



Contents lists available at ScienceDirect

## Nurse Education Today

journal homepage: [www.elsevier.com/locate/nedt](http://www.elsevier.com/locate/nedt)

# A mixed methods evaluation of team-based learning for applied pathophysiology in undergraduate nursing education

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## ARTICLE INFO

## Keywords:

TBL  
Team-based learning  
Biosciences in nurse education  
Applied pathophysiology  
Evidence-informed decision making

## ABSTRACT

**Background:** It is important for nurses to have a thorough understanding of the biosciences such as pathophysiology that underpin nursing care. These courses include content that can be difficult to learn. Team-based learning is emerging as a strategy for enhancing learning in nurse education due to the promotion of individual learning as well as learning in teams.

**Objectives:** In this study we sought to evaluate the use of team-based learning in the teaching of applied pathophysiology to undergraduate student nurses.

**Design:** A mixed methods observational study.

**Methods:** In a year two, undergraduate nursing applied pathophysiology module circulatory shock was taught using Team-based Learning while all remaining topics were taught using traditional lectures. After the Team-based Learning intervention the students were invited to complete the Team-based Learning Student Assessment Instrument, which measures accountability, preference and satisfaction with Team-based Learning. Students were also invited to focus group discussions to gain a more thorough understanding of their experience with Team-based Learning. Exam scores for answers to questions based on Team-based Learning-taught material were compared with those from lecture-taught material.

**Results:** Of the 197 students enrolled on the module, 167 (85% response rate) returned the instrument, the results from which indicated a favourable experience with Team-based Learning. Most students reported higher accountability (93%) and satisfaction (92%) with Team-based Learning. Lectures that promoted active learning were viewed as an important feature of the university experience which may explain the 76% exhibiting a preference for Team-based Learning. Most students wanted to make a meaningful contribution so as not to let down their team and they saw a clear relevance between the Team-based Learning activities and their own experiences of teamwork in clinical practice. Exam scores on the question related to Team-based Learning-taught material were comparable to those related to lecture-taught material.

**Conclusions:** Most students had a preference for, and reported higher accountability and satisfaction with Team-based Learning. Through contextualisation and teamwork, Team-based Learning appears to be a strategy that confers strong pedagogical benefits for teaching applied pathophysiology (bioscience) to student nurses.

## 1. Introduction

Nurses need to have a thorough knowledge of the biosciences, including applied pathophysiology, in order to understand health and disease and therefore deliver the best care (Taylor et al., 2016). However, student nurses, and registered nurses, have admitted to difficulties understanding the bioscience underpinning nursing care (Davies, 2010; McVicar et al., 2015). Consequently, students and academics have called for a greater emphasis on bioscience in nurse education (Fell and James, 2012; Taylor et al., 2015). One approach to addressing this

might be the use of innovative teaching methods to improve student engagement and attainment in what can be a challenging subject area (Saville et al., 2012).

There is growing evidence that team-based learning (TBL), a student-centred but teacher-directed flipped classroom strategy, has increased student satisfaction and higher engagement compared to traditional teaching methods (Sisk, 2011). TBL also appears to promote team participation and improved knowledge acquisition (Haidet et al., 2014). Possibly for these reasons, TBL is increasingly being used in medical and nurse education (Haidet et al., 2014). Researchers have

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examined TBL in the teaching of applied pathophysiology to student nurses. In an evaluation of the teaching of clinical oncology, excellent attendance, high student participation and positive course evaluation were provided as evidence of engagement with TBL but evaluation or academic performance data were not reported (Middleton-Green and Ashelford, 2013). A randomised controlled trial (RCT) on the teaching of nurses' management of patients with respiratory conditions found that problem-solving ability, knowledge and clinical performance were significantly higher in the TBL cohort versus control (traditional teaching) (Kim et al., 2016).

Increased student engagement has been a common finding where TBL has been evaluated across various courses in nurse education (Branson et al., 2016; Clark et al., 2008; Feingold et al., 2008; Mennenga, 2015). However, this does not necessarily translate into students' preference for TBL versus traditional lectures (Mennenga, 2013) even where academic performance appears to have improved (Della Ratta, 2015). Thorough planning and evaluation is therefore required to best inform the implementation of new approaches like TBL if wide-spread adoption by staff and students is going to be successful (Andersen et al., 2011; Smith and Coleman, 2008).

Therefore, in this study we combined the use of both the validated TBL-SAI (Student Assessment Instrument) (Mennenga, 2012) and focus-group discussions to gain a thorough understanding of students' experience with TBL of applied pathophysiology. We further aimed to explore any effect on exam performance.

## 2. Methods

This was a mixed methods observational study.

### 2.1. Participants

The TBL intervention was offered to all year 2 undergraduate student nurses (students who commenced year 2 in one of two intakes: September 2014 or February 2015) at one UK higher education institution.

### 2.2. Structure of the Module

One (circulatory shock) topic out of ten in an applied pathophysiology module was delivered by TBL. All other topics were delivered by traditional lectures and seminars. The pre-reading consisted of three elements that were made available to students on the institution's virtual learning environment one week prior to class: 1. a book chapter (essential); 2. an online one-hour lecture that was tailored to making the more complex aspects of the topic more accessible and to promote engagement (essential); 3. optional supplementary materials - to cater for different learning preferences (two alternative book chapters, links to an educational videos website and one podcast and two journal articles). The students were required to answer 10 four-option multiple choice questions (MCQs) first as individuals (Individual Readiness Assurance Test - IRAT) then in teams (Group Readiness Assurance Test - GRAT). Students were allocated to teams of five or six students based on their year one anatomy and physiology test scores with the aim of spreading ability across the teams. Following Collins (2006) the MCQs were aimed at the levels of testing knowledge and combined comprehension and application (Collins, 2006).

These were delivered to the entire cohort in a one-hour lecture theatre setting where students were not allowed to access educational materials. Teams received immediate feedback using scratch cards and the lecturer identified knowledge gaps and gave a mini-lecture to address these. This was followed by two-hour concurrent seminar sessions each led by a different member of faculty (with between four and five teams in each of eight seminar rooms) consisting of two patient case scenarios (application exercises). In association with each patient scenario students had to select the best answer from seven statements

(Middleton-Green and Ashelford, 2013). All statements were relevant to the case, but, as in clinical practice, had to be prioritised.

All teams had the same two scenarios and answer choices, and teams simultaneously reported their answers by holding up a letter-sign that corresponded to their chosen answer after the seminar leader counted down from three. The timing for intra-team and inter-team discussions was at the discretion of the seminar leader, who acted as a facilitator inviting challenges. The best performing teams were rewarded with sweets; since this was a 'one off' within the module peer review was not considered to be an appropriate incentive.

### 2.3. Data Collection

Our research design was sequential, for quantitative data elicitation was followed by qualitative data collection (Padgett, 2012). Following the literature on mixed-methods research (Kroll and Neri, 2009; Nastasi et al., 2010), our methods were fully integrated during analysis and interpretation of results, when we compared and contrasted results from the quantitative and qualitative datasets. The inferences and implications made in this article are informed by this integration.

### 2.4. Quantitative Outcome Measures

Immediately after the intervention, students were invited to complete the TBL-SAI, which has 33 items rated on a five-point Likert scale, reported to be valid and reliable (Mennenga, 2012); it measures TBL perceptions. The TBL-SAI includes three subscales measuring accountability (student preparation for class and contribution to team), preference (for TBL versus lecture) and student satisfaction with TBL. Students' learning was assessed by a two-hour unseen examination paper consisting of 10 short-answer questions covering all topics, one of which was on circulatory shock.

### 2.5. Qualitative Data

A convenience sample was invited for focus group discussions (FGDs). FGDs were chosen because they elicit opinions as they are displayed in public, which complemented the individual-level responses obtained via the TBL-SAI. Consistent with relevant literature on the execution of FGD (Grossen, 2007; Kitzinger, 1994), in the group discussions we sought to foster debate, argumentation and elaboration on initial responses, as well as multi-layered meanings that contextualised the responses obtained through the TBL-SAI.

The FGD schedule mirrored the TBL-SAI subscales, seeking to obtain more information and identify conflicting views, if present, in the groups. Five FGDs, each composed of students from five out of the eight seminar groups, took place between two and six months after the TBL intervention to probe for long-term assessment of the intervention after the examination had taken place. FGD lasted 39 min on average and were audio recorded. Participants were provided with refreshments.

### 2.6. Data Analysis

Quantitative data were analysed in SPSS (version 21). Two research assistants performed simple verbatim transcription of FGD recordings. Transcripts were imported into the package MAXQDA, where thematic analysis was performed (Braun and Clarke, 2006). Categorisation included deductive codes derived from the TBL-SAI headings, simultaneously inducing codes from the data. Illustrative quotes were chosen on the basis of the quality and brevity with which students articulated each point, and on the representativeness of the quote in relation to the overall theme.

### 2.7. Ethical Approval

Institutional ethical clearance was granted for the study.

### 3. Results

At entry to the nursing degree programme the cohort consisted of 203 student nurses of which 187 (92%) were female and 125 (62%) were mature (over 21 years) students, similar to the profile of nursing students in the UK (Royal College of Nursing, 2008). In total, 167 out of the 197 (85% response rate) of students enrolled on the applied pathophysiology module completed the TBL-SAI. A subsample of 37 students took part in five FGDs, with an average of seven participants per group.

#### 3.1. TBL-SAI

For analysis of the TBL-SAI responses, two items were removed (Q23. I do [sic] better on exams when we used team-based learning to cover the material; Q31. I think team-based learning helped me improve my grade) as the questionnaire was completed prior to the module examination. One further item was removed (Q19. I remember information longer when I go over it with team members during the GRATs used in team-based learning) when it was noted that some students could not remember what GRAT stood for at the time of completing the questionnaire. Internal consistency was maintained despite these changes: Cronbach's alpha ( $\alpha$ ) (Bland and Altman, 1997) for total scale was marginally reduced from 0.90 to 0.88 for the scale less the three deleted items; for the preference subscale Cronbach's alpha was changed from 0.83 to 0.79; it was unchanged for the satisfaction ( $\alpha = 0.91$ ) and accountability ( $\alpha = 0.71$ ) subscales). These accord with published internal consistency data of the TBL-SAI (Mennenga, 2013).

There were no significant differences on any of the TBL-SAI scales between participants in the eight seminar groups where application exercises took place suggesting the lack of a teacher effect. The results for each subscale and total scale of the TBL-SAI for the entire study cohort are shown in Table 1. As Table 1 indicates the majority of students reported a more favourable experience with TBL compared to traditional lectures.

This overall perception was further elaborated on during FGDs, in which general statements were made in relation to the effectiveness of TBL, for example:

*I still remember it now more than what the other lectures that I...that were PowerPointed [FGD 1]*

This effectiveness could be related to the perceived relevance of activities, as some students identified a clear fit between the learning method, the skills it triggered and the applicability to future practice:

*You're arguing your point...trying to come to like a...combined agreed verdict of what should be done and obviously apply it. ...that's basically what happens in multi-disciplinary teams in hospitals and stuff so you know, yeah it's a good skill to learn I suppose. [murmurs of agreement] [FGD 2]*

**Table 1**  
Mean TBL-SAI scores and proportion of scores for each subscale and total scale.

TBL-SAI <sup>a</sup> subscales and total scale	Valid questionnaires <sup>b</sup> n (%)	Mean score (SD)	Proportion of scores > neutral n (%)	Proportion of scores = neutral n (%)	Proportion of scores < neutral n (%)
Accountability [range 8–40; neutral = 24]	156 (93)	31 (4.2)	145 (93)	4 (3)	4 (3)
Preference [range 14–70; neutral = 42]	160 (96)	47 (7.5)	121 (76)	5 (3)	34 (21)
Satisfaction [range 8–35; neutral = 24]	159 (95)	32 (5.5)	146 (92)	6 (4)	7 (4)
Total scale [range 30–145; neutral = 90]	143 (85)	110 (13.4)	131 (92)	2 (1)	10 (7)

<sup>a</sup> Excluding Q19, 23 and 31.

<sup>b</sup> Questionnaires that were completed or where at least all items for one or more subscales were completed.

#### 3.2. Accountability

A clear majority (93%) of students reported a higher level of accountability with TBL (Table 1). This perceived accountability was confirmed in the FGD results, where it was frequently reported that advance preparation was indispensable. Preparing in advance to be able to contribute meaningfully was seen as acting fairly towards the group, and also as an opportunity to take full advantage of the TBL activities.

*1: And you don't want to be perceived as the one that no one wants to work in a group with cos they don't pull their weight*

*2: [mixed talk] Because you don't do the work, yeah [FGD 3]*

However, there was some evidence acknowledging that accountability was not a priority for all when engaging with the lesson materials. Some students conceded that they might relax their preparation, since responsibility is distributed within the group and not solely resided with the individual:

*...when you are solely responsible or whatever for answering a question, you make sure that you learn. Like when I'm in a group, I'm like ah okay maybe someone else will know it... [FGD 2]*

#### 3.3. Satisfaction

One hundred and forty-six (92%) students reported a higher level of satisfaction with TBL compared to traditional lectures (Table 1). In the FGD students mostly reported enjoying the TBL intervention. Different positive adjectives were associated with specific parts of the intervention, with the video recording being considered a convenient way of engaging with the content, and team activities being described as a mixture of stimulating competition albeit with uncomfortable arrangements. Regarding the latter, students would have preferred to choose their teams and found it difficult to challenge different positions on the correct or best answer. Interestingly, some participants gave nuance to the idea of satisfaction and justified the challenging parts of TBL activities, such as discussing a point in a team with conflicting views:

*But even though you find it uncomfortable, surely it's as a nurse we're going to find ourselves in an uncomfortable situation, are you going to walk away then? [FGD 5]*

#### 3.4. Preference

Most students (76%) reported a preference for TBL however, it is noted that 21% reported a preference for traditional lectures (Table 1). In FGD, lectures were reported as a necessary and significant feature of university life. However, students readily provided examples of the type of interactive lecture practice that they enjoy being implemented, as well as countless examples of lectures as negative experiences. While

TBL overall was seen as a very good alternative to lectures, participants' discourse tended to focus on specific parts of the TBL intervention, such as the video-recorded lecture. The latter was mentioned more saliently as a positive element of the intervention and the one that made a significant difference in comparison to traditional lectures:

*...I think particularly with university level learning for me one of the key things is when you're given independence to learn at your own pace in your own time and having this lecture available online that kind of thing benefits... [FGD3]*

Interestingly, students spontaneously pointed to a 'novelty factor' which might have influenced their enjoyment of the intervention. They suggested that the TBL intervention was enjoyable precisely because it was an alternative to the traditional lecture: in the same way that other forms of the flipped classroom, practice-based learning and role-play, were perceived to be engaging:

*4: I think also because it was different we all just did it,  
6: [interrupts] it was exciting  
8: if it's just pre-reading, like now then we wouldn't do it [FGD 2]*

### 3.5. Exam Performance

The mean exam scores for each question and for each paper (September and February cohorts sat different exam papers) are shown in Figs. 1 and 2. These clearly indicate that students performed no better or worse on the question related to TBL-taught material than for

the other nine questions which were all related to lecture/seminar taught material.

### 4. Discussion

Based on the findings from the TBL-SAI, this cohort of UK-based nursing students reported increased accountability and satisfaction with TBL as well as a preference for this method. These are concordant with the findings from previous nurse education studies in the US that used the TBL-SAI as an evaluation measure (Mennenga, 2015; Branson et al., 2016). Additionally, the collection of thematic-rich data from FGDs in this study enabled a thorough interpretation of these TBL-SAI results.

There were strong indications of the potential for TBL to aid closing of the perceived theory-practice or practice-theory gap that can arise if university education fails to keep pace with developments in the clinical environment or vice-versa (Benner et al., 2009). Students acknowledged that decisions regarding patient care are usually best achieved within a team environment, and this was reinforced by the team activities. Students desire this type of contextualisation and are far more likely to engage with the learning when they see a clear relevance for practice (Evans et al., 2010) and this is commensurate with the theory of adult learning (Knowles et al., 2011). Teams also needed to justify their clinical decision-making, which is relevant for future registered nurses who will be held accountable for their actions (Nursing and Midwifery Council, 2015). It has been highlighted that competent individual practitioners can combine to form an incompetent team

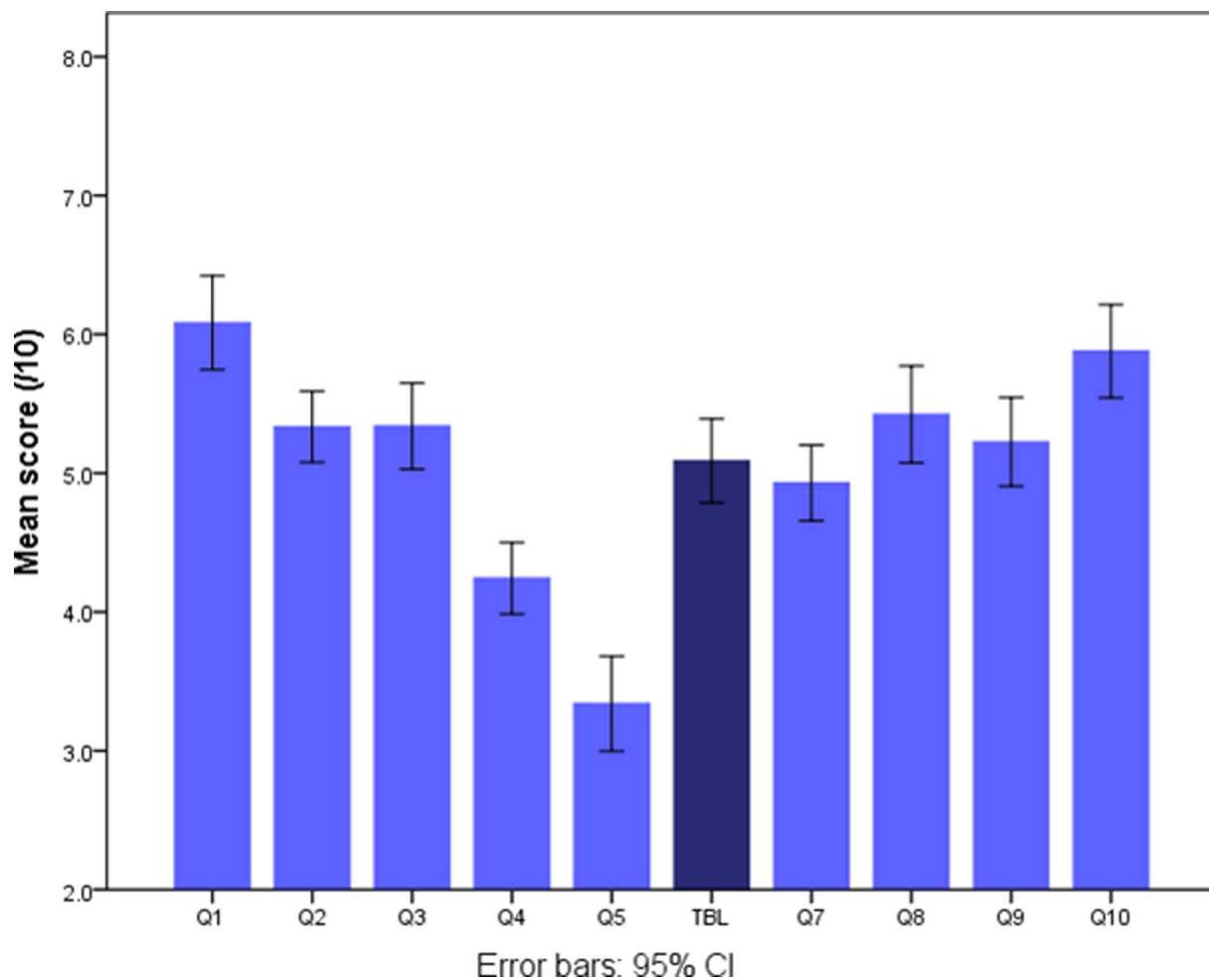


Fig. 1. Exam scores for each question with question related to TBL highlighted in dark blue (September cohort) (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

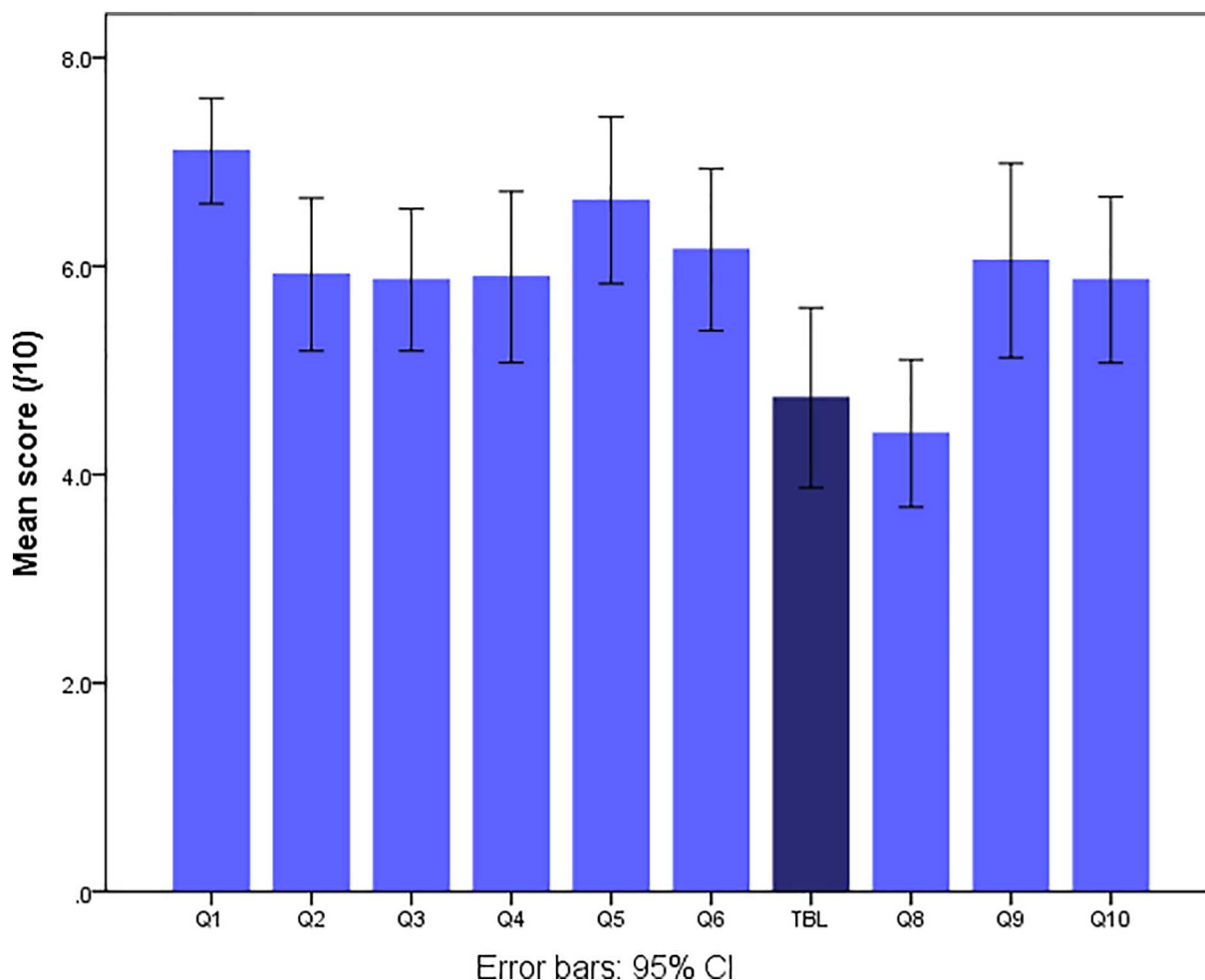


Fig. 2. Exam scores for each question with question related to TBL highlighted in dark blue (February cohort) (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

(Lingard, 2009). This further emphasises the importance of preparing students to be not only safe and competent nurses but also effective members of the healthcare team.

While our TBL-SAI results indicated that students perceived themselves to be more accountable to their peers because of TBL arrangements, during FGDs participants chose to refer to their preparation for group-activities in general, not only in regard to TBL-specific activities. This reinforced that some of the benefits of TBL are achieved through the emphasis on small group work (where non-participative anonymity cannot be maintained in the way a lecture might allow for), and focussing on patient cases in this way has been highlighted as a strong pedagogical approach for nursing education (Benner et al., 2009).

Some students admitted to being poorly-prepared for class. To counteract this social loafing, it is advocated that individual's test results, weighted against team results, count towards the students' end of module grade (Haidet et al., 2014). Peer evaluation, where each team member grades each other's contribution to the team, can also be used to influence the individual's overall grade to incentivise team participation. However, this is not without risk and requires careful handling as students generally do not favour grading their peers (Haidet et al., 2014).

Despite the positive results regarding satisfaction with TBL, the analysis yielded evidence of participants' multifaceted understanding of learning. At different times in the FGDs, participants identified gratification and discomfort as two contrasting sides to the same process of learning. Findings indicated that students were not only aware, but also at ease, with learning being challenging and uncomfortable, since this

was perceived to match real-life clinical situations. Thus, while satisfaction is often associated with enjoyment and a positive attitude, students might also link the learning process to discomfort. The latter point is in line with theories of experiential learning, which acknowledge the value of experiencing discomfort when transforming learners' skills and competence (Johnston and Tinning, 2001; Maudsley and Strivens, 2000). It may also be noted that while student satisfaction is gaining prominence as an important metric in higher education (Robinson and Sykes, 2014), increased engagement is not necessarily synonymous with increased satisfaction in TBL (Haidet et al., 2014). Further, satisfaction with TBL is not clearly linked to academic performance (Della Ratta, 2015; Mennenga, 2013).

In relation to preference, while participants welcomed 'non-traditional' approaches, they also expected lectures as part of their university experience. In accordance with findings from a large multi-university survey (Sander et al., 2000), students desired interactive lectures that used various media to promote active learning. It is therefore unsurprising that in the present study the preference for TBL over lectures exhibited a weaker majority than that of accountability and satisfaction. Students may find it difficult to adjust from the passive methods of teaching to which they are more accustomed (Della Ratta, 2015; Mennenga, 2013). In a first-time implementation study, students were preferentially neutral about TBL versus lectures (Mennenga, 2013), but when the study was replicated two years later a strong preference for TBL was reported (Mennenga, 2015). This was thought to have been achieved through greater student preparation in advance, for example, exposure to a flipped classroom approach in the preceding

year, thus helping to manage expectations (Mennenga, 2015). These experiences emphasise the importance of achieving student ‘buy-in’ to a new approach, however beneficial it might seem from a pedagogical perspective.

In our study, examination performance on TBL-taught material was in line with that taught by lectures which is commensurate with the TBL literature (Haidet et al., 2014; Sisk, 2011); TBL generally appears not to increase nor decrease exam performance. However, to effectively measure the learning associated with TBL or any flipped classroom approach, it may be that assessment needs to be realigned to capture higher level learning outcomes (McLaughlin et al., 2014). In a quasi-experimental study TBL-taught nursing students scored significantly higher on critical thinking, leadership and management skills (Branson et al., 2016), while in another study, nursing students randomised to be taught via TBL scored significantly higher on problem-solving, knowledge and clinical performance (Kim et al., 2016).

Our results also indicate that participants evaluated TBL in broader terms than accountability, satisfaction and preference alone. In particular, students referred to certain elements of the TBL intervention repeatedly, with the recorded lecture being particularly salient. There is often the perception that TBL as a whole is a teaching method that researchers can measure the effects of, and with generally positive results (Haidet et al., 2014; Sisk, 2011). However, our study points to the need of understanding TBL as a complex intervention (Craig et al., 2008) with a variety of components that need to be disaggregated for measurement. When this is done, it is clear that the same approach to TBL may not work in every setting. For example, while one study similarly found recorded lectures to be an important component of a TBL intervention, another study found the opposite (Mennenga, 2013) and evaluation scores at that institution actually improved when recorded lectures were dropped (Mennenga, 2015). Future studies evaluating TBL should take this complexity into account and longitudinal studies are required to assess knowledge retention in clinical practice. Further, outcomes achieved via TBL may be more fairly compared against that of other forms of small-group teaching, not just lectures.

This evaluation study took place at one UK higher education institution for just one six-week applied pathophysiology module in the second year of an undergraduate adult nursing degree. Therefore, the findings may not be generalizable to non-pathophysiology modules or other academic levels of study. Further, only one topic within the module was delivered using TBL. While this allowed for important comparisons to be made with lecture-taught topics within the module, it cannot be ruled out that some students were comparing their TBL experience to lectures in other modules. Only covering one topic also precluded the use of peer evaluation which is considered an important component of TBL. There was also the possibility of a novelty factor, where TBL may have been rated highly simply for being a change from the normal student experience. It is unknown whether this favourability would remain if a whole module or programme were delivered by TBL. While exam results of TBL versus lecture-taught topics were commensurate with findings in the literature, the lack of randomisation precludes conclusions regarding the efficacy of TBL. Although informal evaluation by staff was very positive, formal accounts were not sought meaning important feedback that could influence the success of greater implementation of TBL may remain unknown.

## 5. Conclusion

This group of nursing students exhibited a preference for TBL over traditional teaching and this was associated with high levels of accountability and satisfaction. Exam scores for TBL-taught material were neither higher nor lower than those based on lecture-taught material. FGDs provided for a greater understanding of the students' experience and indicated that they saw the clear relevance of this approach to clinical practice. The contextualisation facilitated by TBL promoted engagement with applied pathophysiology (bioscience). TBL therefore

appears to be a strategy that confers strong pedagogical benefits for the preparation of future nurses.

## Abbreviations

FGD	focus group discussion
GRAT	Group Readiness Assurance Test
IRAT	Individual Readiness Assurance Test
MCQ	multiple choice question
TBL	team-based learning
TBL-SAI	Team-Based Learning Student Assessment Instrument

## Competing Interests

The authors declare that they have no competing interests.

## Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sector.

## Authors' Contributions

JB was responsible for the concept of the study, quantitative data collection and analysis and the first draft of the paper. JP was responsible for the qualitative arm of the study including design, data collection and analysis. Both authors contributed to and approved the final manuscript.

## Declarations

### *Ethics Approval and Consent to Participate*

Ethical approval was granted by the Social Science & Humanities Research Ethics Panel, Bournemouth University (Ref: 9865). All participants provided written informed consent.

### *Consent for Publication*

All participants provided written informed consent and gave their consent to the anonymous publication of data.

### *Availability of Data and Materials*

Data are available from the corresponding author upon request.

## Acknowledgements

We would like to thank Dr. Sharon Docherty, Research Fellow in Quantitative Methods, Bournemouth University who provided statistical advice, and Pippa Empson and Jade Offer, undergraduate students, who helped with data collection and analysis. Thank you to Dr. Heidi Mennenga for granting permission to use the TBL-SAI and to Laura Middleton-Green who provided invaluable advice at the start of the project. We are also most grateful to all the BSc (Hons) Adult Nursing students and teaching staff whose enthusiasm made the study possible.

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