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Creators	Rutter, Paul and Nation, Leanne Marie

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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

Leanne Marie Nation, MSc*, Paul Rutter, PhD

School of Pharmacy, University of Wolverhampton, West Midlands, UK

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

* Corresponding author: Leanne Marie Nation, MSc, School of Pharmacy, University of Wolverhampton, Wulfruna Street, Wolverhampton, West Midlands WV11SB, UK.

E-mail: Leanne.nation@wlv.ac.uk

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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,

progression, and perception at the University of Wolverhampton, School of Pharmacy.

Materials and methods

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

Attainment data

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

Firstly

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

And **secondly**

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

Progression data

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

test to allow comparisons between modules using different teaching methodologies.

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.

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.

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.

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

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.

Focus group

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.

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.

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

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

Evaluation and assessment

Student attainment data

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

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

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

Table 1

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

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

TBL, team-based learning.

^a Independent t -test.

^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, $p = 0.224$).

Survey data

A response rate of 57.3% ($n = 43$) was obtained. In all, 19 respondents (44.2%) were females and 24 (55.8%) were males. Student perception on preparation for PBL and TBL sessions is shown in Table 2. More students enjoyed completing TBL work compared with PBL and also felt that TBL preparatory work increased their understanding of module material more than PBL, although these findings did not reach statistical significance.

Student perception of their "engagement" during workshops is shown in Table 3. All (100%) students agreed that the preparatory multiple-choice question (MCQ) test used in TBL gave them a better understanding of module material; this is compared with 55.8% in PBL. Most students agreed that discussing (84%) and completing (84%) the MCQs within their TBL teams during the workshop was beneficial to their learning. In comparison, 60.4% agreed that the PBL question and answer (Q&A) session for their group's presentation was beneficial to their learning and 58.1% agreed that taking part in other group's Q&A sessions gave them a better understanding of the module material. Approximately a third of the students disagreed that listening to other groups PBL presentations helped their understanding.

Table 4 reports student perception on the effectiveness of the two teaching methods, PBL and TBL. More students (60.5%) agreed that TBL was more effective than lectures, compared with 44.2% agreement for PBL; this did not reach significance (paired t -test, $p = 0.68$). Similarly, more students (55.8%) agreed that TBL was a better way to deliver material than lecturing, which was higher than that of PBL (35%); this difference was significant (paired t -test, $p = 0.002$).

General student perception of the three teaching methodologies is shown in Table 5. TBL (60.5%) and traditional methods (60.5%) were equally enjoyed by students, which were higher than that of PBL (51.1%). Not surprisingly then, the students' least preferred learning methodology was PBL. There is similar agreement with PBL, TBL, and traditional methods of teaching regarding the methods students feel they learn best. Traditional methods (60.5%) and TBL (58.1%) were the preferred method of teaching, compared with 39.5% preferring PBL.

Open-ended questions asking for student perception on their experiences revealed a degree of commonality between their PBL and TBL experiences. For PBL, four themes were identified: student engagement; understanding and learning; quality of presentations; and learning style. For TBL, three themes were identified: team working, understanding and learning, and learning style.

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

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

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

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

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

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

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

	PBL			TBL			p Value
	Agree, % (n)	Neutral, % (n)	Disagree, % (n)	Agree, % (n)	Neutral, % (n)	Disagree, % (n)	
PBL/TBL is a more effective way of learning than lecturing	44.2 (19)	32.6 (14)	23.3 (10)	60.5 (26)	18.6 (8)	21 (9)	0.68 ^a
PBL/TBL is a better method of delivery 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

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

^a Paired *t*-test.

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

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

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

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

Discussion

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

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

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

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

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

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

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

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

Conclusion

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

Uncited references

3,4.

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