2023-02

Evidence-based teaching in contact lenses education: Teaching and learning strategies

Zeri, F

10.1016/j.clae.2023.101822
Contact Lens and Anterior Eye
Elsevier BV

Contact Lens and Anterior Eye 46 (2023) 101822

Contents lists available at ScienceDirect

Contact Lens and Anterior Eye

journal homepage: www.elsevier.com/locate/clae

Evidence-based teaching in contact lenses education: Teaching and learning strategies

Fabrizio Zeri [a,b,j], Frank Eperjesi [c], Craig Woods [d,j], Stefan Bandlitz [b,e], Ajay Kumar Bhootra [f], Mahesh R. Joshi [g], Manbir Nagra [h], Helmer Schweizer [i], Shehzad A. Naroo [b,j,*]

[a] University of Milano-Bicocca, Department of Materials Science, Milan, Italy
[b] College of Health and Life Sciences, Aston University, UK
[c] H & F Consultancy Ltd, Sutton Coldfield, UK
[d] School of Optometry and Vision Science, University of New South Wales, Australia
[e] Höhere Fachschule für Augenoptik Köln, Cologne School of Optometry, Cologne, Germany
[f] Himalaya Optical, Kolkata, India
[g] Eye and Vision Research Group, University of Plymouth, UK
[h] Independent, Leamington Spa, UK
[i] Helmer Schweizer Consulting Group, Switzerland
[j] International Association of Contact Lens Educators, Canada

ARTICLE INFO

Keywords:
Evidence-based teaching
Contact lens
Blended learning
Group work
Case-based learning
Reflective practice

ABSTRACT

Introduction: Contact lens (CL) practice is an ever-changing field with clinical knowledge, techniques and equipment continuously evolving. These new developments are backed with clinical trials and research to ensure that practitioners feel confident that there is an evidence base to support these advances. Evidence-based practice is now a crucial part of CL practice, and its importance also filters down to CL education. For example, lectures are one of the most popular tools for an educator but, is standing at the front of a lecture theatre full of students a more effective way of teaching than providing the same material for students to read by themselves? What evidence exists specific to CL education?

Method: An expert panel of educators completed a comprehensive literature review of current evidence of teaching methods in CL training, or if not available then what can be learnt from other health care professional training that could be potentially applicable to CL education.

Results: Due to the amount of evidence available in the overall subject area relating to healthcare education, the initial plan of compiling evidence into one narrative review paper was discarded in favour of producing two linked papers. Here, the first paper details definitions of terminology, and also teaching methods. The second paper focuses on assessment and specific clinical training required to attain CL practice competency. In this first paper, no direct evidence of the spreading and benefit of new education strategies evidence such as flipped classrooms, spaced learning, test-enhanced learning, group work, CBL, PBL, TBL, and reflective practice in CL education was found. The only technique that was widely used in the CL field was case reports and the group discussion of them. Nevertheless, the authors found a consensus of opinion from other disciplines that are transferable to CL teaching and could help students meet the intended learning outcomes.

Conclusion: There is a small amount of evidence supporting CL education, but most of this seems to be related to the practical element of the training. However, there is a lot of evidence in the field of healthcare education from related disciplines which provides additional but important learning tools that may be effectively implemented in CL education.

Abbreviations: BCLA, British Contact Lens Association; CBL, Case-Based Learning; CL, Contact Lens; CPD, Continuing professional development; EBP, Evidence-based practice; EBT, Evidence Based teaching; EMQ, Extended matching question; HE, Higher Education; IACLE, International Association of Contact Lens Educators; MCQ, Multiple choice question; OSCE, Objective structured clinical examination; OSPE, Objectively structured practical examination; PBL, Problem-based learning; TBL, Team-based learning.

* Corresponding author at: College of Health and Life Sciences, Aston University, UK.
E-mail address: s.a.naroo@aston.ac.uk (S.A. Naroo).

https://doi.org/10.1016/j.clae.2023.101822
Received 8 February 2023; Accepted 8 February 2023
Available online 15 February 2023

1. Introduction

Contact lens (CL) education involves the delivery of theoretical knowledge and the development of clinical skills, using a mixture of teaching techniques such as lectures, practical classes, and clinics. Educators use a variety of tools, such as videos and images of real and simulated clinical cases. Furthermore, various aspects of CL training use many different assessment techniques. Questions arise as to the evidence supporting the use or introduction of a particular teaching and/or assessment method and how effective that method is to deliver the information to students and to assess their ability to perform the taught task. These questions concern the field of evidence-based education more generally, importantly in the delivery of health care training and can be applied to every aspect of CL education, from the overall design of a teaching module, the use of a technology, the assessment method and confirmation of individual units of clinical competency. There are two levels of focus in this general arena of evidence-based education [1]. Firstly, to utilise existing evidence from worldwide research and literature on education (directly derived from research in CL education or from other similar fields potentially applicable to CL education). Secondly, to establish sound evidence where existing evidence is lacking or of a questionable, uncertain, or weak nature.

The International Association of Contact Lens Educators (IACLE) embarked on a project to conduct a comprehensive review of the peer reviewed literature for evidence to: (1) support the teaching and assessment methods in CL education: (2) bring a consensus to the field; (3) determine whether incumbent teaching methods helped students meet the intended learning outcomes; and (4) whether there was an absence of evidence that required further investigation.

IACLE assembled a panel of recognised contact lens teaching experts who assessed current teaching and assessment practices and evaluated published scientific evidence to determine what contact lens teaching and assessments could be considered as evidence based. The common hierarchical evidence model of scientific research [2] was used to judge the importance of evidence. The IACLE evidence-based teaching (EBT) consensus was initially planned as one paper but due to the volume of information collated it has been separated into two papers. The first paper provides a definition of EBT and focuses on teaching methods in CL higher education (HE) which promote learning in the area. The second paper details assessment in CL HE and the teaching of clinical skills required for CL practice.

2. Evidence based teaching definition

The approach to teaching based on the best scientific evidence (empirically validated tools and techniques) is known as evidence-based teaching (EBT) [3]. Several definitions of EBT have been proposed. For example, 'the conscientious, explicit, and judicious integration of best available research on teaching technique and expertise within the context of student, teacher, department, college, university, and community characteristics' [4]. This general definition of EBT has been tailored by the IACLE EBT panel to the specific field of CL as, 'the conscientious, explicit, and judicious integration of best available research in CL related science on teaching and assessment techniques and expertise within the context of CL education.' An EBT approach is relevant for the education of health-care related professions, which are particularly challenging since students need to learn broad theoretical knowledge and develop practical clinical skills in simulated and real-world clinical settings. This has a direct and important impact on the health care system efficiency [5], including in the field of eye care [6]. Unfortunately, many changes and developments in educational thinking and practice become fashionable or transient and it is unclear if they offer improved or more efficient alternate methods to traditional methods, due to the lack of scientific evaluation of new approaches [1]. However, the effort to drive changes based on EBT in HE [7], is improving [8]. Embracing EBT in CL education will enable students to become successful in HE settings and in their future professional life, developing stronger evidence based practice [2].

3. Teaching methods in CL HE

Teaching can be defined as an engagement with learners to enable their understanding and application of knowledge, concepts and processes. Teaching is not just delivery, but includes design, content selection, assessment and reflection. Therefore, CL teaching could be considered as that which is undertaken by a CL educator, who has the control over the various elements mentioned in order to help the student learn. Additionally, learning is a process that leads to change, which occurs as a result of experience and increases the potential for improved performance as a CL practitioner and future learning. Teaching and learning are the two sides of the coin that is education, and they are ardently interconnected. The evidence-based teaching promotes learning [3], so the whole process is meant as evidence-based education (also known as evidence-based teaching and learning) [9].

3.1. Blended learning: face-to-face teaching versus flipped classroom

Blended learning is also referred to as technology-mediated instruction, web-enhanced instruction, or mixed-mode instruction. Although there has always been ambiguity about the definition of blended learning [10], it could be described as an approach to education that combines the use of media, group work and online educational materials and opportunities for interaction online with physical classroom methods. Ideally, blended learning, and more specifically flipped classroom learning, should be approached in a step-by-step fashion [11], but the COVID-19 pandemic forced teachers into web-based teaching and having to adapt the flipped classroom approach very quickly [6]. In the classic lecture format (face-to-face) a topic or subject is first introduced during the contact time in the classroom. Students may follow this with homework in their own time, and with practical training, if that is applicable to the subject matter. The latter being an essential element in CL education and is discussed in the companion paper [12]. The idea that theoretical lecturing or direct face-to-face instruction alone does not make the best use of the available contact time and resources resulted in the concept of 'flipped classroom' learning (also known as reverse, inverse, or backwards classroom learning) [13,14]. The most important element of flipped classrooms is that students learn about the subject before class, freeing up contact time with the teacher during class time for practical or higher order thinking activities. In this model it is recognised that the contact time with the teacher in the classroom is precious so should be valued and used well. This supports the idea that students should turn theory into practice but should not be confused with practical classes that offer a hands-on session only. Flipped classroom learning includes the use of materials, media and information and communication technologies [15,16], such as online presentations, videos, audio files, and online tests before the class, as well as preparing presentations, and group work discussions before, during and after class [17]. It has been reported that in order to have equality to access that digital capabilities of learners need to be taught explicitly and should not be assumed. To improve student learning outcomes, digital skills and competencies need to be embedded throughout the curriculum and addressed through learning objectives [18]. Practical exercises are very applicable to CL education too. The point of a practical exercise is to apply pre-learned thinking to a new, live problem in class. Group discussions and group work is popular with students and leads to better test results [19]. A flipped classroom aims to increase student engagement and learning through completion of pre-readings at home (or in groups) and work on live problems during class time. This approach brings more activities, including some that have been considered homework, into the classroom. In the class, students are engaged in learning with a mentor's guidance [17]. This approach allows students to self-pace (student-centred model) [13]. High achievers may skip already understood parts,

while allowing lower achieving and struggling students to review again, learn from the more advanced students through structured dialogue, and be better prepared when they come to the face-to-face class [17,20,21]. Flipped classrooms are a great opportunity for educators with motivation and interest to upgrade their teaching methods by learning new skills and teaching higher-order skills and processing, like analysis or application of knowledge [22]. Educator interest is higher and leads to better use of formal instructional time [23,24 22].

There are no publications on the use of a flipped classroom in CL teaching. However, different forms of flipped classroom methods have been used in other modules of optometry education [15,25–29] and more extensively in other fields of medicine where students face similar learning problems [5,30–35]. In many cases the flipped classroom was demonstrated to be useful [32,33,35–38] and in other cases it did not affect learning outcomes, [25,30,39] although students had a positive attitude towards it [25,30,33,37,40]. In particular, studies have shown that flipped classrooms increase learner satisfaction with the ability to access pre-class assignments (learn at their own pace) and students enjoy the greater focus on discussions and hands-on activities [17,20,36]. It should be noted that there is mixed data on the effects of flipped classrooms with regards to long-term knowledge retention and changes in clinical practice behaviours [36]. Studies do, however, show that students perform at least as well as those who attended traditional lectures and no detriment is seen [17]. Some studies show increased retention in flipped classroom settings [17,41]. There are, however, also arguments against the flipped classroom, such as an increase in time investment, especially by teachers but also by students, and its applicability to some fields of HE [11,39].

Student acceptance and motivation is essential for the flipped classroom to be effective [21]. Students need to have intrinsic motivation and a sense of autonomy to finish pre-work before the class. Some students enjoy working with peers and measured gain in competencies (such as passed tests). Research suggests that successful flipped classroom models foster student motivation intrinsically and extrinsically [17,21]. Students' motivation to review the materials before class increases with pre-class quizzes [20,36].

The social response to the COVID-19 pandemic and the forced move to online teaching did not leave teachers with a choice. Flipped classroom, even full-time online materials had to be developed in a very short time, including for optometry [27,28,42] and the discussion of lack of evidence on knowledge retention was not debated since the alternative was no education at all. Now that planned blended learning has returned it is time to evaluate if the flipped classroom has a future in CL HE [6,8]. For most learners the flipped classroom is a new experience that differs from how they have been taught or studied in the past. Educators spend significant time in flipping medical curricula. They can invest 127 % more time in course development and 57 % more time to maintain that course than a traditional lecture [13]. Once developed, maintenance will require less time, though. Students most often cited the preparation time prior to class was burdensome [20]. The success of a flipped classroom model depends on students arriving to class prepared and familiar with the material provided, so that in-class time can be used to apply that knowledge via cases and examples, as well as clarifying knowledge gaps that may still exist. Teachers should avoid to provide too much pre-class work or information [43,44]. To improve student engagement the required pre-class studying time should be no more than 20–30 min and ideally videos should not be longer than six minutes [17,45,46].

3.2. Spaced learning

The concept of spaced learning is one of the most robust phenomena in pedagogy [47]. It has been shown that retention is enhanced if learning is broken into sessions using temporary intervals [48,49]. Providing temporary intervals interacts positively with repetition which is an important factor affecting learning and memory. As Romans used to say, *repetita iuvant,* which translates as 'repetition helps'. If the repetition is broken by intervals then learning is enhanced, this is known as the space repetition effect [50]. Spaced repetition is very effective for promoting any form of learning and has considerable potential for improving learning in various settings [51]. Spaced repetition has been shown to be effective with learners of all ages and it increases recall irrespective of age [50]. Spaced learning or teaching is an approach through which content is intensively taught multiple times with scheduled breaks when students can perform some physical or distractor activities [52]. The purpose of such activities is to relax the learner and take their mind off the learning material that has just been learnt, but often related to the material. Learners can become overly carried away by distractor activities, and these distractor activities may sometimes occupy their minds when the following teaching session begins. It may also be boring to listen to the same contents of a lecture several times and discuss the same material in the distractor activity. These may be considered the challenging aspects that a lecturer has to deal with in implementing spaced learning. Spaced learning can be an effective strategy that can improve the clinical topic-specific knowledge and clinical skills required in healthcare professionals and for this reason, especially in the last 15 years [47], it has been widely adopted in undergraduate studies, postgraduate studies [53–56], residency programmes [57], and continuing professional development programs for health professionals [55,58]. However, spaced learning is rarely defined in the health profession education literature and poorly implemented in practice [47]. Spaced education has the potential to improve learning in health professionals education and therefore in CL HE. However, no direct evidence is available in this field.

3.3. Test enhanced learning

In an educational environment tests can be considered as a method of assessment of students' knowledge (this will be discussed in detail in the second paper) and as a method to improve learning outcomes during teaching (formative assessment) [59]. In formative assessment students are provided with constructive feedback so that they can improve their learning performance [60]. Research in cognitive psychology has established that tests during teaching can affect learning by promoting better long-term knowledge retention, a phenomenon known as the testing effect, or test-enhanced learning [61,62]. In the testing effect, the long term memory is enhanced when some of the learning hours are devoted to retrieval of information from memory [63]. Tests promote the retrieval of information and lead to increased retention more than studying alone does. This is one of the most consistent findings in cognitive psychology [62]. Numerous methods can be used for formative assessment, such as multiple-choice questions, practical assessment, short answer questions, essays, case studies, role play, group discussion, group work presentations, project reports, debates and quizzes [59].

Taking a test after studying potentiates further study and improves the retention of learning [64,65]. More specifically, it has been demonstrated that quizzing, not additional reading of the same material, improved subsequent test scores, and short answer questions produced more robust benefits than multiple choice quizzes [65]. Others noted that tests improved retention more than repeated studying [62]. Furthermore, retrieval practice improved meaningful learning and the most frequent way of implementing retrieval practice in a classroom is to have students answer questions [66]. Feedback enhances benefits of tests by informing the learner about their learning performance in relation to the learning outcomes. Feedback helps the learner redirect and refocus the action to achieve learning outcomes by aligning effort and activity with the outcomes. In one study it was noted that feedback enhanced positive effects and reduced negative effects of multiple choice question based tests and therefore, educators should provide feedback when using multiple choice questions [67]. Feedback is a valuable function to correct memory errors and metacognitive errors, as it enhances retention by allowing students to correct initial erroneous

responses. Moreover, feedback also doubled the retention of correct low-confidence responses [67].

It is clear from the literature that test enhanced learning is a concept linked to the process of remembering concepts and facts, retrieving them from the memory and increasing long term retention of those concepts and facts. There are many ways these concepts can be effectively used during classroom teaching. Some suggestions are provided below:

1. Incorporating frequent quizzes into lectures may raise student academic achievements [68].
2. 'Summary points' at the end of a lecture in the class can help students to recall and articulate key elements of the lecture. Students who were asked to write the main points after a formal teaching session had a significant improvement in their recall at the end of the semester [69].
3. Taking a test before study can improve subsequent learning of that pretested information [70].
4. Telling students about the effect of test enhanced learning can give students a tool to add to their learning toolkit [71].

It has been demonstrated that test enhanced learning is effective in enhancing knowledge recall and retention and transfer in health professions [72], but there are no studies of test enhanced learning in CL HE. Test-enhanced learning facilitates improved retention of factual knowledge. Contact lens practice is a combination of factual knowledge in addition to the clinical skill of the practitioner. Therefore, using tests to solidify knowledge presents a promising tool for building clinical skills.

3.4. Group work

Learning in a peer group is known to be an effective pedagogy and helps to improve learning outcomes and academic achievements [73]. This is especially useful in health related professions such as optometry where working effectively in a team is essential. Problem-based learning (PBL), cooperative learning, collaborative learning, and team-based learning (TBL) are examples of small-group pedagogies [74,75]. These active learning methods have been used efficiently in health education [76,77] including optometry [78–80]. Group work improved student learning compared to traditional didactic lectures [73] and provided an opportunity to discuss ideas, share knowledge and learn from peers. Learning in groups enhanced student engagement, teamwork, communication skills and decision making [73–75]. This can provide the student with opportunities to compare their work with peers. Group discussion improves knowledge retention, self-directed learning and develops critical thinking. These are important for optometry where students have to use critical thinking and adapt to novel situations [76]. Group work can be instituted in a variety of methods. In cooperative group work, the students work independently to complete a specific project by working on different parts of a research project and combining these sections to create a complete assignment [81]. Whereas collaborative learning is more interactive where students discuss a specific problem and solve it within a group [81]. The role of teacher in collaborative learning is as a facilitator while students lead learning themselves. Teachers can promote learning by stimulating discussion in the group and direct the learning towards desired outcomes [82]. PBL group work involves small groups working on solving a case scenario with direct supervision of a teacher and is used extensively in health education [83]. The issues with such group learning is that some students might not participate or contribute effectively to the group task, which can lead to conflicts within the group, especially if marks are awarded equally to all members of the group [79]. Team based learning (TBL) has a more defined procedure [79]. Students in small groups (typically around 4–8 students) are provided with preparatory work in advance, as in the flipped classroom model. The information from preparatory work is then assessed individually and within groups with a fixed assessment method such as multiple-choice questions. Initially, students are asked to answer these questions individually followed by group interactions until all questions are correctly answered. This exercise ensures that students have good understanding before the next stage of group work. The group then complete another similar case in a group setting using the understanding gained from the previous exercise [84,85]. TBL is a structured method of group work where content is learned in advance of application of the knowledge in a group setting. Also, such sessions can be conducted by a limited number of teachers as students are involved in active learning within an already defined framework. A systematic review of TBL studies showed a positive impact of TBL on learning [76]. However, there was only limited acceptance of the method among students compared to traditional didactic lectures. This could be because of the increased demands on students in TBL [76]. In the context of CL teaching, basic clinical skills, such as keratometry, lens insertion and removal for example, in the university setting are learnt by practicing with fellow students. This can be considered a type of small group learning which can be further enhanced by providing students with preparatory materials such as video demonstrations.

3.5. Case studies and Case-Based learning (CBL)

Case studies (also known as case reports) are detailed narratives that describe, for scientific, medical or educational purposes, a medical problem experienced by one or several patients [86]. Typically, case studies are used to highlight new approaches or treatments as well as rare findings or manifestations of ubiquitous conditions [87]. Although they represent the lowest level of clinical scientific evidence in the evidence pyramid clinical, case studies often serve as a stimulus for further questions and more rigorously designed scientific studies [2,88,89]. Case-based learning (CBL) is described as an active learner-centred approach for medical students, that helps to develop clinical skills [90]. The reading of published case reports in text books, journals or on websites is important as a part of basic and continuing medical education [91]. The goal of CBL could be considered as a necessary preparation of students for clinical practice through the use of authentic clinical cases [92]. Two recently published meta-analyses showed that CBL is effective for the education of medical students as it improved knowledge, performance, teaching satisfaction as well as the students ability to analyse cases [93]. [94] Developing, writing, presenting and discussing a case report by the learners themselves can further hone learning and communication skills [95]. Furthermore, by writing a case study students can improve their experience in researching the literature, scientific writing, understanding evidence-based medicine and improve presentation skills [96]. It is useful if medical education programmes support students in case report writing and clinical teachers encourage and assist students to publish their case reports [90]. Case presentation is reported to be one of the most frequently used clinical teaching and learning techniques [97]. An online survey of 214CL educators worldwide reported, that during the COVID-19 pandemic 46 % of the educators were using the IACLE case reports (https://iacle.org/resources/iacle-case-report-series/) and 32 % were discussing clinical cases with colleagues [6]. To enhance continuing education and avoid the risk of professional isolation for optometrists in practice it has been seen that case-based discussions improved their knowledge and that the peer interaction in case-based continuing education can avoid professional isolation [98].

3.6. Problem-based learning (PBL) and team-based learning (TBL)

The concept of problem-based learning (PBL) was developed in the in the late 1960s at McMaster University, Canada [99]. PBL in medical education involves students working on clinical scenarios with the process facilitated by a tutor [100]. Similar to CBL, PBL is collaborative learning with small groups and a clinical case is often used as a starting point (Table 1) [101,102]. After receiving case information, a discussion

Table 1
Similarities and differences between problem-based learning (PBL), case-based learning (CBL) and team-based learning (TBL) [102].

	Problem-based learning	Case-based learning	Team-based learning
Advance preparation	No advance preparation	Advance preparation	Advance preparation Individual readiness assurance test
Activity	Case based	Case based	Individual or team readiness assurance test; Brief lecture & activity
Learning objectives	Written by students	Given to students	Given to students
Organisation	Small groups (4–8 students)	Small groups (4–8 students)	Small groups (4–8 students)
Learning method	Self-directed	Shared facilitator and self-directed	Shared facilitator and self-directed
Role of faculty	Limited guidance	Active guidance	Active guidance
Inquiry style	Open inquiry	Guided or structured inquiry	Guided or structured inquiry
Number of sessions	Multiple sessions	Single sessions	Single sessions
End of session	Student presentations	Wrap-up by faculty	Wrap-up and peer evaluation

starts where students attempt to generate a hypothesis and organise their own leaning process to identify and solve the problem [100,102]. While CBL primarily aims to apply knowledge to provide a solution to a clinical case [100], PBL is used to build knowledge along a problem definition with an open result. Often a single solution is not required as learning from peer-discussion was the goal [101]. It can be conducted without specific preparation for the problem [102]. It is reported that optometry students taking a PBL course are better able to assimilate information about patients, cases or diseases by themselves [103]. As, this method requires students to identify and solve problems, without preparation and with limited support from the tutor, it was suggested as a method for more advanced students [102]. However, there is little evidence for the effectiveness of PBL in optometric education, and it was noted that it might not be possible for all students to solve problems and learn at the same time [100,104]. TBL may include an assessment to ensure that course content is mastered, before or after the students undertake the session [105].

In two studies where a modified TBL was integrated into the clinical training of ophthalmology students, it was shown that performance, self-study, teamwork, class engagement and satisfaction of the students were enhanced [106,107]. When comparing TBL to PBL in medical education, students preferred the structured TBL sessions as they found them more conducive to learning, engagement and participation [108]. When digital TBL was integrated into health curricula of postgraduate nursing and optometry students reported high satisfaction and engagement [109]. TBL has been suggested as a possible replacement of PBL to establish standardised small group learning in medical school [110]. However, beside the evidence from other health care professions and optometric education in general, there are currently no studies that explicitly address the advantages and disadvantages of PBL, CBL, and TBL in CL education. Nevertheless, it seems very likely that the findings from other disciplines are transferable to CL teaching.

3.7. Reflective practice

Reflective practice in education facilitates integration of practical skills with theoretical knowledge [111] and can help learners understand their clinical experiences within a wider context [112], strengthening connections between experiences, knowledge and judgement [113]. Reflection has also been shown to yield improvements in skillsets such as critical thinking [114] and can help in promoting communication between students and teachers [115]. The role of reflection is underpinned by some of the best-known theories of experiential learning [116], and supported through research within contextual healthcare learning settings. Despite the merits of self-reflection, engaging healthcare students in such activities has proven challenging for some educators [117]. Here some of the popular approaches to reflection, its use within optometric education, and areas which may benefit from additional research, are discussed.

Reflection is not a stand-alone practice. Additional components, such as feedback from stakeholders (for example, supervisors, peers or patients), and setting of goals or objectives, can help structure reflection. Others have emphasised that reflection is not merely a review of past actions followed by a plan for the future, but that critical reflection also requires the challenging of existing beliefs and knowledge [118]. Various approaches to reflection have been trialled, including journal-keeping [119,120], electronic logs, and group reflection. Whilst the merits of written reflection have been well documented [121], reflection can take other forms too. For example, supervisors can encourage student reflection through asking open-ended questions about experiences [112], or through role playing [122], and workshops [123]. In addition to differences in format, reflection may take place at different time-points, for example immediately after the experience or even much later [112]. Whilst feedback is a familiar concept within healthcare training, it appears that reflection is an under used approach [112]. Furthermore, it remains unclear which is the best way to assess reflection. Inconsistencies in defining reflection and differences in standards can make assessment challenging [124].

Several models of reflection exist in the education setting [125]. One of the simplest and most successful reflective models is based on three questions: 'what', 'so what', 'now what' [126]. The first question in the reflective model stands for "*What is the problem?*" [127], and refers to a description of the experience that may be a clinical experience, or a case study or a lesson [128]. The second question of the reflective model stands for "*So what could I have done to make it better?*" [127] and it refers to an analysis of significant aspects of this experience [128]. The third question of the reflective model stands for "*Now what do I have to do to make things better?*" [127], and refers to the way in which the experience and reflection will inform future practice.[128]

Kolb's learning cycle [116] is one of the best-known models of learning. The cycle begins with concrete experience, which, in the case of CL could be the assessment of CL fitting. The next stage is reflection, this may involve reflecting on one's performance, and may incorporate the use of feedback. The individual may then begin to understand why an event occurred and have ideas about how to change outcomes in future. These new ideas, knowledge, and reflection are then used to trial different approaches.

Another model is the Gibb's reflective cycle [129] that, as with most models of reflection, begins with a description of the experience, involves reflection about feelings in relation to the experience which includes an evaluation of positive and negative aspects, before leading to an action plan. Gibb's cycle encourages individuals to consider how they might act to achieve a different outcome. Compared to many other models of reflection, Gibb's reflective cycle involves a greater number of steps and detail.

Atkins and Murphy [125] proposed their own framework for reflective practice comprising five elements: i) Awareness of the experience including positive or negative aspects; ii) Describing the situation, including specific events that occurred; iii) Analysis of feelings and knowledge, that is, identifying limitations of knowledge and considering alternatives; iv) Evaluation of knowledge, that is, did it resolve or explain the problem; v) Identify if any learning has occurred.

While some healthcare professions benefit from a body of published research demonstrating contextual applications of reflective practice, there is no research describing its use within CL educational settings and very few in the optometric field. In a study that investigated reflective

journal writing by optometry students following a clinical experience, benefits were found in staff-student communication [115]. Further, communication which occurs outside the time-pressured clinical environment can allow staff to spend longer addressing student questions and to refer to points which may have arisen but not been fully addressed at the time. Optometry student communication skills have been shown to improve by methods such as reflection on clinical cases, background reading and making entries into an online reflective journal prior to small group workshops, which involved activities such as student discussions and role playing [130].

Reflection is a key element of some of the best-known theories of experiential learning. Benefits may include the development of critical thinking skills and promoting active engagement with the learning process. Structure can be added to reflection by using feedback and goal setting but the literature highlights how incorporation of new knowledge or challenging of current beliefs is needed to reflect critically [116]. Despite the existence of many models of reflection within the pedagogical literature, few reports outline their efficacy within optometric settings and there is nothing in the CL setting, hence further research is needed to optimise efficacy of learning.

4. Conclusion

New teaching techniques and environments have emerged over the last few decades based upon scientific evidence such as flipped classrooms, spaced learning, test-enhanced learning, group work, clinical case studies, CBL, PBL, TBL, and reflective practice. Most of these techniques found wide applications in the education of healthcare-related professions since they could potentially be very useful for students who need to learn a broad theoretical knowledge and develop practical clinical skills. A discrete body of evidence has demonstrated these techniques and environments being particularly useful in health professions education and more specifically in the optometric HE. Notwithstanding these premises, in this review, no direct evidence of the spreading and benefit of these strategies in CL education was found. The only technique used widely used in the CL field, especially during the COVID-19 pandemic, was case reports and the group discussion of them. Nevertheless, the IACLE panel engaged in this review found a consensus from findings in other disciplines that are transferable to CL teaching and could help students meet the intended learning outcomes. However, further investigation into the efficacy of this direct application in the CL field would be required and beneficial for the entire community of CL educators, or other disciplines that wish to adapt this approach of evidence-based teaching.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Davies P. What is evidence-based education? Br J Educ Stud 1999;47(2):108–21.
[2] Wolffsohn JS, Dumbleton K, Huntjens B, Kandel H, Koh S, Kunnen CME, et al. CLEAR – evidence-based contact lens practice. Contact Lens Anterior Eye 2021; 44. https://doi.org/10.1016/j.clae.2021.02.008.
[3] Dunn DS, Saville BK, Baker SC, Marek P. Evidence-based teaching: Tools and techniques that promote learning in the psychology classroom. Aust J Psychol 2013;65:5–13. https://doi.org/10.1111/ajpy.12004.
[4] Groccia JE, Buskist W. Need for evidence-based teaching. New Dir Teach Learn 2011:5–11. https://doi.org/10.1002/tl.463.
[5] Frenk J, Chen L, Bhutta ZA, Cohen J, Crisp N, Evans T, et al. Health professionals for a new century: Ttransforming education to strengthen health systems in an interdependent world. Lancet 2010;376:1923–58. https://doi.org/10.1016/S0140-6736(10)61854-5.
[6] Naroo SA, Morgan PB, Shinde L, Lee C, Ewbank A. Contact lens education for the practitioners of the future. Ophthalmic Physiol Opt 2021;41:603–9. https://doi.org/10.1111/opo.12791.
[7] Borrego M, Henderson C. Increasing the use of evidence-based teaching in STEM higher education: A comparison of eight change strategies. J Eng Educ 2014;103: 220–52. https://doi.org/10.1002/jee.20040.
[8] Naroo SA, Kapoor R, Zeri F. Times they are a-changin for contact lens practice. Contact Lens Anterior Eye 2021;44(3):101445.
[9] Cranney J. Toward psychological literacy: A snapshot of evidence-based learning and teaching. Aust J Psychol 2013;65:1–4. https://doi.org/10.1111/ajpy.12013.
[10] Graham CR. Blended learning systems: Definition, current trends, and future directions. Handb blended Learn Glob Perspect local Des 2006:3–21.
[11] Phillips J, Wiesbauer F. The flipped classroom in medical education: A new standard in teaching. Trends Anaesth Crit Care 2022;42:4–8. https://doi.org/10.1016/j.tacc.2022.01.001.
[12] Woods C, Naroo S, Zeri F, Bakkar M, Barodawala F, Evans V, et al. Evidence for commonly used teaching, learning and assessment methods in contact lens clinical skills education. Cont Lens Anterior Eye 2023;46(2):101821.
[13] McLaughlin JE, Roth MT, Glatt DM, Gharkholonarehe N, Davidson CA, Griffin LM, et al. The flipped classroom: A course redesign to foster learning and engagement in a health professions school. Acad Med 2014;89(2):236–43.
[14] Lage MJ, Platt GJ, Treglia M. Inverting the classroom: A gateway to creating an inclusive learning environment. J Econ Educ 2000;31:30–43. https://doi.org/10.1080/00220480009596759.
[15] Herse P, Lee BA. Optometry and webct: A student survey of the value of web-based learning environments in optometric education. Clin Exp Optom 2005;88: 46–52. https://doi.org/10.1111/j.1444-0938.2005.tb06663.x.
[16] Gupta VK, Gupta VB. Using technology, bioinformatics and health informatics approaches to improve learning experiences in optometry education, research and practice. Healthc 2016;4:86. https://doi.org/10.3390/healthcare4040086.
[17] Tolks D, Schäfer C, Raupach T, Kruse L, Sarikas A, Gerhardt-Szép S, et al. An introduction to the inverted/flipped classroom model in education and advanced training in medicine and in the healthcare professions. GMS Z Med Ausbild 2016; 33. https://doi.org/10.3205/zma001045.
[18] Phuong Nguyen K, Ken Luke A, Cheng Y, John A, Cham M. The limited level of digital skills and competencies of optometry students. J Inf Technol Educ Res 2022;21:097–114. https://doi.org/10.28945/4929.
[19] Gaudet AD, Ramer LM, Nakonechny J, Cragg JJ, Ramer MS. Small-group learning in an upper-level university biology class enhances academic performance and student attitudes toward group work. PLoS One 2010:e15821. https://doi.org/10.1371/journal.pone.0015821.
[20] Hew KF, Lo CK. Flipped classroom improves student learning in health professions education: A meta-analysis. BMC Med Educ 2018;18:1–12. https://doi.org/10.1186/s12909-018-1144-z.
[21] Abeysekera L, Dawson P. Motivation and cognitive load in the flipped classroom: definition, rationale and a call for research. High Educ Res Dev 2015;34:1–14. https://doi.org/10.1080/07294360.2014.934336.
[22] Morton DA, Colbert-Getz JM. Measuring the impact of the flipped anatomy classroom: The importance of categorizing an assessment by Bloom's taxonomy. Anat Sci Educ 2017;10:170–5. https://doi.org/10.1002/ase.1635.
[23] Martinelli SM, Chen F, Mcevoy MD, Zvara DA, Schell RM. Utilization of the flipped classroom in anesthesiology graduate medical education: an initial survey of faculty beliefs and practices about active learning. J Educ Perioper Med 2018; 20. https://doi.org/10.46374/volxx-issue1-martinelli.
[24] King AM, Gottlieb M, Mitzman J, Dulani T, Schulte SJ, Way DP. Flipping the classroom in graduate medical education: a systematic review. J Grad Med Educ 2019;11:18–29. https://doi.org/10.4300/JGME-D-18-00350.2.
[25] Goodwin D, Hua LV, Hayes JR. Blended learning in optometric clinical procedures instruction. Optom Educ 2014;39:58–64.
[26] Hua LV, Goodwin D, Weiss A. Traditional vs. blended learning of pharmacology. Optom Educ 2013;39:28–34.
[27] Ramani KK, Hussaindeen JR. Optometric education in the post-COVID-19 era: A time of forced change! Indian J Ophthalmol 2021;69:746. https://doi.org/10.4103/ijo.IJO_2820_20.
[28] Sehgal S, Shinde L, Madheswaran G, Mukherjee P, Verkicharla P, Easwaran S, et al. Impact of COVID-19 on Indian optometrists: A student, educator, and practitioner's perspective. Indian J Ophthalmol 2021;69(4):958.
[29] Acosta ML, Sisley A, Ross J, Brailsford I, Bhargava A, Jacobs R, et al. Student acceptance of e-learning methods in the laboratory class in optometry. PLoS One 2018;13. https://doi.org/10.1371/journal.pone.0209004.
[30] Lin Y, Zhu Yi, Chen C, Wang W, Chen T, Li T, et al. Facing the challenges in ophthalmology clerkship teaching: Is flipped classroom the answer? PLoS One 2017;12(4):e0174829.
[31] Wang A, Xiao R, Zhang C, Yuan L, Lin N, Yan Lu, et al. Effectiveness of a combined problem-based learning and flipped classroom teaching method in ophthalmic clinical skill training. BMC Med Educ 2022;22(1).
[32] Tang F, Chen C, Zhu Yi, Zuo C, Zhong Y, Wang N, et al. Comparison between flipped classroom and lecture-based classroom in ophthalmology clerkship. Med Educ Online 2017;22(1):1395679.
[33] Ding C, Li S, Chen B. Effectiveness of flipped classroom combined with team-, case-, lecture- And evidence-based learning on ophthalmology teaching for eight-year program students. BMC Med Educ 2019;19:1–9. https://doi.org/10.1186/s12909-019-1861-y.
[34] Zhu L, Lian Z, Engström M. Use of a flipped classroom in ophthalmology courses for nursing, dental and medical students: A quasi-experimental study using a mixed-methods approach. Nurse Educ Today 2020;85:104262. https://doi.org/10.1016/j.nedt.2019.104262.
[35] Lu RY, Yanovitch T, Enyedi L, Gandhi N, Gearinger M, de Alba Campomanes AG, et al. The flipped-classroom approach to teaching horizontal strabismus in

ophthalmology residency: a multicentered randomized controlled study. J AAPOS 2021;25(3):137.e1–6.
[36] Chen F, Lui AM, Martinelli SM. A systematic review of the effectiveness of flipped classrooms in medical education. Med Educ 2017;51:585–97. https://doi.org/10.1111/medu.13272.
[37] Tainter CR, Wong NL, Cudemus-Deseda GA, Bittner EA. The "flipped classroom" model for teaching in the intensive care unit: rationale, practical considerations, and an example of successful implementation. J Intensive Care Med 2017;32:187–96. https://doi.org/10.1177/0885066616632156.
[38] Balasopoulou A, Kokkinos P, Pagoulatos D, Plotas P, Makri OE, Georgakopoulos CD, et al. Symposium Recent advances and challenges in the management of retinoblastoma Globe - saving Treatments. BMC Ophthalmol 2017;17:1. https://doi.org/10.4103/ijo.IJO.
[39] Riddell J, Jhun P, Fung C-C, Comes J, Sawtelle S, Tabatabai R, et al. Does the flipped classroom improve learning in graduate medical education? J Grad Med Educ 2017;9(4):491–6.
[40] Diel RJ, Yom KH, Ramirez D, Alawa K, Cheng J, Dawoud S, et al. Flipped ophthalmology classroom augmented with case-based learning. Digit J Ophthalmol DJO 2021;27(1):1–5.
[41] Kraut A, Omron R, Caretta-Weyer H, Jordan J, Manthey D, Wolf S, et al. The flipped classroom: A critical appraisal. West J Emerg Med 2019;20(3):527–36.
[42] Fortepiani A, Lourdes M. Implementing an exclusively on-line flipped classroom model in optometry during the pandemic. FASEB J 2021. https://doi.org/10.1096/fasebj.2021.35.S1.04251.
[43] Moffett J. Twelve tips for "flipping" the classroom. Med Teach 2015;37.
[44] Sharma N, Lau CS, Doherty I, Harbutt D. How we flipped the medical classroom How we flipped the medical classroom. Med Teach 2015;37(4):327–30.
[45] Guo PJ, Kim J, Rubin R. How video production affects student engagement: An empirical study of MOOC videos. L@S 2014 - Proc. 1st ACM Conf. Learn. Scale, 2014, p. 41–50. https://doi.org/10.1145/2556325.2566239.
[46] Rana J, Besche H, Cockrill B. Twelve tips for the production of digital chalk-talk videos. Med Teach 2017;39:653–9. https://doi.org/10.1080/0142159X.2017.1302081.
[47] Versteeg M, Hendriks RA, Thomas A, Ommering BWC, Steendijk P. Conceptualising spaced learning in health professions education: A scoping review. Med Educ 2020;54:205–16. https://doi.org/10.1111/medu.14025.
[48] Bradley A, Patton A. Spaced Learning: Making memories stick. Monkseat High Sch 2014.
[49] Pashler H, Rohrer D, Cepeda NJ, Carpenter SK. Enhancing learning and retarding forgetting: Choices and consequences. Psychon Bull Rev 2007;14:187–93. https://doi.org/10.3758/BF03194050.
[50] Toppino TC, Kasserman JE, Mracek WA. The effect of spacing repetitions on the recognition memory of young children and adults. J Exp Child Psychol 1991;51:123–38. https://doi.org/10.1016/0022-0965(91)90079-8.
[51] Dempster FN. Spacing effects and their implications for theory and practice. Educ Psychol Rev 1989;1:309–30. https://doi.org/10.1007/BF01320097.
[52] Mat-jizat JE, Abas B, Mansor M, Khalid K. The effectiveness of spaced learning as a pedagogical strategy in enhancing student learning and motivation. Int J Acad Res Bus Soc Sci 2020;10:494–506. https://doi.org/10.6007/ijarbss/v10-i5/7221.
[53] Gyorki DE, Shaw T, Nicholson J, Baker C, Pitcher M, Skandarajah A, et al. Improving the impact of didactic resident training with online spaced education. ANZ J Surg 2013;83(6):477–80.
[54] Matzie KA, Kerfoot BP, Hafler JP, Breen EM. Spaced education improves the feedback that surgical residents give to medical students: a randomized trial. Am J Surg 2009;197:252–7. https://doi.org/10.1016/j.amjsurg.2008.01.025.
[55] Phillips JL, Heneka N, Bhattarai P, Fraser C, Shaw T. Effectiveness of the spaced education pedagogy for clinicians' continuing professional development: a systematic review. Med Educ 2019;53:886–902. https://doi.org/10.1111/medu.13895.
[56] Kerfoot BP, DeWolf WC, Masser BA, Church PA, Federman DD. Spaced education improves the retention of clinical knowledge by medical students: A randomised controlled trial. Med Educ 2007;41:23–31. https://doi.org/10.1111/j.1365-2929.2006.02644.x.
[57] Matos J, Petri CR, Mukamal KJ, Vanka A, Vrana KE. Spaced education in medical residents: An electronic intervention to improve competency and retention of medical knowledge. PLoS One 2017;12(7). https://doi.org/10.1371/journal.pone.0181418. e0181418.
[58] Robinson T, Janssen A, Kirk J, DeFazio A, Goodwin A, Tucker K, et al. New approaches to continuing medical education: a QStream (spaced education) program for research translation in ovarian cancer. J Cancer Educ 2017;32(3):476–82.
[59] Race P, Brown S, Smith B. 500 tips on assessment. New York: Routledge; 2005. https://doi.org/10.4324/9780203307359.
[60] Hattie J, Timperley H. The power of feedback. Rev Educ Res 2007;77:81–112. https://doi.org/10.3102/003465430298487.
[61] Larsen DP, Butler AC, Roediger HL. Test-enhanced learning in medical education. Med Educ 2008;42:959–66. https://doi.org/10.1111/j.1365-2923.2008.03124.x.
[62] Roediger HL, Karpicke JD. Test-enhanced learning: Taking memory tests improves long-term retention. Psychol Sci 2006;17(3):249–55.
[63] Karpicke JD, Roediger HL. The Critical Importance of Retrieval for Learning. Science (80-) 2008;319(5865):966–8.
[64] Klionsky DJ. The quiz factor. CBE Life Sci Educ 2008;7:265–6. https://doi.org/10.1187/cbe.08-02-0009.
[65] McDaniel MA, Anderson JL, Derbish MH, Morrisette N. Testing the testing effect in the classroom. Eur J Cogn Psychol 2007;19:494–513. https://doi.org/10.1080/09541440701326154.
[66] Smith MA, Karpicke JD. Retrieval practice with short-answer, multiple-choice, and hybrid tests. Memory 2014;22:784–802. https://doi.org/10.1080/09658211.2013.831454.
[67] Butler AC, Roediger HL. Feedback enhances the positive effects and reduces the negative effects of multiple-choice testing. Mem Cogn 2008;36:604–16. https://doi.org/10.3758/MC.36.3.604.
[68] Yang C, Luo L, Vadillo MA, Yu R, Shanks DR. Testing (Quizzing) boosts classroom learning: a systematic and meta-analytic review. Psychol Bull 2021;147:399. https://doi.org/10.1037/bul0000309.
[69] Lyle KB, Crawford NA. Retrieving essential material at the end of lectures improves performance on statistics exams. Teach Psychol 2011;38:94–7. https://doi.org/10.1177/0098628311401587.
[70] Little JL, Bjork EL. Pretesting with Multiple-choice Questions Facilitates Learning. Expand. Sp. Cogn. Sci. - Proc. 33rd Annu. Meet. Cogn. Sci. Soc. CogSci 2011, 2011, p. 294–9.
[71] Stanger-Hall KF, Shockley FW, Wilson RE, DeHaan RL. Teaching students how to study: A workshop on information processing and self-testing helps students learn. CBE Life Sci Educ 2011;10(2):187–98.
[72] Green ML, Moeller JJ, Spak JM. Test-enhanced learning in health professions education: a systematic review: BEME Guide No. 48. Med Teach 2018;40(4):337–50.
[73] Kalaian SA, Kasim RM. Effectiveness of various innovative learning methods in health science classrooms: a meta-analysis. Adv Heal Sci Educ 2017;22:1151–67. https://doi.org/10.1007/s10459-017-9753-6.
[74] Swanson E, McCulley LV, Osman DJ, Scammacca Lewis N, Solis M. The effect of team-based learning on content knowledge: A meta-analysis. Act Learn High Educ 2019;20:39–50. https://doi.org/10.1177/1469787417731201.
[75] Hammar CE. Group work as an incentive for learning students experiences of group work. Front Psychol 2014:5. https://doi.org/10.3389/fpsyg.2014.00558.
[76] Fatmi M, Hartling L, Hillier T, Campbell S, Oswald AE. The effectiveness of team-based learning on learning outcomes in health professions education: BEME Guide No. 30. Med Teach 2013;35(12):e1608–24.
[77] Burgess A, van Diggele C, Roberts C, Mellis C. Facilitating small group learning in the health professions. BMC Med Educ 2020;20:1–6. https://doi.org/10.1186/s12909-020-02282-3.
[78] Weisinger HS. Prideaux 3 D. Modernizing optometric education in australia: ideas from medical education. Optom Educ 2011.
[79] Hrynchak PK, Spafford MM. Optometry Students' Attitudes about Team-Based Learning. Optom Educ 2015:40.
[80] Zeri F, Cervio R, Mosci M, Tavazzi S, Naroo S. Group work and peer assessment in optometry higher education. Scand J Optom Vis Sci 2020;13:10–8. https://doi.org/10.5384/sjovs.vol13i1p10-18.
[81] Gunderson DE, Moore JD. Group learning pedagogy and group selection. Int J Constr Educ Res 2008;4:34–45. https://doi.org/10.1080/15578770801943893.
[82] van Diggele C, Burgess A, Mellis C. Planning, preparing and structuring a small group teaching session. BMC Med Educ 2020;20:1–8. https://doi.org/10.1186/s12909-020-02281-4.
[83] Polyzois I, Claffey N, Mattheos N. Problem-based learning in academic health education. A systematic literature review. Eur J Dent Educ 2010;14:55–64. https://doi.org/10.1111/j.1600-0579.2009.00593.x.
[84] Parmelee DX. Team-based learning: Moving forward in curriculum innovation: A commentary. Med Teach 2010;32:105–7. https://doi.org/10.3109/01421590903548554.
[85] Vasan NS, DeFouw DO, Holland BK. Modified use of team-based learning for effective delivery of medical gross anatomy and embryology. Anat Sci Educ 2008;1:3–9. https://doi.org/10.1002/ase.5.
[86] Gagnier JJ, Kienle G, Altman DG, Moher D, Sox H, Riley D, et al. The CARE guidelines: Consensus-based clinical case reporting guideline development. Glob Adv Heal Med 2013;2013(oct23 1).
[87] Hoffman JR. Rethinking case reports. West J Med 1999;170:253–4.
[88] Murad MH, Asi N, Alsawas M, Alahdab F. New evidence pyramid. Evid Based Med 2016;21:125–7. https://doi.org/10.1136/ebmed-2016-110401.
[89] Budgell B. Guidelines to the writing of case studies. J Can Chiropr Assoc 2008;52:199–204.
[90] Sayre JW, Toklu HZ, Ye F, Mazza J, Yale S. Case reports, case series – from clinical practice to evidence-based medicine in graduate medical education. Cureus 2017:9. https://doi.org/10.7759/cureus.1546.
[91] Nissen T, Wynn R. The clinical case report: A review of its merits and limitations. BMC Res Notes 2014;7:1–7. https://doi.org/10.1186/1756-0500-7-264.
[92] Thistlethwaite JE, Davies D, Ekeocha S, Kidd JM, MacDougall C, Matthews P, et al. The effectiveness of case-based learning in health professional education. A BEME systematic review: BEME Guide No. 23. Med Teach 2012;34(6):e421–4.
[93] Cen XY, Hua Y, Niu S, Yu T. Application of case-based learning in medical student education: a meta-analysis. Eur Rev Med Pharmacol Sci 2021;25:3173–81. https://doi.org/10.26355/eurrev_202104_25726.
[94] Dong H, Guo C, Zhou L, Zhao J, Wu X, Zhang X, et al. Effectiveness of case-based learning in Chinese dental education: a systematic review and meta-analysis. BMJ Open 2022;12(2). https://doi.org/10.1136/bmjopen-2020-048497. e048497.
[95] Luciano G, Jobbins K, Rosenblum M. A curriculum to teach learners how to develop and present a case report. MedEdPORTAL J Teach Learn Resour 2018;14:10692. https://doi.org/10.15766/mep_2374-8265.10692.
[96] Florek AG, Dellavalle RP. Case reports in medical education: A platform for training medical students, residents, and fellows in scientific writing and critical thinking. J Med Case Rep 2016;10:1–3. https://doi.org/10.1186/s13256-016-0851-5.

[97] Onishi H. The role of case presentation for teaching and learning activities. Kaohsiung J Med Sci 2008;24:356–60. https://doi.org/10.1016/S1607-551X(08)70132-3.
[98] Bullock A, Barnes E, Ryan B, Sheen N. Case-based discussion supporting learning and practice in optometry. Ophthalmic Physiol Opt 2014;34:614–21. https://doi.org/10.1111/opo.12151.
[99] Neville A, Norman G, White R. McMaster at 50: lessons learned from five decades of PBL. Adv Heal Sci Educ 2019;24:853–63. https://doi.org/10.1007/s10459-019-09908-2.
[100] Al Wadani F, Khan AR. Problem-based learning in ophthalmology: A brief review. Oman J Ophthalmol 2014;7:1. https://doi.org/10.4103/0974-620X.127908.
[101] Srinivasan M, Wilkes M, Stevenson F, Nguyen T, Slavin S. Comparing problem-based learning with case-based learning: Effects of a major curricular shift at two institutions. Acad Med 2007;82:74–82. https://doi.org/10.1097/01.ACM.0000249963.93776.aa.
[102] Hopper MK. Alphabet soup of active learning: comparison of PBL, CBL, and TBL. HAPS Educ 2018;22:144–9. https://doi.org/10.21692/haps.2018.019.
[103] Yolton DP, Yolton RL, Laukkanen HRV. Implications of problem-based education for the future of optometric practice. Optometry 2000;71:104–10.
[104] Kirschner PA, Sweller J, Clark RE. Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. Educ Psychol 2006;41:75–86. https://doi.org/10.1207/s15326985ep4102_1.
[105] Gold JM, Collazo RA, Athauda G, Obeso VT, Toonkel RL. Taking CBL to the lecture hall: a comparison of outcomes between traditional small group CBL and a novel large group team-based CBL teaching method. Med Sci Educ 2020;30:227–33. https://doi.org/10.1007/s40670-019-00871-6.
[106] Huang Z, Li M, Zhou Y, Ao Y, Xin W, Jia Yu, et al. Modified team-based learning in an ophthalmology clerkship in China. PLoS One 2016;11(4). https://doi.org/10.1371/journal.pone.0154250. e0154250.
[107] Wu W, Pu L, Zhang E, Xiong S, Zhou X, Xia X, et al. Application of team-based learning to ophthalmology in China. Front Public Heal 2022:922325.
[108] Burgess A, Bleasel J, Haq I, Roberts C, Garsia R, Robertson T, et al. Team-based learning (TBL) in the medical curriculum: Better than PBL? BMC Med Educ 2017;17:1–11. https://doi.org/10.1186/s12909-017-1068-z.
[109] Currey J, Sprogis SK, Burdeu G, Story I, Considine J, O'Donnell M, et al. Stakeholder acceptance of digital team-based learning. Nurse Educ Pract 2020;46. https://doi.org/10.1016/j.nepr.2020.102833. 102833.
[110] Burgess A, Bleasel J, Hickson J, Guler C, Kalman E, Haq I. Team-based learning replaces problem-based learning at a large medical school. BMC Med Educ 2020;20:1–8. https://doi.org/10.1186/s12909-020-02362-4.
[111] Mann K, Gordon J, MacLeod A. Reflection and reflective practice in health professions education: A systematic review. Adv Heal Sci Educ 2009;14:595–621. https://doi.org/10.1007/s10459-007-9090-2.
[112] Branch WT, Paranjape A. Feedback and reflection: teaching methods for clinical settings. Acad Med 2002;77(12, Part 1):1185–8.
[113] Plack MM, Greenberg L. The reflective practitioner: Reaching for excellence in practice. Pediatrics 2005;116:1546–52. https://doi.org/10.1542/peds.2005-0209.
[114] Forneris SG, Peden-McAlpine C. Evaluation of a reflective learning intervention to improve critical thinking in novice nurses. J Adv Nurs 2007;57:410–21. https://doi.org/10.1111/j.1365-2648.2007.04120.x.
[115] Carlson NB, Chu G, Denial A, Lyons S. Using reflective journal writing in optometric clinical education. Optom Educ 2007;32:43–7.
[116] Kolb DA. Experiential learning: Experience as the source of learning and development. Second Edi. Upper Saddle River, New Jersey: Pearson Education, Inc; 2014.
[117] Stewart J. Reflecting on reflection: increasing health and social care students' engagement and enthusiasm for reflection. Reflective Pract 2012;13:719–33. https://doi.org/10.1080/14623943.2012.670627.
[118] Mezirow J. Fostering critical reflection in adulthood. San Francisco: Jossey-Bass Publishers; 1990.
[119] Baker CR. Reflective learning: a teaching strategy for critical thinking. J Nurs Educ 1996;35:19–22. https://doi.org/10.3928/0148-4834-19960101-06.
[120] Simpson E, Courtney M. A framework guiding critical thinking through reflective journal documentation: A middle eastern experience. Int J Nurs Pract 2007;13:203–8. https://doi.org/10.1111/j.1440-172X.2007.00629.x.
[121] Chirema KD. The use of reflective journals in the promotion of reflection and learning in post-registration nursing students. Nurse Educ Today 2007;27:192–202. https://doi.org/10.1016/j.nedt.2006.04.007.
[122] Hanya M, Yonei H, Kurono S, Kamei H. Development of reflective thinking in pharmacy students to improve their communication with patients through a process of role-playing, video reviews, and transcript creation. Curr Pharm Teach Learn 2014;6:122–9. https://doi.org/10.1016/j.cptl.2013.09.009.
[123] Cross * V, Liles C, Conduit J, Price J. Linking reflective practice to evidence of competence: a workshop for allied health professionals. Reflective Pract 2004;5(1):3–31.
[124] Koole S, Dornan T, Aper L, Scherpbier A, Valcke M, Cohen-Schotanus J, et al. Factors confounding the assessment of reflection: A critical review. BMC Med Educ 2011;11:1–9. https://doi.org/10.1186/1472-6920-11-104.
[125] Atkins S, Murphy K. Reflection: a review of the literature. J Adv Nurs 1993;18:1188–92. https://doi.org/10.1046/j.1365-2648.1993.18081188.x.
[126] Borton T. Reach, touch and teach. New York, NY, USA: McGraw-Hill.; 1970.
[127] Rolfe G, Freshwater D, Jasper M. Critical reflection for nursing and the helping professions: A users guide. Basingstoke: Palgrave; 2001.
[128] Driscoll J, editor. Practising clinical supervision: a reflective approach for healthcare professionals. Elsevier Health Sciences; 2006.
[129] Gibbs G. Learning by doing: A guide to teaching and learning methods. [eBook] 1988;2.
[130] Brandenburg R, Pesudovs K. Teaching communication skills: an Australian Optometry Program's new course. Optom Educ 2014;19:19–27.