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Short Communication

A comparison of pharmacy student attainment, progression, and perceptions using team- and problem-based learning: Experiences from Wolverhampton School of Pharmacy, UK

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Abstract

Objective: To compare pharmacy student attainment, progression, and perception of team-based (TBL) and problem-based learning (PBL) in comparison to more traditional didactic teaching methods.

Design: Student attainment and progression were established through comparison of examination data before and after TBL implementation and for the three teaching methodologies. Student perceptions of TBL and PBL were sought via a questionnaire and focus group.

Assessment: Summative examination performance was used to assess the effect of TBL implementation. Student attainment and progression increased after TBL implementation (attainment grade score: pre-TBL 7.7 vs. 11.19 post-TBL; $p = 0.01$ and progression: 89% vs. 92%; $p = 0.574$). Summative examination performance was also used to assess the effect of three teaching methodologies in the same cohort. Student attainment was higher with TBL compared with PBL (grade score: 11.19 vs. 8.73; $p \leq 0.001$) and slightly but not significantly worse than those seen with traditional didactic teaching (grade score: 11.19 vs. 11.83; $p = 0.355$). Student progression was the highest with traditional teaching, then TBL, and finally PBL (96% vs. 92% vs. 88%; $p = 0.224$). Student perceptions favored TBL compared with PBL but traditional teaching methods were favored over both TBL and PBL.

Conclusion: The study shows that student attainment and progression were better using TBL compared with PBL, although traditional approaches to teaching saw comparable attainment and progression to TBL. Student perceptions favored traditional teaching more than TBL, which was more liked than PBL.

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Keywords: Team-based learning; Problem-based learning; Student perception

Introduction

Active learning with new educational methods, such as problem-based learning (PBL) and team-based learning (TBL) (Fig. defines these teaching methodologies), is becoming established in health care education. Health

professional education programs, in particular medical education, have been at the forefront of implementing and using these new methods of learning.^{1,2}

This is, in part, due to medical regulatory bodies raising concerns that “traditional” medical education—didactic teaching, would not meet the needs of current and future doctors.¹ The use of PBL began in undergraduate medical education at the end of the 1960s, and McMaster University School of Medicine in Canada was the first institution to adopt a curriculum delivered through the PBL approach.¹ Subsequently, medical schools across the globe introduced

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*Problem-based learning*³ is a small group teaching method, which combines acquisition of knowledge with the development of generic skills and attitudes. Generic skills are teamwork, critical evaluation of literature, presenting skills, self directed learning and the use of resources. PBL uses appropriate problems to increase knowledge and understanding of an area. Students undertake independent self directed study and then return to their small group to refine and present the knowledge acquired.

*Team-based learning*⁴ is an active teaching methodology that advocates higher levels of learning, such as application and evaluation. TBL requires students to prepare for the class by undertaking individual directed study. The readiness assurance process in the classroom is designed to prepare learners to apply new knowledge in the team application exercises. Students take an individual readiness assurance test (iRAT), and then form into their TBL teams to take the same test as a team; the group readiness assurance test (gRAT). Students remain in their teams to complete team application exercises; to encourage higher-order thinking, teamwork and communication skills, to enable interaction and promote learning. The TBL process concludes with peer evaluation.

Fig. Definitions of PBL and TBL.

PBL, for example, Beer Sheva (Israel), Maastricht (the Netherlands), Newcastle (Australia), and Albuquerque (US).¹ TBL is a more recent teaching methodology, which was developed by Larry Michaelson in the late 1970s in business education.⁵ Subsequently, it has been adopted in health professional education, and is now commonly employed in medical education, and used to teach topics such as evidence-based medicine, clinical experiences, and clerkships.¹

The benefits of PBL and TBL in medical education have been shown, but the picture in pharmacy education is less clear. PBL in pharmacy education was first described in the early 1980s, where PBL was used to teach problem solving skills, but it was not until the mid to late 1990s that widespread use was reported in US pharmacy schools.⁶

The use of TBL in pharmacy education was first reported by Letassy et al.⁷ Like PBL, the adoption of TBL in a number of pharmacy schools has since been reported.^{8,9} The use of these methods in undergraduate pharmacy education is likely to grow, given that accreditation bodies such as the Accreditation Council for Pharmacy Education and the Australian Pharmacy Council advocate their use.^{10,11}

The effect of PBL and TBL on student attainment (examination performance) and progression (examination pass rate) in pharmacy education has been reported; PBL data show mixed outcomes. For example, Raman-Wilms¹² and Romero et al.¹³ both found that PBL increased student

attainment when compared with traditional approaches, although Ross et al.¹⁴ and Romero et al.¹⁵ showed no increase in student attainment. TBL outcomes appear to be more positive. Letassy et al.⁷ and Conway et al.¹⁶ found that student progression rates increased. Both authors reported that there was a lower failure rate after TBL implementation compared with historical pre-TBL data, which used a more traditional approach. Student perception also seems to favor TBL over PBL.^{12,17}

Rationale and objectives

Given the emergence of these teaching methods within pharmacy education, and the generally positive outcomes associated with them, the pharmacy course committee at the University of Wolverhampton decided to pilot the use of PBL and TBL teaching in the third year of the program (in the UK, students study for four years at the university before undertaking a one-year clinical internship prior to registration) alongside traditional teaching methodologies. PBL was used to deliver a therapeutics module that covered respiratory, gastrointestinal, and endocrine conditions; TBL was used to teach a differential diagnosis and prescribing module. For comparison purposes, relating to student attainment, a module (that covered pharmaceutical biotechnology) taught using traditional didactic methods was included. The aim of the study was to compare TBL, PBL, and traditional didactic methods in student attainment,

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184 progression, and perception at the University of Wolver-
185 hampton, School of Pharmacy.

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187 **Materials and methods**

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189 A **mixed-method** approach was used. Exam data were
190 analyzed to gauge attainment and progression and a student
191 survey and focus group schedule were performed to
192 investigate student perception toward the introduction of
193 PBL and TBL.

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195 *Attainment data*

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197 Student performance was assessed via summative marks
198 gained at the end of each module. The University of
199 Wolverhampton **employs** a grade point score system
200 (GPA), where zero is the lowest score and 16 is the highest
201 achievable score; a score of five or greater is a pass. Data
202 were reviewed in two **ways**.

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Firstly

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- 205 ● *Before and after TBL implementation*: Historical
206 exam result data, for the academic year 2010/2011
207 (taught in a traditional manner), were compared to
208 exam results from 2012/2013 that used the TBL
209 approach. No data for 2011/2012 were available as
210 the module was not taught due to a course restructure.
211 Examination scores were entered into SPSS (version
212 20), and then analyzed using descriptive statistics and
213 statistically using an independent *t*-test. Exams sat by
214 both pre- and post-TBL cohorts followed the same
215 assessment pattern. Standard TBL methodology was
216 employed (irat/grat/tapps) but counted only as form-
217 ative marking and not summative. This allowed
218 comparison of summative performance as both
219 cohorts sat the same summative examination diet.

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And **secondly**

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- 222 ● *TBL vs. PBL (vs. traditional)*: Exam data for the
223 academic year 2012/2013 were compared from the
224 three respective modules. Examination scores were
225 entered into SPSS (version 20), and then analyzed
226 using descriptive statistics and statistically using one-
227 way ANOVA and post hoc analysis Bonferroni test.

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230 *Progression data*

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232 Final student scores for each respective module were
233 acquired through standard university systems that allowed
234 tracking of individual progression. Each of the three
235 respective modules had varying assessment patterns but
236 ultimately had a percentage mark, which was used as the
237 basis for establishing progression. Progression data were
238 entered into SPSS (version 20), and then analyzed using
239 descriptive statistics and statistically using **Fisher's** exact

test to allow comparisons between modules using different
teaching methodologies.

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Survey

The survey was developed to gather student perception
of PBL and TBL compared to more traditional didactic
teaching. It was administered to all third-year ($n = 75$)
students after year three teaching had finished. Students
were provided with the details of the study and an
information sheet. Prior to completing the survey, students
gave written consent.

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The survey contained 30 items, of which 27 were **five-**
point Likert scale questions that used a strongly agree to
strongly disagree scale; three questions were free text
responses. The survey consisted of four sections: section
A established basic demographic information; **sections B**
(10 questions) and C (nine questions) looked at student
perception of PBL and TBL; and section D (11 questions)
aimed to establish their overall view of PBL and TBL in
comparison to traditional teaching methods.

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The survey was assessed for reliability and validity.
Cronbach's alpha was used to test the reliability and the
survey was shown to be reliable (Cronbach's $\alpha = 0.899$). A
face validity check was performed; the questions were
checked for ease of reading as well as the overall layout,
and were shown to be valid.

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The survey was then piloted on **10** randomly selected
fourth-year students. Following the pilot, minor amend-
ments to three of the questions were made to aid clarity. No
other changes were made.

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Likert data were entered into SPSS (version 20) and
analyzed by aggregating positive and negative responses to
produce percentage responses. Data were then statistically
analyzed using the paired *t*-test to compare student's
responses to survey sections B (PBL) and C (TBL).
Responses to the open-ended questions were analyzed
thematically by the lead author L.N. and verified by P.R.,
and findings used as a basis for constructing the focus group
schedule questions.

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Focus group

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For the focus group, all **third-year** students were invited
via **e-mail** to participate in a focus group. Students were
provided with the details of the focus group and its **purpose**,
and written consent was gained prior to the start of the
focus group.

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The focus group schedule explored how students
approached the preparatory work for PBL and TBL, their
attitude toward **delivery**, and asked for their general
thoughts on PBL and TBL. No specific questions were
posed on traditional teaching methods. A face validity
check was performed on the focus group schedule by two
experienced researchers, and found to be valid. No changes
were made to the focus group schedule.

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296 Six students volunteered to attend a focus group; as a
 297 consequence one focus group ($n = 6$) was conducted at the
 298 University of Wolverhampton by L.N., who acted as the
 299 moderator, along with a second assistant moderator to
 300 facilitate data capture. The focus group was audio recorded
 301 and then transcribed verbatim. The moderator did not
 302 deviate from the focus group schedule.

303 For data analysis, each student was given a student **code**
 304 to ensure anonymity. The transcript was repeatedly listened
 305 to until the researcher was familiar with the content and then
 306 transcribed verbatim. The data were analyzed using constant
 307 comparison analysis to derive emergent themes. Ethical
 308 approval was gained from the **behavioral** science ethics
 309 committee at the University of Wolverhampton.

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312 Evaluation and assessment

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314 Student attainment data

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316 Student attainment and progression before and after TBL
 317 implementation are shown in **Table 1**. Students achieved a
 318 higher mean GPA score after TBL (11.19) implementation
 319 compared with before TBL (7.70) implementation; this
 320 difference was significant (independent t -test, $p = 0.01$).
 321 Progression rates were also higher after TBL implementation
 322 (92%) compared with before TBL (89%), although this result
 323 did not reach significance (Fisher's exact test, $p = 0.574$).

324 The average year end grade point average (GPA) scores
 325 achieved for both cohorts (2010/11 and 2012/13) were
 326 compared to see if changes in GPA scores were associated
 327 with the TBL teaching methodology rather than cohort
 328 differences in academic ability. For 2010/11, the average
 329 year end GPA score was 9.14 (compared **with** 7.70 for the
 330 specific module differential diagnosis and prescribing) and
 331 in 2012/13, the year GPA score was 10.06 (compared **with**
 332 11.19). This seems to suggest that increased attainment was
 333 due to TBL and not cohort differences.

334 Student attainment and progression data for the three
 335 modules studied in year three of the program showed that
 336 students achieved the highest mean GPA score with tradi-
 337 tional teaching methods (11.83), followed by TBL (11.19)
 338 and then PBL (8.73); this difference was significant (one-
 339 way ANOVA, $p < 0.001$). Further post hoc analysis using
 340 the Bonferroni test showed a significant difference between
 341 TBL and PBL attainment ($p < 0.001$) and similarly

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343 Table 1

344 Student attainment (average grade point score) and progression (%)
 345 data **before** and **after** TBL **implementation**

	Attainment	p Value	Progression	p Value
347 Pre-TBL	7.70	–	89.1	–
348 Post-TBL	11.19	0.01 ^a	92.0	0.574 ^b

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350 **TBL**, team-based learning.

351 ^a Independent t -test.

352 ^b Fisher's exact test.

between traditional methods and PBL ($p < 0.001$). No
 significant difference was seen between TBL and traditional
 teaching ($p = 0.355$). Progression rates were the highest in
 the traditional module (96.0%), followed by TBL (92.0%)
 and then PBL (88.0%), although these did not reach
 significance (Fisher's exact test, $p = 0.224$).

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408 **learning**, and learning style.

408 Table 2
409 Student perception of PBL and TBL in relation to preparatory work ($n = 43$)

410 411 412 413 414 415 416 417 418 419 420	PBL			TBL		
	Agree, % (n)	Neutral, % (n)	Disagree, % (n)	Agree, % (n)	Neutral, % (n)	Disagree, % (n)
414 I always complete the preparatory work set by the tutor 415 for a PBL/TBL session	95.4 (41)	2.3 (1)	2.3 (1)	97.7 (42)	2.3 (1)	0
416 I enjoy completing the preparatory work for a PBL session 417 in a group/TBL session individually	57.1 (25)	31.0 (13)	11.9 (5)	69.7 (30)	30.2 (13)	0
418 I have a better understanding of the module material by 419 doing the PBL preparatory group work/TBL individual preparatory 420 directed reading work	83.4 (36)	9.5 (4)	7.1 (3)	93.1 (40)	7.0 (3)	0

421 PBL, problem-based learning; TBL, team-based learning.

425 Table 3
426 Student perception of PBL and TBL workshops ($n = 43$)

427 428 429	Characteristic	Agree, % (n)	Neutral, % (n)	Disagree, % (n)
430	<i>PBL workshops</i>			
431	I have a better understanding of the module material by delivering the pre-prepared group 432 work to the class	55.8 (24)	25.6 (11)	18.6 (8)
433	I have a better understanding of the module material by taking part in the question and answer 434 session on the presentation delivered by my group	60.4 (26)	20.9 (9)	18.6 (8)
435	I have a better understanding of the module material by listening to other groups deliver their 436 pre-prepared work to the class	51.2 (22)	16.3 (7)	32.6 (14)
437	I have a better understanding of the module material by taking part in the question and answer 438 session for the other groups' presentations	58.1 (25)	18.6 (8)	23.3 (10)
439	<i>TBL workshops</i>			
440	I have a better understanding of the module material by doing the individual preparatory 441 multiple-choice questions (MCQs)	100.0 (43)	0	0
442	I have a better understanding of the module material by discussing the MCQs in teams 443 in the workshop	83.7 (36)	11.6 (5)	4.7 (2)
444	I have a better understanding of the module material by completing the MCQs in teams 445 in the workshop	83.7 (36)	11.6 (5)	4.7 (2)

446 PBL, problem-based learning; TBL, team-based learning.

449 Table 4
450 Student perception on the effectiveness of PBL and TBL ($n = 43$)

451 452 453 454	PBL			TBL			p Value	
	Agree, % (n)	Neutral, % (n)	Disagree, % (n)	Agree, % (n)	Neutral, % (n)	Disagree, % (n)		
455	PBL/TBL is a more effective way of learning 456 than lecturing	44.2 (19)	32.6 (14)	23.3 (10)	60.5 (26)	18.6 (8)	21 (9)	0.68 ^a
457	PBL/TBL is a better method of delivery 458 of the module material than lecturing	34.9 (15)	30.2 (13)	34.9 (15)	55.8 (24)	20.9 (9)	23.3 (10)	0.002 ^a

459 PBL, problem-based learning; TBL, team-based learning.

460 ^a Paired *t*-test.

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Table 5
General student perceptions toward the three teaching methods (n = 43)

	Agree			Disagree			Neutral		
	PBL, % (n)	TBL, % (n)	Trad ^a , % (n)	PBL, % (n)	TBL, % (n)	Trad ^a , % (n)	PBL, % (n)	TBL, % (n)	Trad ^a , % (n)
I enjoy learning using PBL/TBL/Trad ^a compared to other methods of teaching	51.1 (22)	60.5 (26)	60.5 (26)	16.3 (7)	14.0 (6)	11.6 (5)	32.6 (14)	25.6 (11)	27.9 (12)
I feel that I learn better with PBL/TBL/Trad ^a approach of teaching compared to other methods of teaching	53.5 (23)	60.5 (26)	62.8 (27)	25.6 (11)	11.6 (5)	11.6 (5)	20.9 (9)	27.9 (12)	25.6 (11)
I prefer to learn using PBL/TBL/Trad ^a compared to other methods of teaching	39.5 (17)	58.1 (25)	60.5 (26)	39.5 (17)	16.3 (7)	7.0 (3)	21 (9)	25.6 (11)	32.5 (14)

PBL, problem-based learning; TBL, team-based learning.
^a Traditional.

Understanding and learning styles were common emergent themes in PBL and TBL; students liked being able to research a topic in depth for PBL and TBL; but in PBL, some found it difficult when they came across material they could not understand. Students found TBL to be a useful teaching method, as it allowed them to research the topic and then use the MCQ test to test their own knowledge. Secondly regarding learning style, students generally preferred traditional teaching to PBL, but would like to see PBL continue if supplemented with additional lectures. Similarly, students preferred traditional lectures compared with TBL.

The two themes attributed to PBL only were student engagement and quality of presentations. With student engagement students enjoyed working as part of a group, but found it difficult when some group members did not contribute to the task. Secondly, students felt the material presented to them by other students was of poor quality and not appropriate for revision purposes. The third theme attributed to TBL only was team working; students felt it was beneficial working within a team to discuss the material, but most students highlighted that not everyone contributed to the team discussions.

Focus group

Six students took part in a single focus group. Student's perception was broadly categorized into positive and negative attributes.

Positive attributes

Students highlighted the positive aspects of PBL and TBL, in particular working with new people, improving their team working skills, and taking responsibility for self-directed work. Students also valued the feedback provided in both PBL and TBL sessions and found this useful to highlight gaps in their knowledge. Students preferred TBL, with students seeing the benefit of participating in TBL team discussions, which allowed them to learn from each other and helped to increase their confidence.

I valued the team discussions (in TBL), they can give you different perspectives of the right answer and explain it better—FGP3.

Having the individual and group test scores available in the TBL session was seen as particularly beneficial, as this provided immediate feedback. The transparent nature of knowing each others' scores created competitiveness between students to work harder.

Negative attributes

Students did not highlight any disadvantages to TBL but did voice concern over PBL, in particular, group members not equally contributing to the given task, for example

632 preparing a presentation. Adopting this approach led to a
633 lack of understanding toward specific topic areas.

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635 It's easier to split it all up (work), which is a disadvant-
636 age, I knew my slide really well, but I did not understand
637 the other slides—FGP4.

638

639 **Opinions** toward PBL presentations were negative;
640 students spoke of group members not attending to present
641 their work, which resulted in a lack of quality in the
642 information presented, as other students had to present the
643 absent **student's** work.

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646 Discussion

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648 This study has shown that PBL was associated with the
649 poorest attainment and progression and was the least
650 preferred by students. Attainment and progression improved
651 following implementation of TBL, and **were** comparable to
652 those by traditional teaching methods in the comparator
653 module. Furthermore, student attainment was significantly
654 higher **after TBL** implementation when compared **with**
655 **before TBL** implementation. These findings echo those
656 reported both in pharmacy^{7,18–21} and medical education,^{22–}
657 ²⁶ where TBL has shown an increase in student attainment.
658 The findings observed with PBL also seem consistent with
659 the majority of the pharmacy literature, which show that
660 PBL has no difference in student attainment.^{13–15} This has
661 also been shown in the medical literature.^{27,28}

662 Students clearly preferred TBL over PBL, **which** again
663 mirrors the findings of other studies both in pharmacy^{19,29}
664 and medical education.^{22–24,30,31} With TBL, students liked
665 doing the preparatory work individually, as they were
666 responsible for their own learning, but valued the group
667 **discussion** as it allowed them to better understand the
668 material content. Both of **these** are reflective of other
669 studies.^{18,21}

670 Overall, student perception similarly **avored** traditional
671 teaching and TBL, and both were generally preferred to
672 PBL. This was somewhat expected with traditional teach-
673 ing, more so than with TBL, given that students had been
674 taught in this manner for the previous two years and were
675 familiar with this method of learning. Newer **approaches**
676 such as PBL and TBL place greater emphasis on students
677 acquiring knowledge rather than being imparted this knowl-
678 edge through traditional teaching methods. This shift in
679 learning, along with unfamiliarity of the new methods, may
680 go some way **in** explaining the differences in the findings
681 with PBL. Additionally, this preference may account for
682 differences in attainment; liking seems to be linked to
683 performance and it may not be the instructional method
684 per se that **accounts** for those differences. Further work is
685 needed to explore this. Student attainment and progression
686 using TBL **were** very similar to those by traditional
687 **methods, which suggest** that TBL will be an important
688 instructional method to be used with future cohorts.

688 An unexpected finding from the results of TBL was the
689 emergence of competitiveness. Students liked having a
690 score for their individual **MCQs** (iRAT); they found that
691 the competitiveness that arose from the publication of these
692 results gave them the drive to work harder. This **"compet-**
693 **itive"** dimension to TBL does not appear to have been
694 reported in other pharmacy TBL papers. At the University
695 of Wolverhampton, students normally receive their results
696 **individually**, and they are not shared with other students.
697 With TBL, students knew each **other's** marks (students
698 agreed to marks being shared); this transparency of scores in
699 a public forum allowed students, for the first time, to
700 benchmark themselves against each **other**, and this seems to
701 have given students the drive and motivation to perform
702 better. This finding requires further investigation to better
703 understand the competitiveness nature of TBL and how best
704 this can be harnessed to drive student learning.

705 Students did not like or perform particularly well using
706 PBL. Students found it undesirable having to rely on peers
707 and other PBL groups to gather, **present**, and rely on this
708 information. These findings might, in part, be explained by
709 students stating that they felt **underprepared** to present
710 assigned topics. Other pharmacy educators have reported
711 similar student engagement issues.^{12,17} In contrast, medical
712 education seems to report more positive accounts of
713 **students'** preparedness and engagement.^{27,32} These differ-
714 ences, from a UK perspective, between pharmacy and
715 medical students might be explained by the **"type"** of
716 student each discipline attracts. In the UK, medical schools
717 are highly oversubscribed, allowing them to selectively
718 recruit the most able and committed students through
719 rigorous selection processes. This is not the case in
720 pharmacy, where recent expansion in the number of **schools**
721 of **pharmacy** has led to pharmacy programs taking students
722 whose first degree choice may not be pharmacy.³³

723 This may affect how students want to be taught; PBL is
724 a more self-driven teaching method compared **with** TBL
725 (which is more structured) and traditional lecture-type
726 delivery and the latter two methodologies require less
727 self-learning. **Self-determination** theory, as reported by
728 Albanese, highlights two types of motivating **conditions:**
729 controlled and autonomous.³⁴ In autonomous motivators,
730 subject interest drives learning; in those students where
731 pharmacy may not be the first choice, there is the potential
732 for less motivation and possibly less success with PBL.
733 Compounding our findings may also be the concept of
734 situational context, reported as being important with PBL.³²
735 UK undergraduate pharmacy students have limited exposure
736 to the workplace, which is in stark contrast **with** medical
737 students.

738 The study does have limitations. Firstly, the attainment
739 data **before** and **after TBL** implementation **were** from two
740 different student cohorts. Therefore, the results could be due
741 to differences in student cohorts rather than the instructional
742 method. The average GPA score across the year for the **pre-**
743 **TBL-implementation** cohort was 9.14, compared **with** the
744 745

744 GPA score for the module in the study of 7.7; students
 745 performed below the average year GPA score. The average
 746 GPA score across the year for the **post-TBL-implementation**
 747 cohort was 10.06, compared **with** the GPA score for the
 748 module in the study of 11.19; students performed better than
 749 the average year GPA score. Given that the content did not
 750 **change**, improvement in attainment is likely due to the TBL
 751 methodology rather than cohort differences. Secondly, some
 752 students may naturally perform better in one area of the
 753 program than another (the three modules covered different
 754 aspects of the program), despite the teaching method used.
 755 We acknowledge this problem, but in the study design this
 756 could not be mitigated against. It is possible that students
 757 found content from one module easier than another and
 758 might account for some of the differences seen in attainment
 759 and progression. However, student feedback did support the
 760 notion that PBL was the least preferred and was therefore
 761 likely to influence their performance.

763 Conclusion

765 The study results indicate that students favor the use of
 766 TBL and traditional learning methods compared **with** PBL.
 767 Following implementation of TBL in a differential diagnosis
 768 and prescribing module, student attainment improved
 769 significantly.

771 Uncited references

773 3.4.

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