# Students' Perceptions of Team-based Learning in an Undergraduate Optics Module

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## Abstract

Team based learning (TBL) uses collaborative learning to engage students with course material and has been adopted in various health-related courses. This new pedagogy offers many advantages including an improvement in marks and positive student perceptions. In addition, it offers the right environment to develop communication skills and teamwork. Although TBL is increasingly been used in medical and nurse education, to date very few studies have reported on the preferred teaching methods in optics courses. This study, evaluated students' experiences with TBL in an optics undergraduate module using a questionnaire developed in 2012 by Heidi Mennenga (Team-based Learning Student Assessment Instrument). The questionnaire contains 33 items in 3 subscales: accountability, preference for TBL and student satisfaction with TBL. When responding, students were reminded that TBL was only included in the tutorials of this module as lectures included active learning but did not include a TBL approach. During tutorials students worked in small groups and the same structure was followed for each session: individual Readiness Assessment Test (iRAT), team RAT (tRAT) and application exercises (optics calculations based on the theory covered during lectures). Two-consecutive cohorts (2017/18 and 2018/19) taking this module were invited to complete the questionnaire anonymously. In both cohorts, students reported a more favourable experience with TBL compared to traditional lectures. The satisfaction subscale showed the highest score compared to the other two subscales within the questionnaire. Based on these findings, a TBL approach should be promoted in optics related courses to increase student satisfaction with the courses.


Keywords: active learning, team-based learning, questionnaire

**Introduction**

Team-based learning (TBL) is an active learning methodology suitable for a range of disciplines. Originally developed by Larry Michaelsen four use in business school it has now gained popularity in a variety of health-related disciplines including medical schools (Burgess et al, 2017; Kazory and Zaidi, 2018), nursing (Branney and Priego-Hernández, 2018) and pharmacy (Ofstad and Brunner, 2013; Tweddell et al, 2016). Despite its benefits, TBL is still a relatively new pedagogy in optometric education and limited information is available regarding students' preferences in optics related modules (Hrynchak and Spafford, 2015).

Active learning approaches are often contrasted with traditional methods that are teacher-centered and result in passively transfer of information from teachers to students. Essentially, active learning approaches require students to do meaningful learning activities and think about what they are doing (Bonwell and Eison, 1991). Typically, TBL sessions take part in a small-group class activities consisting of three phases (Sibley et al, 2015). During the first phase students are given a series of activities to individually revise specific learning objectives. This first phase occurs before the actual TBL class and mimics a flipped classroom approach. The second phase includes the readiness assessment test using multiple-choice questions to assess concepts. These questions are first answered individually and then as part of a team. The final phase includes application exercises to apply the theoretical concepts into practice.

When considering the implementation of new pedagogical approaches to learning it is important to assess students' learning preferences. Hrynchak and Spafford (2015) evaluated optometry students' attitudes towards TBL, and found that students' satisfaction with TBL was favorable and improved with additional experience. In contrast, Herse and Lee (2005) surveyed the usefulness of a variety of learning tools by optometry students in an optometry department in Australia. The preferred learning style of this group of students was passive learning of content. It was postulated that perhaps this was because they were taught using traditional passive teaching methods. Similarly, in a systematic review of TBL in health-related education a mixed learner reaction was found (Fatmi et al, 2013). It was proposed that this could be as a result of an increase in the workload and the accountability associated with TBL. In 2012, Heidi Mennenga developed a valid and reliable questionnaire to assess the effectiveness of TBL. Since then, the Team-based Learning Student Assessment Instrument (TBL-SAI) has been used in a variety of academic fields to determine the impact that TBL has on learners (Branney and Priego-Hernández, 2018; Kazory and Zaidi, 2018; Livingston et al, 2014). The aim of this study was to assess the students' views of TBL and traditional lectures in an optics module using the TBL-SAI questionnaire.

**Methods**

**Structure of the Module**
Refractive Management and Methods of Ocular Examination is a 2-semester (30 credits) module in the second year of the BSc (Hons) Ophthalmic Dispensing. It consists of traditional lectures, laboratory sessions and tutorials. Since 2017/18, tutorials include a TBL approach. This study took part in Semester 1 where the

following topics are covered: schematic eye, spherical ametropia, astigmatism, retinal image formation and magnification, ophthalmic drugs, ophthalmoscopy, keratometry, slit-lamp and visual acuity. During tutorials, students need to solve optics calculations based on the theoretical context described in lectures.

**Structure of the TBL tutorials**

Recommended pre-reading materials and optics calculations were uploaded to the virtual learning environment system (Canvas) at least one week before the TBL session. During the TBL tutorial, students were divided into groups (4-5 students each). The session started with an individual readiness assessment test (iRAT) followed by the team readiness assessment test (tRAT). These were presented using Poll Everywhere, an audience response system that takes anonymous responses from students via mobile phones. The responses were displayed on charts using PowerPoint. The RAT consisted of 10 short multiple-choice questions with five possible answers (see example in Figure 1).
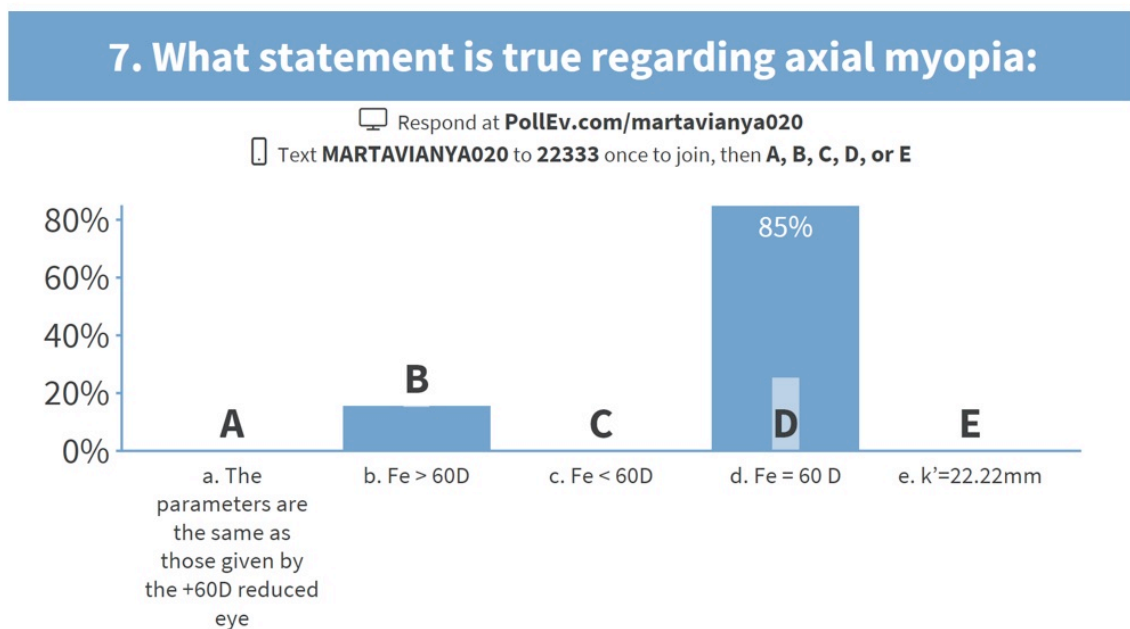


Figure 1: Example of a Readiness Assessment Test question presented via Poll Everywhere

The instructor (MV-E) facilitated the sessions and provided some feedback to the entire class when appropriate. The application exercise consisted mainly of optics calculations required as part of this course.

**Participants**

Second-year ophthalmic dispensing students (Anglia Ruskin University, United Kingdom) that had attended at least one tutorial in this module were invited to complete the TBL-SAI questionnaire. The study received ethical approval by the Vision and Hearing Departmental Research Ethics Panel at Anglia Ruskin University and followed the principles of the Declaration of Helsinki. Written informed consent was obtained from all students after receiving a full briefing of the nature of the study. Two consecutive cohorts were invited to participate following the introduction of

TBL in this module (cohorts 17/18 and 18/19). Participation in this study was optional and responses were anonymous.

**TBL-SAI instrument and data collection**
TBL-SAI instrument was developed by Mennenga (2012). Permission for use was granted from the author at the start of this study. The instrument consist of 33-items including three subscales measuring accountability (8 questions), preference for TBL (16 questions) and student satisfaction with TBL (9 questions). Each item is scored using a 5-point Likert scale (1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree and 5-Strongly Agree). The scale was reversed for negatively worded items (#4, #11, #13, #14, #16, #18, #21, #22, #28 and #30) as described by Mennenga (2012).

To score the questionnaire, both individual subscales as well as a total score was calculated. The subscale scoring ranges as follows: accountability (range 8-40, neutral= 24), preference for TBL (range 16 -80, neutral=48) and satisfaction with TBL (range 9-45, neutral=27). A higher score indicates a higher level of the trait under measurement: higher level of accountability, higher preference for TBL and higher level of satisfaction with TBL.

The accountability subscale assesses students' preparation before class and accountability to the teams' learning. The preference subscale evaluates attention level and engagement with lectures and TBL sessions. Finally, the satisfaction subscale assesses students' satisfaction with TBL. The questionnaire has a space for free text comments at the end. Data collection took place in class at the end of a tutorial session in week 10 and before a summative exam in
week 11 (November 2017 and November 2018 for each cohort).

**Data Analysis**
Questionnaire data were analysed using MedCalc statistical software 18.10 (MedCalc Software bvba, Ostend, Belgium). Mean ± SD (for each subscale and total scale) were calculated. One-way analysis of variance (ANOVA) was conducted to evaluate differences between the two cohorts for each of the three subscales and the total score. Statistical significance was set at 0.05. All questionnaire items were kept for analysis.

**Results**

A total of 35 and 38 students were enrolled in this module in the 2017/18 and 2018/19 cohorts respectively. Participation to this study was voluntary. In the 17/18 cohort, 66% (23/35 students) agreed to take part whereas the response rate for the 18/19 cohort was 58% (22/38 students). Table 1 provides descriptive statistics (mean and SD) for each subscale as well as total score for each student cohort. The means of the subscale and total score were higher than the neutral scores (Table 1). The total instrument score showed a preference towards TBL. A neutral score (ie. no preference for TBL or lectures) for the total instrument is 99 and scores higher than 102 indicate preference for TBL. The total instrument scores for the 17/18 and 18/19 cohorts were 118 ± 9.0 and 122 ± 7.6 respectively.

Table 1: TBL-SAI scores (mean, SD) for each subscale and total instrument score
(cohorts 17/18 and 18/19)

| Subscale (n) | Accountability | Preference for TBL | Satisfaction with TBL | Total score |
|---|---|---|---|---|
| Range | 8-40 | 16-80 | 9-45 | 33-165 |
| Neutral | 24 | 48 | 27 | 99 |
| Cohort 17/18 (22) | 28 (2.7) | 53 (5.0) | 38 (4.8) | 118 (9.0) |
| Cohort 18/19 (23) | 30 (2.6) | 56 (4.7) | 37 (3.7) | 122 (7.6) |

One-way ANOVA showed a statistical significant difference among the two cohorts of students (17/18 and 18/19) for the student accountability subscale ($F_{1,43}$=7.03, p=0.01). Post-doc analysis using the Scheffe test indicated a significant difference existed between both cohorts (p<0.05). Both cohorts, showed an accountability subscale above the neutral score of 24 and the second delivery of this course showed the highest accountability subscale (mean ± SD, 30 ± 2.7 vs 28 ± 2.8). No statistical significant differences among the two cohorts were found for the preference for TBL subscale ($F_{1,43}$=3.30, p=0.08), satisfaction with TBL subscale ($F_{1,43}$=0.48, p=0.49) and total score ($F_{1,43}$=2.77, p=0.10).

**Accountability subscale**
Table 2 indicates that 53% and 62% of the students in cohorts 17/18 and 18/19 reported high level of accountability (responded 5-Strongly Agree or 4-Agree to these items). The majority of students (82% of students in the 17/18 and 100% in the 18/19 cohort) disagreed or strongly disagreed with the negatively worded item #4 "My contribution to the team is not important". However, only 18% and 22% respectively agreed or strongly agreed with item #6 "I am accountable for my team's learning".

Table 2: Proportion of scores for each TBL-SAI subscale

| TBL-SAI subscales | Proportion of scores > neutral | | Proportion of scores = neutral | | Proportion of scores < neutral | |
|---|---|---|---|---|---|---|
| | 17/18 cohort | 18/19 cohort | 17/18 cohort | 18/19 cohort | 17/18 cohort | 18/19 cohort |
| **Accountability** | 53% | 62% | 33% | 30% | 14% | 8% |
| **Preference for TBL** | 50% | 57% | 25% | 24% | 25% | 19% |
| **Satisfaction with TBL** | 85% | 83% | 14% | 17% | 1% | 0% |

**Preference for TBL subscale**

The preference subscale indicated that students favoured TBL in both cohorts and was found to be 53% and 56% in the 17/18 and 18/19 cohorts respectively (Table 1). Approximately half of the students agreed or strongly agreed with items in this subscale, indicating a preference for TBL as compared with 25% and 19% (17/18 and 18/19 cohorts) that preferred traditional lectures (Table 2). The majority of students in both cohorts (90% and 95% in 17/18 and 18/19 respectively) agreed or strongly agreed with item #20 "I remember material better after the application exercises used in Tutorials". In contrast, both cohorts showed the lowest agreement for item #16 "I remember material better when the instructor lectures about it" and item #18 "It is easier to study for tests when the instructor has lectured over the material".

**Satisfaction subscale**

Most students (85% in the 17/18 cohort and 83% in the 18/19 cohort) reported a higher level of satisfaction with TBL compared to traditional lectures (Table 2). Only one student in each cohort reported neutrality to item #30 "Team-based learning activities are a waste of time" whereas all the others disagreed or strongly disagreed with this item. The majority of students also agreed with item #27 "I think team-based learning activities are an effective approach to learning" and disagreed with the negatively worded item #28 "I do not like to work in teams".

**Open comments**

A total of 9 students provided open comments at the end of the questionnaire. Six comments related to the benefits experienced with TBL such as:

"I really liked tutorials this semester, it helps me to remember information more easily" cohort 17/18

"We help each other and can ask questions without being afraid of judgement. Also I feel the answers are explained in a simpler way" cohort 17/18

"Working is groups we don't usually sit with is also more useful" cohort 18/19

The remaining three comments related to the pace of delivery of the sessions as illustrated with the following quote:

"It is a good way to consolidate class work but sometimes it does take more time than is needed when working with students with different abilities" cohort 17/18

**Conclusion**

Using the TBL-SAI instrument, this study showed how embedding TBL in an optics module had significant positive benefits. The total instrument score showed a preference for TBL and this preference increased in the second delivery of this module (scores for the 17/18 and 18/19 cohorts were 118 and 122 respectively, neutral score = 99). In addition, all the subscales within this instrument also indicated a higher accountability and/or preference for TBL. The satisfaction subscale showed the highest score compared to the other two subscales within the questionnaire. Similar findings have been reported by Kazory and Zaidi (2018) in a cohort of first-year medical students (total overall score 118). Branney and Priego-Hernández (2018) also reported preference for TBL in a second year undergraduate nursing course (total overall score 110). This is the first report using TBL-SAI within the context of a UK-based undergraduate optics related module. These findings suggest that TBL approach can increase student satisfaction and should be promoted in optics related courses.

Analysis of the individual items within the TBL-SAI highlighted several areas of interest. First, regarding the accountability subscale most of the students in these cohorts disagreed or strongly disagreed with item #4 "My contribution to the team is not important'. This highlights one of the positive benefits of using this new approach as students enjoy been able to contribute with their skills to the learning of others in their teams. Abdelkhalek et al (2010) indicated that TBL helps developing professional skills such as communication and teamwork. This is particularly relevant to students in optometric courses, as they will be expected to work in teams during their careers. As one might expect, it is less likely that students will be given opportunities to contribute to the teamwork during traditional lectures. Secondly, the majority of students in both cohorts agreed or strongly agreed with item #20 "I remember material better after the application exercises used in Tutorials". On the other hand, both cohorts showed the lowest agreement for item #16 "I remember material better when the instructor lectures about it". This clearly indicates the value of using structured TBL sessions (RAT and application exercises) to complement material previously covered in lectures. Finally, when questioned about satisfaction with TBL the majority of students also agreed with item #27 "I think team-based learning activities are an effective approach to learning". It is worth noting that the TBL sessions were formative in nature and students did not receive any summative mark as part of these sessions. This could have influenced items within the student satisfaction subscale as students might feel differently when working with others in a team that carries summative weight towards the overall module mark.

Although this questionnaire offers the opportunity for open comments, the information gained was limited. In this module, Poll Everywhere was used during the RAT. If such a strategy is used, educators might consider using a timer to limit the time participants have to respond. This will ensure RAT runs smoothly and no time is lost waiting for answers to be submitted. Instead, time should be spend clarifying

misconceptions to the whole group and/or facilitating discussion among groups. Alternatively, immediate feedback assessment test cards (IF-AF) have successfully been used in this context as they transform multiple-choice questions into an interactive learning experience.

This study does not capture the lecturer views regarding the preparation involved when introducing this new approach but Tweddell et al (2016) reported extensively on the faculty experience of introducing TBL in a pharmacy course. Clearly, introducing any type of active learning is time consuming but the structured approach offered with TBL made the preparation less onerous. During the implementation phase, educators should also consider the impact of TBL related activities on the overall course workload. In addition, those considering this approach may also want to consider space requirements as the layout of the room need to be changed to create the right learning environment. The rooms used in this study allowed for tables to be arranged into groups rather than rows. Finally, educators considering this approach are encouraged to find suitable ways to explore the students' perceptions to ensure comments feed forward in future revisions of their modules.

# References

Abdelkhalek N., Hussein A., Gibbs T, Hamdy H. (2010). Using team-based learning to prepare medical students for future problem-based learning. *Med Teach*, 32, 123–129.

Bonwell, C.C. and Eison, J.A. (1991). Active Learning: Creating Excitement in the Classroom. ASHEERIC Higher Education Report No.1, George Washington University: Washington, DC.

Branney, J. and Priego-Hernández, J. (2018). A mixed methods evaluation of team-based learning for applied pathophysiology in undergraduate nursing education. *Nurse Education Today*, 61, 127–133.

Burgess, A., Bleasel, J., Haq, I., Roberts, C., Garsia, R., Robertson, T. and Mellis C. (2017). Team-based learning (TBL) in the medical curriculum: better than PBL? *BMC Medical Eucation*, 17, 243–253.

Fatmi, M., Hartling, L., Hillier, T., Campbell, S., Oswald, A.E. (2013). The effectiveness of team-based learning on learning outcomes in health professions education: BEME Guide No. 30. *Med Teach*, 35, e1608–24.

Herse, P. and Lee, A. (2005). Optometry and WebCT: a student survey of the value of web-based learning environments in optometric education. *Clinical & Experimental Optometry*, 88, 46–52.

Hrynchak, P.T. and Spafford, M.M. (2015). Optometry Students' Attitudes about Team-Based Learning. *Optometric Education*, 40 (2), 89–93.

Kazory, A. and Zaidi, Z. (2018). Team-Based Learning Activities for First-Year Medical Students: Perception of the Learners. *Southern Medical Journal,* 111(9), 525–529.

Livingston, B., Lundy, M. and Harrington, S. (2014). Physical therapy students' perceptions of team-based learning in gross anatomy using the Team-Based Learning Student Assessment Instrument. *J Educ Eval Health Prof*, 11, 1–10.

Mennenga, H.A. (2012). Development and psychometric testing of the team-based learning student assessment instrument. *Nurse Educ*, 37, 168–172.

Ofstad, W. and Brunner L.J. (2013). Team-Based Learning in Pharmacy. *American Journal of Pharmaceutical Education*, 77 (4), Article 70.

Sibley, J., Ostafichuk, P., Roberson, B., Franchini, B., Kubitz, K. and Michaelsen, L. (2015). Getting Started With Team-Based Learning. Sterling: Stylus Publishing.

Tweddell, S., Clark, D. and Nelson, M. (2016). Team-based learning in pharmacy: The faculty experience. *Currents in Pharmacy Teaching and Learning*, 8, 7–17.

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