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Research Article

Lecture-Based *vs* Case-Based Instruction Method in Optometry. A Four-Year Perspective

Li Li Tan[1]*, PhD, MMedSc(Optom), BOptom(Hons), FAAO, FBCLA, Sumasri Kallakuri[2], B.S (Opt)
School of Chemical and Life Sciences, Singapore Polytechnic, Singapore

***Corresponding authors:** Li Li Tan, 500 Dover Road, School of Chemical and Life Sciences, Singapore Polytechnic, Singapore

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Abstract

Purpose: To study the effectiveness of lecture-based learning vs case-based learning instruction method in Optometry education.

Methods: The traditional Lecture-Based Learning (LBL) and Case-Based Learning (CBL) instruction method was compared using (i) student's performance in end-semester exam and (ii) student's self-rated evaluation implemented in Ocular Disease 1 module, Diploma in Optometry. Two LBL cohorts consists of 153 students and another two CBL cohorts consists of 145 students were studied. One-way ANOVA (two-tailed) was performed to explore differences in end-semester exam marks between LBL and CBL cohorts. For 11 student's self-rated evaluation, mean ± SD score of the ratings was computed and responses to the 15 statements were analyzed and computed in % (n).

Results: CBL cohorts were shown to have significantly higher mean marks and greater number of students obtaining 80 marks and above, as compared to the LBL cohorts (one-16 way ANOVA, $p < 0.05$). The spread of marks was narrower in the CBL cohorts with a 'trend-up' mean connect line from LBL to CBL. 63% response rate was received on student's self-rated evaluation. Students reported that CBL enabled them to apply learning to real-world applications, possess better analytical skills and helps to learn independently through team work.

Conclusion: This study suggests that the integrated case-based instruction method have been effective in promoting better performers in learning ocular disease 1. This can be the future direction in optometry education as it develops self-directed learners, enhance analytical skills and problem solving skills as few essential skills for optometrists.

Keywords: Case-Based Learning; Lecture-Based Learning; Optometry Education; Ocular Disease; Effectiveness

Introduction

Lecture-based learning (LBL) has been the primary teaching modality in medical and optometry education. LBL is a teacher-centered approach that relies on the passive knowledge transfer from teacher to students. The teacher explains the material to the students who seek to understand the teacher's point of view in science [1]. In this approach, students tend to lose their focus quickly as such learning strategies are very much didactic [2]. LBL often uses assessment models that reward a student's ability to reproduce facts without truly understanding the topic [3]. The efficacy of this traditional lecture-based teaching has been questioned [4,5] and has led to a search for alternative methods of instruction such as Case-Based Learning (CBL). CBL presents an unknown case where information is drawn out through questioning and appropriate investigation in order to plan for a solution. This is happening in optometry day- to-day practice. Student satisfaction and perception of the CBL paradigm, shows it enhances the learning experience and learning attitudes of students [6,7]. CBL linking theory with practice and drawing prior clinical sciences knowledge into realistic patient contexts, leads to increased motivation, appreciation of the integration of the clinical sciences and promotes a self-directed lifelong learning approach to patient centric care long after graduation [8,9,10]. Comparatively, CBL is potentially more stimulating, engaging and challenging and can be more effective than a LBL approach.

Diploma in Optometry (DOPT) in Singapore Polytechnic (SP) trains optometrists who are eye care professionals to serve for the eye care needs in Singapore. The course takes three years to cover basic sciences to optometry related modules such as ocular diseases, clinical optometry, clinical practice and contact lenses. In their final year, students are rotated into various clinical training sessions to conduct eye examinations on public members. They often given an unknown patient/case where they are required to draw out information through history taking, to perform indicated eye examination/investigation, diagnose the eye conditions and devise the management plan. In order to be competent in doing all the above tasks, students require good communication, analytical and critical thinking skills. In order to address all the above skills, CBL could be a better option.

In the past, LBL was the sole teaching pedagogy adopted in SP optometry education. It was very much didactic and teacher-centered. To move away from the traditional teaching 85 culture, CBL was introduced in Academic Year (AY) 2013/14 semester 1 for DOPT. A year 2 module (Ocular Disease 1) was piloted. It was continued

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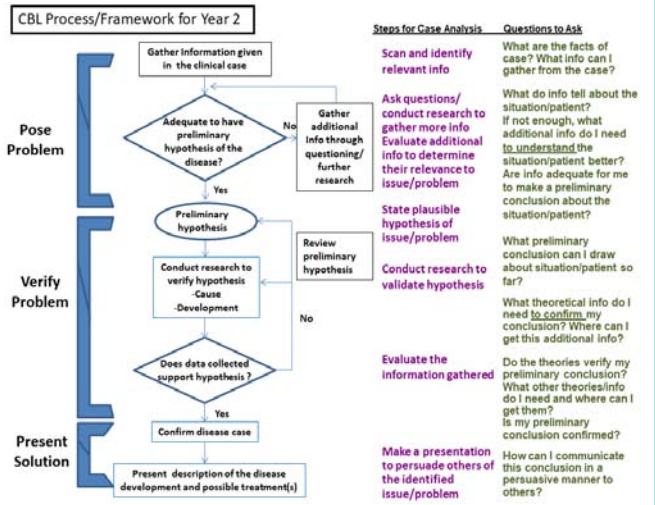

Figure 1: The CBL process.

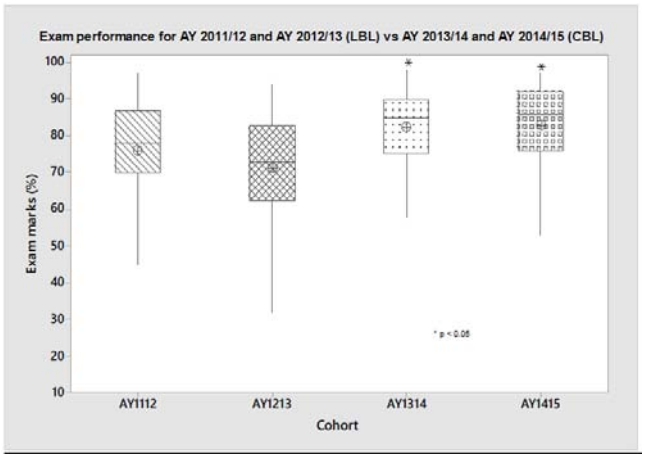

Figure 2: Box plots showing exam performance for AY 2011/12 and AY 2012/13 (LBL) vs AY 2013/14 and AY 2014/15 (CBL). AY 2013/14 and AY 2014/15 have shown significantly better performance as compared to AY 2011/12 and AY 2012/13 (one-way ANOVA, $p < 0.05$).

in AY 2014/15. To date, there are no reports on comparing LBL and CBL instruction method in optometry education. The purpose of this study was to compare the effectiveness of the two instruction methods using students' performance at their end-semester exam who undergone a single instructional session of either CBL or LBL. We hypothesized that students undergoing CBL would yield better performance as compared to those undergoing LBL.

Materials and Methods

The current study was done after both the LBL and CBL cohorts have graduated without any prior plans. The end-semester exam marks were retrieved retrospectively from the database and analyzed. In this paper, we compared the exam marks for the same module (Ocular Disease 1) of four cohorts, over the past four years. AY 2011/12 and AY 2012/13 were the cohorts when LBL was carried out and AY 2013/14 and AY 2014/15 were the cohorts when CBL was done. The effectiveness of the two tested instruction method (LBL vs CBL) was compared using (i) student's performance in end-semester exam and (ii) student's self-rated evaluation. This method was adapted from İlgüy [11] and Zhao and Potter [2].

The LBL cohorts (total of 153 students) consists of 76 students (46 females and 30 males) in AY 2011/12 and 77 students (45 females and 32 males) in AY 2012/13. They were in their year one semester two when taking the module with the age range of 16-17 years. The CBL cohorts (total of 145 students) consists of 72 students in AY 2013/14 (42 females and 30 males) and 73 students in AY 2014/15 (46 females and 27 males). They were in their year two semester one when taking the module with the age range of 17-18 years.

The CBL process were designed and facilitated as shown in Figure 1. At the start of the session the student expectations were set so as to achieve the desired learning outcomes. Students working in groups of 4 to 5, randomly selected by the teacher. The session started with a clinical case being introduced to the students without any prior teaching of content knowledge and students were guided through three phases. The first phase "Pose problem" comprises of the introduction of the case by teacher and students would be analyzing the case, acquire deeper knowledge through further questioning to gather more information and generate preliminary hypothesis (preliminary/differential diagnoses). The second phase "Verify problem" were mainly done by students, it comprises of conducting additional research and brainstorming sessions to review and further validate their hypothesis. This can be done out-of-class among students. Face-to-face in-class sessions were also conducted for students to verify their findings from the teacher through-out the second phase. During in-class sessions, the teacher was the facilitator and facilitated the entire session, at times providing answers but most of the time just guiding them and trying to engage all students. The last phase "Present solution" comprises of evaluating the information gathered, arriving at the conclusion (final diagnosis), presenting the methodology which leads to the conclusion, followed by the management plan(s) based on the diagnosis made. The clinical case was presented by students using progressive disclosure in a fixed order throughout the session. After which, quizzes was conducted to test for student's understanding. The three phases above require lot of inquisitiveness, collaboration and self-directedness from the students.

The above mentioned CBL process mimic the actual clinical case management process in day-to-day optometry practice. The case was the patient who presented with a problem and the optometrist has to diagnose the condition in a methodical way. The optometry student has to ask a patient questions and to gather information through history taking to arrive at a set of preliminary/differential diagnosis (pose problem phase). Some guiding questions were included in the case so as to initiate the thinking process of the students. After history taking, the student has to perform series of eye examinations to verify the hypothesis (verify problem phase), in CBL this takes place during out-of-class session with their peers and in-class discussion with their teacher who is an optometrist. During in-class discussion, the student clinician went through the motion of performing the required eye examinations by asking various questions to further validate their diagnosis. The teacher would provide the findings of the eye examinations as per student's request, with no inputs/judgement as

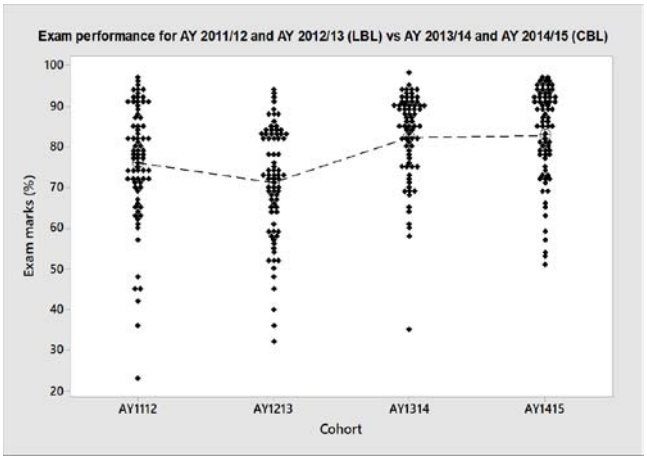

Figure 3: Individual value plot showing exam performance for AY 2011/12 and AY 2012/13 (LBL) vs AY 2013/14 and AY 2014/15 (CBL) with mean connect line. AY 2013/14 and AY 2014/15 (CBL) have shown narrower spread of marks as compared to AY 2011/12 and AY 2012/13 (LBL).

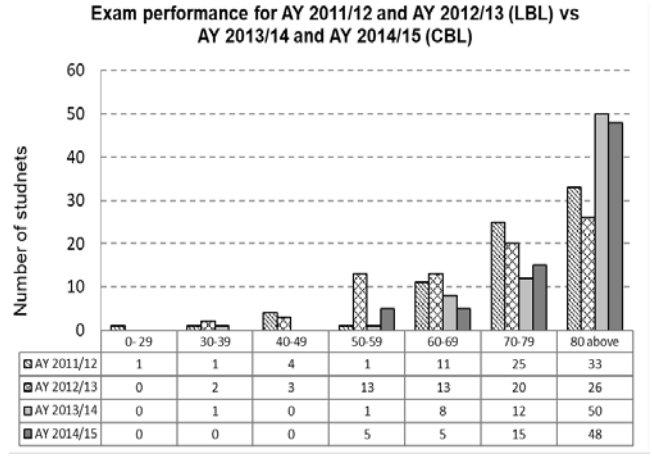

Figure 4: Histogram showing exam marks distribution for AY 2011/12 and AY 2012/13 (LBL) vs AY 2013/14 and AY 2014/15 (CBL). Number of students obtaining 80 marks and above has increased significantly in the CBL cohorts (one-way ANOVA, $p < 0.05$).

to right or wrong, needed or not needed, leaving the evaluation to the students. Once the students have gathered all the information, they moved onto the last phase (present solution phase). They evaluated all the information gathered, arrived at a conclusion (the final diagnosis) followed by devising the management plan(s) for the patient. During both the out-of-class and in-class sessions, students learned from and interacted with their peers. This interaction not only facilitated learning but also enhanced communication skills. At the end of the lessons, self- and peer-assessment were performed to help students improve on their deficiencies.

On the other hand, LBL was done using didactic lecture and tutorials with case studies. Students diagnose an ocular condition based on the information provided by the teacher, followed by devising the management plan(s). The teacher was the sole information provider in this learning method and the entire process of case diagnosis and management was guided through by the teacher.

Only the students undergone CBL were asked to complete a 15 statements self-rated evaluation to feedback on their learning experience (Table 1) as the system was not implemented prior to that. Likert scale was used to rate their response on each statement where 1 = strongly disagree to 5 = strongly agree. At the end of the semester, both the LBL and CBL students had their end-semester written exam. Topics taught, examination format and weightage for the written exam were the same in both LBL and CBL cohorts. All the exam questions were moderated by other faculty with same level of complexity and strictly adhere to the standard set by the examination office of the Singapore Polytechnic.

Data analysis

The end-semester exam marks of the four cohorts were compiled and tabulated. One-way ANOVA followed by Tukey pairwise comparisons was performed to explore differences in end-semester exam marks between LBL and CBL cohorts. All tests were two-tailed and $p < 0.05$ was considered significant. All data were presented as mean ± SD, unless otherwise stated. Results were presented using box plots and individual value plots.

Table 1: The student self-rated evaluation.

	Statement	Rating
A1	Maintain a keen interest in research	
A2	Feel inspired to discover new knowledge in my area of study	
A3	Apply learning to real-world applications	
A4	Conduct information search	
A5	Learn independently	
A6	Find ways to overcome obstacles in learning	
A7	Handle tight deadlines	
A8	Contribute to team goals effectively	
A9	Better understand the opinions of team members	
A10	Identify my strength(s) as a team member	
A11	Write in a more organised manner	
A12	Enjoy my class	
A13	Be actively engaged in class	
A14	Identify a set of possible causes to a problem	
A15	Possess better analytical skills	

1: Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly Agree.

For student's self-rated evaluation, mean ± SD score of the ratings was computed and responses to the 15 statements were analysed using Minitab ver. 18.1 (minitab.com/legal/trademarks, US). The self-rated opinions using Likert scale (from 1 = 186 strong disagree to 5 = strongly agree) for each of the statements were computed in % (n).

Ethical Approval

This study was granted exempt status by the Institutional Review Board of the Singapore Polytechnic.

Results

Student's Performance in end-semester exam

On comparing the end-semester exam results three observations were made. Firstly, there were significant improvement in the

	Cohort	Module offered semester	Exam marks (%) (mean ± SD)	95% CI	p value (one-way ANOVA)
LBL	AY 2011/12 (n = 76)	Yr1 S2	76.0 ± 14.7	(73.0, 79.0)	a
LBL	AY 2012/13 (n = 77)	Yr1 S2	71.1 ± 13.9	(68.2, 74.0)	b
CBL	AY 2013/14 (n = 72)	Yr2 S1	82.4 ± 11.0	(79.4, 85.4)	b
CBL	AY 2014/15 (n = 73)	Yr2 S1	82.8 ± 11.7	(79.8, 85.8)	b

SD = standard deviation
[a]p < 0.05, Tukey pairwise comparisons
[b]p < 0.01, Tukey pairwise comparisons

Table 2: Comparison table showing exam performance for LBL (AY 2011/12 and AY 2012/13) vs CBL (AY 2013/14 and AY 2014/15).

average marks for the CBL cohorts as compared to LBL cohorts. In terms of student's performance in end-semester exam, mean marks for the CBL cohorts were shown to be significantly higher (82.4 for AY 2013/14 and 82.8 for AY 2014/15) as compared to LBL cohorts (76.0 for AY 2011/12 and 71.1 for AY 2012/13). The differences were statistically significant (one-way ANOVA, $p < 0.05$) (Table 2 and Figure 2).

Secondly, the marks SD was lower in the CBL cohorts (11.0 for AY 2013/14 and 11.7 for AY 2014/15) as compared to the LBL cohorts (14.7 for AY 2011/12 and 13.9 for AY 2012/13) (Table 2). Individual value plot shows that the spread of marks were narrower in cohorts taught by CBL as compared to cohorts taught by LBL with a 'trend-up' mean connect line from LBL to CBL (Figure 3).

Thirdly, the number of students obtaining 80 marks and above had increased significantly in the CBL cohorts. Referring to the histogram showing exam marks distribution for the four studied cohorts, number of students obtaining 80 marks and above has increased significantly in the CBL cohorts as compared to the LBL cohorts (one-way ANOVA, $p < 0.05$) (Figure 4).

Student's self-rated evaluation

In total 92 responses (63% response rate) were received from the CBL cohorts. 37 responses from AY 2013/14 cohort and 55 responses from AY 2014/15 cohort. Mean ± SD score of the ratings was 3.71 ± 0.19 for AY 2013/14 and 3.91 ± 0.23 for AY 2014/15 (Table 3). On comparing the student feedback score among the AY 2013/14 and AY 2014/15 cohorts, we observed that the feedback improved positively in most aspects.

Responses to the 15 statements were mixed (Table 4). Students in the CBL cohorts reported that knowledge gained enabled them to apply learning to real-world applications (A3, 82.5%, those who indicated agree and strongly agree) and the teaching approach possessed better analytical skills (A15, 78.2%). They were able to learn independently (A5, 79.3%) in particular when conducting information search (A4, 73.9%) and was able to identify a set of possible causes to a problem (A14, 73.9%). They also reported that the lessons enabled those to contribute to team goals effectively (A8, 77.2%) and better understanding the opinions of team members (A9, 66.3%). They enjoyed their classes (A12, 77.1%) and were inspired to discover new knowledge (A2, 70.6%) and be actively engaged (A13, 60.9%). On the other hand, students found that they had difficulty in handling tight deadlines (A7, 55.4%) and writing in a more organised manner (A11, 60.8%) (Table 4).

Discussion

Case-Based Learning (CBL) is an effective pedagogical method in healthcare professional education which develops independent learning, critical thinking, and inquisitive and communication skills. Without teaching the content knowledge, students are engaged and learn actively through authentic case analysis and develop life-long learning skills [12]. In CBL, cases are summarized versions of narratives or stories that involve moral dilemmas and real-life

Table 3: Student's self-rated evaluation on attending the CBL lessons (n = 92).

	Statement	Rating	
		AY 2013/14 (n = 37)	AY 2014/15 (n = 55)
A1	Maintain a keen interest in research	3.54	3.67
A2	Feel inspired to discover new knowledge in my area of study	3.65	4.05
A3	Apply learning to real-wolrd applications	3.97	4.19
A4	Conduct information search	3.92	3.85
A5	Learn independently	3.86	4.05
A6	Find ways to overcome obstacles in learning	3.35	3.76
A7	Handle tight deadlines	3.78	3.47
A8	Contribute to team goals effectively	3.78	3.96
A9	Better understand the opinions of team members	3.76	3.66
A10	Identify my strength(s) as a team member	3.78	3.65
A11	Write in a more organised manner	3.54	3.92
A12	Enjoy my class	3.51	4.22
A13	Be actively engaged	3.43	3.87
A14	Identify a set of possible causes to a problem	3.76	4.07
A15	Possess better analytical skills	3.95	4.18
		3.71 ± 0.19	3.91 ± 0.23

Table 4: Self-rated opinions from 92 students (AY 2013/14 and AY 2014/15) about attending the CBL lessons.

	Statement	Strongly disagree % (n)	Disagree % (n)	Neutral % (n)	Agree % (n)	Strongly agree % (n)
A1	Maintain a keen interest in research	1.1 (1)	5.4 (5)	35.9 (33)	45.6 (42)	12.0 (11)
A2	Feel inspired to discover new knowledge in my area of study	1.1 (1)	1.1 (1)	27.2 (25)	48.9 (45)	21.7 (20)
A3	Apply learning to real-wolrd applications	1.1 (1)	1.1 (1)	15.2 (14)	52.1 (48)	30.4 (28)
A4	Conduct information search	1.1 (1)	1.1 (1)	23.9 (22)	56.5 (52)	17.4 (16)
A5	Learn independently	1.1 (1)	3.3 (3)	16.3 (15)	55.4 (51)	23.9 (22)
A6	Find ways to overcome obstacles in learning	1.1 (1)	6.5 (6)	34.8 (32)	46.6 (43)	10.9 (10)
A7	Handle tight deadlines	4.4 (4)	5.4 (5)	34.8 (32)	36.9 (34)	18.5 (17)
A8	Contribute to team goals effectively	0.0 (0)	4.4 (4)	18.5 (17)	60.9 (56)	16.3 (15)
A9	Better understand the opinions of team members	1.1 (1)	5.4 (5)	27.2 (25)	54.3 (50)	12.0 (11)
A10	Identify my strength(s) as a team member	1.1 (1)	4.4 (4)	33.7 (31)	44.5 (41)	16.3 (15)
A11	Write in a more organised manner	0.0 (0)	5.4 (5)	33.7 (31)	39.1 (36)	21.7 (20)
A12	Enjoy my class	1.1 (1)	3.3 (3)	18.5 (17)	55.4 (51)	21.7 (20)
A13	Be actively engaged	0.0 (0)	3.3 (3)	35.9 (33)	48.9 (45)	12.0 (11)
A14	Identify a set of possible causes to a problem	1.1 (1)	2.2 (2)	22.8 (21)	48.9 (45)	25.0 (23)
A15	Possess better analytical skills	1.1 (1)	1.1 (1)	19.6 (18)	44.5 (41)	33.7 (31)

1: Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly Agree.

problem solving [13]. Heath [14] described the essential features of a case in terms of 'an account or development of a situation or sequence of events, which raises issue or problems for analysis and solution. CBL develops higher order critical thinking skills [8]. Students are able to identify learning objects and analyse problems embedded in real-world scenarios thus developing analytical and reasoning ability. They are able to make good decisions taking into consideration multiple perspectives, as a result have a greater sense of confidence when they enter the workplace [15]. CBL also provides opportunities for students to justify their stand or making decisions, solving problems, to integrate their knowledge and offer a new point of view [15]. Apart from that, CBL also encourages collaborative learning and peer teaching. Collaborative learning is a pedagogical style that emphasizes cooperative efforts among students and teachers and making them more active as learners and more interactive as teachers [16]. Peer teaching is a type of collaborative learning benefiting both 'teacher' and 'learner'. A peer, unlike a teacher, is still living in the undergraduate experience. Thus, tutor and tutee are more likely to see each other as equals and to create an open, communicative atmosphere [17]. CBL also improved communication skills through group discussion [18] as it is learner-centered and involves intense interaction among participants. The role of the teacher is to enable students to recognise the state, repertoire and depth of various dimensions of their thinking and to sharpen their abilities to deal with real-world problems. A teacher does not directly convey what they know, but using what they know to convey to the learners what they themselves know or can know [18]. Besides, in CBL, preparation of teaching materials has been shifted from creating presentation slides to sourcing and writing good cases as well as providing guiding questions in the proceedings. The responsibility for learning is transferred to the students with the teacher as facilitator, who leads class discussions and choreographs students' learning experiences [19].

According to the Singapore Optometrist and Optician Board (OOB) (Optometrists and Optician Board) [20] of the Ministry of Health, optometrists are primary eye care providers who specialize in performing eye examinations and to provide appropriate optometric management plan(s). Through the tests, they can detect eye-infections and common eye diseases such as cataract, glaucoma, diabetic retinopathy, age-related macular degeneration, all of which may be treatable if detected early. Besides doing refraction and prescribe spectacles and contact lenses, one of the role of optometrists is to detect eye diseases and refer them to other healthcare practitioners such as ophthalmologists for further investigation and management (Optometrists and Optician Board) [20].

The module aim of Ocular Disease 1 was to provide students with in-depth understanding to the diagnosis and optometric management of diseases of the eye and visual system. In the module, students learn the detection, diagnosis, referral and management of various ocular conditions such as ocular inflammation, congenital conditions and tumours. More ocular conditions are covered in another module, Ocular Disease 2. One of the learning outcomes of Ocular Disease 1 is "recognizing the aetiology and pathological process of various ocular conditions in order to facilitate their prevention, diagnosis and management". Evaluating learning outcomes and retention of information is an important part of education and directly affects the ability of the graduating students [21]. Although we did not evaluate communication skills in this study, Chan [18] reported that CBL improved communication through group discussion. This suggests that in a case-based approach, which is learner-centered and involves intense interaction among students, may be more effective in preparing students for deep learning than a lecture-based approach.

The advantages of case-based method include promotion of self-directed learning, clinical reasoning, clinical problem solving, and decision making by providing repeated experiences in class and by enabling students to focus on the complexity of clinical care [22]. Besides, it also developed critical thinking skills [8]. These elements

are highly desired for an optometrist to perform their role as stated by the OOB (Optometrists and Optician Board) [20]. It helps them to make clinical diagnosis and decision efficiently followed by appropriate referral when needed.

CBL facilitates the development of reflective thinking and deeper understanding, it helps learners to focus on a case, and encourages a structured approach to problem solving [23,24]. This was demonstrated in the students' self-rated evaluation in this study. For example, from responses in A4 and A5, over 73% of the students found that they were able to learn independently particular in conducting information search (Table 4) and in A14, 73.9% of them reflected they were able to identify a set of possible causes to a problem through CBL. Besides, CBL also involves the telling of a story with a set sequence of events and order in a discipline context. During this process, CBL brings a higher order level of thinking, as students collaboratively devise strategies to analyse to case presented, problem solve and make decisions to fulfil the story ending in accordance to learning outcomes [25]. To a certain extent, CBL uses trigger moments to recall cognitive information covered in areas of curriculum and allows for the application of cognitive knowledge in a practical contextual sense [26].

Based on results shown in the current study, it was clear that students preferred CBL over LBL instruction method. CBL provided open-ended exploration of issues and encouraged debate, discussion, and exploration of ambiguity while providing more structure for the learner on an efficient, goal-directed manner. CBL helps focus the learners on the key points of a clinical case, encourages a structured approach to clinical problem-solving, and allows each learner to be a 'content expert' for part of the session. Facilitators can correct assumptions of the learner during the class discussions [27]. Again, based on the self-rated responses in this study, students claimed that using CBL, they were able to relate learning to real-world applications (over 82% agreed and strongly agreed, A3). In addition, students also felt that CBL improved their analytical skills i.e., able to infer information and provide logical and reasoning skills to derive their possible differential diagnosis (over 78% agreed and strongly agreed, A15).

Case-based studies may be more helpful for students than lecturers, and group learning activities should be considered a means of delivery of information. It was reported that students enjoy CBL and it helps them learnt better [28]. Deeper learning is essential for the retention of information and more efforts should be spent in this aspects [11]. The self-rated responses in this study has also shown that students enjoy their classes and were inspired to discover new knowledge (over 70% agree and strongly agreed, A12 and A2) and lessons enabled them to contribute to team goals effectively (A8, 77.2%), better understanding the opinions of team members (A9, 66.3%) and be actively engaged (A13, 60.9%).

Change in curriculum resulted in changing the module code & name and also the period it was offered to the DOPT students. The module code and name changed from CP3049 Ocular pathology 1 to CP3056 Ocular disease 1, but it should not affect our results as the content was similar in both modules. The module was offered in the second semester of year 1 for the AY 2011/12 & AY 2012/13 cohort (LBL group) while it was offered in the first semester of year 2 for the AY 2013/14 & AY 2014/15 cohort (CBL group). A better exam performance in the CBL cohorts could also be attributed to the improved students' ability or their initial knowledge level in their second year of study as opposed to the first year of study. However, the students' self-rated responses proved that CBL improves their analytical skills as well as their problem solving skills and they in fact were actively engaged and enjoyed the class.

Although the age range for CBL cohorts were older than the LBL cohorts, the entrance level of the four cohorts were the same. All the four cohorts has passed their pre-requisite subjects to ocular disease such as the human anatomy and ocular anatomy and physiology before doing ocular disease 1. The Last Aggregate Score (LAS) of the students was not the same across the 4 cohorts. LAS has progressively increased from 11 (mean LAS of the LBL cohorts) to 14 (mean LAS of the CBL cohorts) meaning the CBL cohorts were relatively weaker when entering to Singapore Polytechnic. However even with not so academically strong students, the exam performance was better in doing the module. CBL has shown to be an effective method to engage the students and also to promote life-long learning skills in them.

Some limitations of the study should be noted. The study group consisted of a small number of students, and consisted of year 1 (the LBL cohort) and year 2 (the CBL cohort) students. Its results may not be reprehensive of the whole optometry cohorts and may not be applicable elsewhere. Although the students had some common characteristics, there may have been some variations in their educational background, which may have influences their approach to the methodologies used.

Conclusion

This study suggests that the integrated case-based instruction method may have been effective in promoting better performers in learning ocular disease 1. This can be the future direction in optometry education as it develops self-directed learners, enhance analytical skills and problem solving skills as few essential skills for optometrists.

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