

# A Pilot Study of Team-based Learning in Paediatric Clerkships

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## Research article

**Keywords:** Team-based learning, paediatrics, clerkship, undergraduate medical education; learning method

**Posted Date:** November 3rd, 2020

**DOI:** <https://doi.org/10.21203/rs.3.rs-40391/v2>

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# Abstract

**Background:** Team-based learning (TBL) is widely used in health profession education. However, the use of TBL in paediatric clerkships is rare. In this study, we explore the efficacy and feasibility of TBL in paediatric clerkships. **Methods:** We retrospectively reviewed the TBL course for paediatric clerkships from August to October 2019 at the Children's Hospital, Zhejiang University School of Medicine, Hangzhou, China. The TBL group (with 107 students) was compared to the students from the prior year that learned using case-based discussion (control group with 222 students). The learning outcomes were measured using theoretical exams when the paediatric clerkships ended. The satisfaction with TBL was evaluated by an anonymous questionnaire in the TBL group. **Results:** The grade point averages before paediatric clerkships in the TBL group (3.58, 3.04-3.96) were similar to those in the control group (3.62, 3.16-4.00). However, the theoretical exam scores in the TBL group (76, 67-82) were significantly higher than those in the control group (72, 64-78) ( $p=0.002$ ). In addition, 92.5% of the students in the TBL group rated that their level of satisfaction was higher than 90%. **Conclusions:** Our study demonstrated that TBL in paediatric clerkships was effective and feasible and that it led to better learning outcomes.

## Background

Clerkships are one of the core components in undergraduate medical education(1). During clerkships in various specialties, medical students participate in immersive learning in different departments, including paediatrics. Paediatric teaching and learning have certain features. However, some studies showed that students showed lower interest in paediatrics(2). Compared with the clerkships in other medical schools (1, 3, 4), the period of our paediatric clerkships were much shorter, only three weeks. Learning and teaching is a challenge for both students and teachers. As is known, active learning enhances the effects of learning(5) by improving knowledge acquisition and evoking memories. We seek to change students' learning methods by changing our teaching methodologies.

Team-based learning (TBL) has become popular in health professions education in recent years(6, 7), including different medical specialties. TBL is a unique and powerful form of small-group learning(8). "It harnesses the power of teams and social learning combined with accountability structures and systematic instructional sequences to let you achieve powerful results"(8). TBL has 4 stages: preparation before class; individual readiness assurance tests; group readiness assurance tests; and application activities, which required students to apply the knowledge from the readiness stage in the "real world"(7). All these stages include the teams working on the same problem and encourage students to learn actively and maximally participate in group discussion. A systemic review of 118 studies(7) showed that 47% of the included studies explored the practice of TBL in undergraduate education; however, only 2 of those articles focused on paediatrics(7). A recent research demonstrated that in China, the application of TBL in medical education was limited(9)

According to the positive findings on TBL in the literature(10-14) and our colleagues' experience, we hypothesize that implementing TBL in paediatric clerkships could improve the effectiveness of learning

paediatrics in undergraduate students. Here, we retrospectively reviewed our students who participated in a paediatric clerkship using TBL in 2019 and compared their outcomes with those of students from the prior year who learned using case-based discussion. We aimed to prove that TBL was effective and feasible in paediatric clerkships according to learners' performance and satisfaction.

## **Methods**

This study was approved by The Ethics Committee of the Children's Hospital, Zhejiang University School of Medicine.

We organized TBL in paediatric clerkships for students who were majoring in clinical medicine from August to October 2019 at the Children's Hospital, Zhejiang University School of Medicine.

### **Subjects**

The students were enrolled in 5-year undergraduate programmes at the Zhejiang University School of Medicine. They participated in clerkships in many specialties in their third year, including 3 weeks in paediatrics. We retrospectively reviewed the teaching methods the students experienced and their performance before and after their paediatric clerkships. The student cohort with TBL-based paediatric clerkships (TBL group) was compared with the student cohort from the prior year (control group) that used case-based discussion as the teaching method. The students' grade point averages (GPAs) in their major courses before their paediatric clerkships were reviewed.

### **Control Group**

The paediatric clerkships for the students from the control group included 4-6 case-based discussions over 3 weeks (Table 1). The cases used in the discussions were chosen by the students themselves during their clerkships and mainly covered core paediatric topics (Table 1). In each case-based discussion, one student in one group volunteered to do the preparatory work including presenting the case to the group and organizing the discussion. The students would conduct the discussion, including presenting a typical case, asking questions to other group members, and explaining the possible rational. One teacher would be assigned to a group as an instructor. The teachers' work was mainly to preview the students' preparatory work (including the slides), observe the discussion, and facilitate the discussion if necessary. The groups held their discussions separately.

## **TBL Group**

The paediatric clerkships for students from the TBL group contained 4 modules. The 4 modules were fixed and covered the following paediatric topics: acute gastroenteritis with fluid therapy, neonatal hyperbilirubinemia, pneumonia, and glomerulonephritis/nephritic syndrome (Table 1).

The faculty members had attended a TBL fellowship training course or a TBL workshop before the TBL started. Finally, 4 teachers participated in the TBL group. Three of those 4 teachers were the same as in the control group, including one teacher who had more than 10 years of teaching experience in paediatrics. Each TBL module was mainly conducted by one paediatric faculty member, and another faculty member would help with the readiness assurance test part.

When the paediatric clerkships started, the students would receive a brief introduction of TBL methods, including how they worked and what they should do in each component. The preparatory materials were assigned 2 days before classes, usually from certain chapters in the textbook or articles. The TBL modules were designed in the “4 Ss” framework (significant problem, same problem, specific choice, and simultaneous reporting) (8). The learning objectives were set to meet the paediatric requirements in the national examination of practicing doctor’s qualifications.

A TBL module began with a closed-book individual readiness assurance test (iRAT) containing 12 multiple-choice questions (MCQs). The iRAT had to be finished in 12 minutes. Those MCQs were based on clinical problems. Students completed the iRAT using a mini-program in the Wechat app. When teachers logged into the mini-program, they could see the iRAT results for each student and each MCQ. During the iRAT, the students did not get feedback on the right answers. Then, the students started the discussion in teams and finished the closed-book team readiness assurance test (tRAT), which included the same questions as the iRAT. The tRAT was conducted using the Immediate Feedback Assessment Technique (IF-AT) via scratch cards or voting cards. The scratch cards were made by our faculty members. The scratch cards eventually would reveal the correct answers to the students and would record the students’ confusion. The voting cards revealed the students’

initial opinions and could provoke an immediate discussion. After the tRAT with the discussion, there was a short time for a mini-lecture conducted by teachers. The teachers would give feedback and clarification to ensure that the key principles were understood by all the students. The application began with another clinical case. The questions were set as clinical problems. In additions, the application questions not only covered the key principles addressed in the tRAT, but they also required the application of other knowledge. After the groups demonstrated their ideas simultaneously, gallery walks started, which allowed groups to cross-examine others and leave comments. The discussion was guided by facilitators, and the groups expressed their thinking. Peer reviews were done via mobile phone after class, using the UT Austin method(8) to obtain descriptive feedback of the performance during the TBL module. That feedback would be given to the students after each TBL module. When each module ended, the teacher would assign some reading material related to the topics.

### **Measuring Outcomes**

During the TBL practice, the iRAT and tRAT scores would be recorded.

At the end of the paediatric clerkships, all students would be evaluated using a closed-book theoretical exam that consisted of 100 MCQs and had a time limit. Those MCQs covered most of the topics that the national examination of practicing doctor's qualifications required in paediatrics and not just the core topics. The ratio of each topic in the final course exam was showed in additional file 1. The students in both the control group and the TBL group took the theoretical exam with the same ratio of each topic. The MCQs that were used in the readiness assurance tests or prior theoretical exams were not repeated. The satisfaction of the students who enrolled in the TBL group was assessed with an anonymous questionnaire when the paediatric clerkships ended. The questions in the questionnaire were answered using a five-point scale, and the response options included strongly agree, agree, neutral, disagree, and strongly disagree. Additionally, an open-ended question was included for students to provide further suggestions or comments on TBL.

### **Statistical Analysis**

The statistical analyses were conducted using SPSS version 25.0 (IBM, Armonk, New York).

Normally and nonnormally distributed continuous data were presented as the mean  $\pm$  standard deviation and the median with the interquartile range (IQR), respectively. A chi-squared test was applied to categorical variables. The Mann-Whitney test was used for nonnormally distributed data, and the *t* test was used for normally distributed data. Significance was considered as a *p* value  $<0.05$ .

## Results

In the 2017-2018 academic year, 222 third-year students (control group) participated in paediatric clerkships using the case-based discussion teaching method in the Children's Hospital, Zhejiang University School of Medicine. In the 2019-2020 academic year, 107 third-year students (TBL group) participated in paediatric clerkships using TBL in the same hospital. The students in the TBL group were all not familiar with TBL before this experience. The demographics and the theoretical exam scores of the two groups are given in Table 2. The GPAs for the major courses before the paediatric clerkships were similar in the two groups ( $p=0.839$ ). However, the theoretical test scores at the end of paediatric clerkship in the TBL group were higher than the control group ( $P=0.002$ ).

### Learning Process in the TBL Group

During the 3-week clerkships in paediatrics, the students in the TBL group went through 4 TBL modules. Their performances were recorded as their iRAT and tRAT scores (Table 3). Comparing the iRAT scores to the tRAT scores in each module, the tRAT scores were all higher than the iRAT scores in each module ( $p<0.05$ ).

### Students' Satisfaction

A total of 99 (92.5%) students in the TBL group responded to the anonymous questionnaire. Overall, more than 90% of the students gave positive feedback on the TBL (Table 4).

The students provided many suggestions for TBL. Some students proposed more TBL modules or an arrangement that covered more core topics. Some students suggested that it would be better if the teacher gave a summary after the discussions. A few students desired more opportunities to express themselves. Two students thought it was slightly rushed to learn 4 modules in 3 weeks. One student complained that one team member was not devoted to class.

## Discussion

This study used TBL in the paediatric clerkships of medical undergraduate students. Our research demonstrated that by using TBL, medical students could obtain more theoretical knowledge than they did with the case-based discussion method. TBL's components were able to quantify the learning process. Students were satisfied with TBL even though they had never experienced before.

Why did TBL work in our 3-week paediatric clerkships? In our opinion, the success was due to the teachers, the students, and TBL itself. After examining other TBL characteristics of facilitators(7), only a small part of the literature mentioned the training of facilitators or the experience of facilitators before implementing TBL. However, we had faculty members that well trained in TBL before TBL was implemented. The training included participating in TBL fellowships in an experienced centre and TBL workshops, which allowed the trainees to immerse themselves in TBL. In addition, we had one of four teachers who was experienced in paediatric teaching. These items made our faculty members well prepared for TBL. Our experience in TBL practice showed that the training experience, rather than the number of faculty members, was the most important factor.

Students were another impact factor in our TBL activities. Before the paediatric clerkships started, the students in the control group had the same GPA in their major courses, and they shared the same textbooks as the students in the TBL group. Although the students dominated the discussions in both groups and were encouraged to learn actively, the results showed that they achieved different results. In the TBL group, every student did the preparatory work. During the discussions, the students in the TBL group showed more interest because they were working on the same question with similar knowledge levels. In contrast, in the control group, the students who volunteered to do the preparation work usually did the most preparatory work, while the others' preparatory work could not be measured. The discussion was quick because other members did not have their own opinions or questions. The control group covered more topics but in less depth. Overall, the TBL group did much better than the control group on the theoretical exam, achieving higher scores. This indicated that the students could learn more theoretical knowledge with TBL, even if they had not previously experienced TBL. Our findings here consisted of other TBL practices in paediatric(10, 14) and non-paediatric fields(15, 16).

TBL itself was the only change in the control and TBL groups. TBL is a structural learning method. The iRATs and tRATs made the students accountable for their readiness. The RAT results may have been scores, but they also informed the teachers of any "weak point" or "confusing part", which made the discussions between groups more powerful and effective. Furthermore, by working in smaller sized groups (5-7 persons per group in the TBL group compared to 8-10 persons per group in the control group) and working on the same question, the students had more opportunities to share their thoughts. When teams debated with each other, they might clarify items and obtain a deeper understanding. This learning process might be more effective because it was learning from peers. This was addressed by another study(17).

In addition, we found that the TBL group required fewer classrooms than the control group. The teachers liked TBL more because they could shorten their teaching time.

Nevertheless, this study had limitations. As the learning and teaching methods changed, the measurement methods for learning outcomes did not change. The theoretical test scores might only show how the knowledge was remembered or applied. Other abilities that might be improved through TBL, such as teamwork and communication, could not be properly assessed in our study. For learning, the theoretical exams when paediatric clerkships ended just tested short-term outcomes. We did not explore the long-term effects. To date, recent studies have presented the opposite results(10, 14). More studies on the long-term outcomes from TBL are needed. Furthermore, the purpose of a clerkship should not only focus on theoretical knowledge, but it should also focus on clinical competency. Some more objective indexes would be needed in clerkships to evaluate students' performance. Thus, we might see how TBL influenced paediatric clerkships.

## Conclusion

In this study, we showed the efficacy and feasibility of TBL in paediatric clerkships, even within a quite short time. Students could master the knowledge and improve self-learning through team cooperation. The quantified learning process provided immediate feedback for students and improved the efficacy of the discussions, which were facilitated by the teachers.

## Abbreviations

TBL: team-based learning

GPA: grade point averages

iRAT: individual readiness assurance test

MCQs: multiple-choice questions

tRAT: team readiness assurance test

IF-AT: Immediate Feedback Assessment Technique

## Declarations

**Ethics approval:** This study was approved by The Ethics Committee of the Children's Hospital, Zhejiang University School of Medicine (No.2019-IRB-153). All procedures performed in this study involving human participants followed the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. For this type of study, formal consent is not required.

**Consent for publication:** Not applicable

**Availability of data and materials:** All data generated or analysed during this study are included in this published article and available from the corresponding author upon reasonable request.

**Competing interests:** The authors declare that they have no competing interests.

**Funding information:** This study was funded by the second batch of teaching reform and research programme in the 13<sup>th</sup> Five-Year plan of higher education in Zhejiang Province (No. jg20190013), and cultivating project in high level education and teaching of Zhejiang University School of Medicine (Nos. cgzd20191005 and cgyb20192012). The funds were utilized for study design and faculty development.

**Authors' contributions:** LX, YZ, ZC, and QS designed the research. LX, YC, YX, and JW conducted the research. LX and YZ collected the data. LX analysed the data. YZ checked all of the data. LX was a major contributor in writing the manuscript. ZC and QS had the primary responsibility for the final content. All authors offered critical comments and read and approved the final manuscript.

**Acknowledgements:** Not applicable.

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## Tables

Table 1 Comparison the setting of the control group and the team-based learning group in a pediatric clerkship

	Control group	TBL group
Duration	3 weeks	3 weeks
Number of students (persons)	35-37	35-37
Groups setting	Divided into 4 groups with 8-10 students in each group	Divided into 6 groups with 5-7 students in each group
Topics	Pneumonia, asthma, gastroenteritis, cholestasis, Kawasaki disease, congenital heart disease, IM, HSP, DKA, precocious puberty, epilepsy, meningitis.	Pneumonia, gastroenteritis, neonatal hyperbilirubinemia, glomerulonephritis/nephritic syndrome
Topics for each student	4-6	4
Time for students' preparing before class	Not measured	2 hours
Activities in class	1 group contained 8-10 students held discussion every time	6 groups were in class together, in TBL ways
Class hours for each student	4-9 hours for 4-6 cases	12 hours
Occupied time of classrooms	16-36 hours	12 hours
Number of teachers (persons)	4	4
Time for each teacher facilitating work in class	4-9 hours	4.5 hours

TBL: Team-based learning, IM: Infectious mononucleosis, HSP: Henoch-Schonlein purpura, DKA: diabetic ketoacidosis,

Table 2 Demographics for students enrolled in the cohorts

	Control group	TBL group	<i>P</i> value
Number of students	222	107	
Male (%)	124 (55.9)	71 (66.4)	0.069
GPA <sup>#</sup>			0.839
Median	3.62	3.58	
IQR	3.16-4.00	3.04-3.96	
Test scores at end of pediatric clerkship			0.002
Median	72	76	
IQR	64-78	67-82	

TBL: Team-based learning; GPA: grade point average; IQR: Interquartile range

#: GPA here was counted from major courses before pediatric clerkship

Table 3 Accuracy of readiness assurance test in each module

	iRAT	tRAT	<i>P</i> value
Module 1	0.50 (0.33-0.58)	0.83 (0.83-0.92)	0.000
Module 2	0.50 (0.42-0.67)	0.79 (0.67-0.83)	0.000
Module 3	0.58 (0.42-0.67)	0.83 (0.75-0.92)	0.000
Module 4	0.58 (0.72-0.75)	0.92 (0.83-1.00)	0.000

iRAT: individual readiness assurance test; tRAT: team readiness assurance test.

Table 4 Questionnaire results of students' satisfaction (n=99)

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
learning better with TBL	63 (63.6%)	33 (33.3%)	3 (3.0%)	0	0
Increasing my motivation for learning	61 (61.6%)	35 (35.4)	3 (3.0%)	0	0
TBL enhanced my ability of self-directed learning	63 (63.6%)	34 (34.3%)	2 (2.0%)	0	0
Promoting collaboration	55 (55.6%)	39(39.4%)	4(4.0%)	1(1.0%)	0
Developing the ability to analysis and sum up the data	53 (53.5%)	43 (43.4%)	3 (3.0%)	0	0
Expressing and communicating better	45 (45.5%)	47 (47.5%)	7 (7.1%)	0	0
Getting feedback and help in time	55 (55.6%)	41(41.4%)	3(3.0%)	0	0
Having fun in TBL	56(56.6%)	38(38.4%)	4(4.0%)	1(1.0%)	0
TBL was effective	60(60.6%)	37(37.4%)	2(2.0%)	0	0
Preferring TBL more than traditional way	54(54.5%)	36(36.4%)	8(8.1%)	1(1.0%)	0

TBL: Team-based learning

## Supplementary Files

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