical students' feedback regarding pathology and the teaching-learning methodologies employed. Trop J Pathol Microbiol. 2017;3:149-54.
[4] Dick F, Leaven T, Dillman D, Torner R, Finken L. Core morphological concepts of disease for second-year medical students. Hum Pathol. 1998;29:1017-20.
[5] Soma L. Interactive tutorial of normal lymph node histology for pathology and laboratory medicine residents and medical students. MedEdPORTAL. 2016;12:10513. Doi: 10.15766/mep_2374-8265.10513. PMID: 30984855; PMCID: PMC6440487.
[6] Nishal A, Patel J, Balvalli R, Yadav PP, Jayani P, Singh R, et al. A comparative study of case-based learning vs. traditional teaching method in pathology in Indian medical graduates. J Med Edu. 2022:21(1):e127188. https://Doi.org/10.5812/jme-127188.
[7] Kar A, Kar T, Dash K, Rout N, Bhuyan P, Panda S, et al. Undergraduate pathology education: Meeting the challenge ahead. Int J Clin Med. 2012;3(2):83-87.
[8] Shaikh F, Inayat F, Awan O, Santos MD, Choudhry AM, Waheed A, et al. Computer-assisted learning applications in health educational informatics: A review. Cureus. 2017;9(8):e1559.
[9] John LJ. A review of computer assisted learning in medical undergraduates. J Pharmacol Pharmacother. 2013;4(2):86-90.
[10] Butterfield A, Gerard EN, Kerr A. A Dictionary of Computer Science. 7th ed. Oxford, United Kingdom: Oxford University Press; 2016.
[11] Baby L, Kavalakkat J, Abraham S, Sathianarayanan S. CAL: A modern tool for pharmacology. Internet J of Medical Simulation. 2009;2(2):e160921190441.
[12] Burford C, Guni A, Rajan K, Hanrahan J, Armitage M, Driscoll A, et al. Designing undergraduate neurosurgical e-learning: Medical students' perspective. Br J Neurosurg. 2019;33(1):79.
[13] Amesse LS, Callendar E, Pfaff-Amesse T, Duke J, Herbert WN. Evaluation of computer-aided strategies for teaching medical students prenatal ultrasound diagnostic skills. Med Educ Online. 2008;13(1):4482.
[14] Almahasees Z, Mohsen K, Amin MO. Faculty's and students' perceptions of online learning during COVID-19. Front Educ. 2021;6:01-10. Doi: 10.3389/feduc.2021.638470.
[15] Sharma P, Singh P, Kalhan S, Garg S. Analysis of factors affecting academic performance of MBBS students in pathology. Ann Int Med Den Res. 2017;3(5):PT09-PT15.
[16] Schneid SD, Pashler H, Armour C. How much basic science content do second-year medical students remember from their first year? Med Teach. 2019;41(2):231-33. Doi: 10.1080/0142159X.2018.1426845.
[17] Mok CH. Methods to improve knowledge retention in medical students. Med Sci Educ. 2020;30:1341. https://Doi.org/10.1007/s40670-020-01057-1.
[18] Bhat SP, Cheriyanath L, Nair M, Nair MM. Perceptions of medical students about pathology training. Journal of Pathology of Nepal. 2021;11(2):1830-34. Doi: 10.3126/jpn. v11i2.28916.
[19] David G. Present-day pathological anatomy and prospects for its development in the 21st century. Arkh Patol. 1988;50:03-13.
[20] Kausar T, Choudhry BN, Gujjar AA. A comparative study to evaluate the effectiveness of Computer Assisted Instruction (CAI) versus Class Room Lecture (CRL) for computer science at ICS level. The Turkish Online J Edu Tech. 2008;7:19-28.
[21] Downing SW. A multimedia-based histology laboratory course: Elimination of the traditional microscope laboratory. Anat Rec B New Anat. 2003;275:196-206.
[22] Kumar RK, Velan GM, Korell SO, Kandara M, Dee FR, Wakefield D. Virtual microscopy for learning and assessment in Pathology. Anat Rec B New Anat. 2003;275:196-206.
[23] Collier Ebenezer SO. The enhancement of the teaching and the learning of the sciences in secondary schools using computer assisted instruction. http://members.aol.com/esocollier/computer- assistedinstruction.html, 2004.
[24] Mahmood MK. A comparison of traditional method and computer assisted instruction on students achievement in general science. British Journal of Educational Technology. 2004;28:199-217.
[25] Spiro RJ, Jehng JC. Cognitive flexibility and hypertext: Theory and technology for the nonlinear and multidimensional traversal of complex subject matter. In D. Nix & R. Spiro (Eds.) Cognition, Education, & Multimedia (pp. 163-205). Hillsdale, NJ: Lawrence Erlbaum Associates.
[26] Haq I, Dacre J. Computer-assisted learning in undergraduate and postgraduate rheumatology education. Rheumatology. 2003;42(2):367-70.
[27] Gorman PJ, Meier AH, Krummel TM. Computer-assisted training and learning in surgery. Comput Aided Surg. 2000;5(2):120-30.
[28] Svirko E, Mellanby J. Teaching neuroanatomy using computer-aided learning: What makes for successful outcomes? Anat Sci Educ. 2017;10(6):560-69.
[29] van Merriënboer JJG, Sweller J. Cognitive load theory in health professional education: Design principles and strategies. Med Educ. 2010;44:85-93.

PARTICULARS OF CONTRIBUTORS:
1. Associate Professor, Department of Pathology, Jalpaiguri Government Medical College, Jalpaiguri, West Bengal, India.
2. Assistant Professor, Department of Pathology, North Bengal Medical College, Siliguri, West Bengal, India.
3. Assistant Professor, Department of Pathology, North Bengal Medical College, Siliguri, West Bengal, India.
4. Assistant Professor, Department of Pathology, MJN Medical College, Coochbehar, West Bengal, India.
5. Assistant Professor, Department of Pathology, North Bengal Medical College, Siliguri, West Bengal, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Kalyan Khan,
Flat No. 11, Bela Apartment, Netaji Subhas Road, Siliguri-734001, West Bengal, India.
E-mail: kkhan2001@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Mar 17, 2023
- Manual Googling: May 18, 2023
- iThenticate Software: Jul 11, 2023 (10%)

ETYMOLOGY: Author Origin

EMENDATIONS: 5

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: **Mar 07, 2023**
Date of Peer Review: **Apr 19, 2023**
Date of Acceptance: **Jul 13, 2023**
Date of Publishing: **Aug 01, 2023**