Research

The effect of repeated online Team-Based Learning on undergraduate nursing students: a quasi-experimental study

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A R T I C L E   I N F O

A B S T R A C T

Background: Little is known about how students' experiences with online Team-Based Learning (TBL) may have changed over time during the COVID-19 pandemic.
Aims: to examine the performance of undergraduate nursing students in online TBL; to evaluate the change in students' attitudes about teamwork and their accountability, preference and satisfaction with online TBL between 1st and 2nd year.
Methods: A one-group pretest-posttest design was used. A cohort of thirty-three undergraduate nursing students attended online TBL sessions during 1st and 2nd year. Students' performance in individual versus team readiness assurance tests in 2nd-year online TBL sessions was compared. Results from a structured questionnaire on students' attitudes about teamwork and from the Team-Based Learning Student Assessment Instrument (TBL-SAI) were collected at different time points.
Results: A statistically significant improvement was identified in students' performance and in the categories "Overall satisfaction with Team Experience" and "Team Impact on Clinical Reasoning Ability" of the structured questionnaire. T-test of TBL-SAI mean scores showed no statistical significance.
Conclusions: In repeated online TBL, teamwork increased students' satisfaction and clinical reasoning ability. Group performance was higher than individual results. Students' accountability, preference and satisfaction with online TBL remained high.

Introduction

In March 2020, the COVID-19 pandemic caused massive shutdowns which forced universities to drastically change their instructional delivery of programs, shifting from in-class to online education, to ensure the continuity of teaching-learning processes (Bassi et al., 2023). From country to country the structure of distance education has taken different forms, methods, lengths and assessment approaches (Kalanlar, 2022). One of the most commonly used learning strategies in distance medical education during the COVID-19 pandemic has been the technology-enhanced learning (TEL), which was implemented in a variety of teaching methods, including the online Team-Based Learning (TBL) (Ahmady et al., 2021). Those who employed face-to-face TBL had to face the challenge of the rapid shift into a mainly online domain whilst trying to maintain the benefits of this pedagogy (Burton et al., 2024).

TBL is a student-centered instructional strategy designed for small group learning in large classes. This active teaching methodology holds students accountable for their preparation for class and in-class engagement, and requires them to apply conceptual knowledge to solve authentic problems (Parmelee et al., 2012).

Originally designed to be applied in face-to-face mode, TBL is characterized by a structured learning sequence whose main steps include pre-class preparation, in-class readiness assurance testing and application exercises (Haidet et al., 2012).

In the pre-class preparation phase, students are required to study pre-reading material sent by the instructor in advance. In class, students' knowledge of the topic is tested by the same set of 10-20 multiple-choice questions that are answered first individually (iRAT—individual Readiness Assurance Test) and then in teams of 5-6 students each, with immediate feedback (tRAT—team Readiness Assurance Test). The instructor then clarifies the concepts that students do

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not get or find difficult. Later, in the application phase (Tapp—team Application), students in teams apply the conceptual knowledge learnt in the iRAT and tRAT to solve real-world problems in challenging clinical case scenarios. Finally, the TBL session ends with a peer evaluation aimed at promoting students' accountability towards the group.

The use of TBL in nursing education has rapidly increased over the last decades: as a consequence, students' outcomes associated with this teaching strategy have become the topic of several recent studies, above all in undergraduate education (Considine et al., 2021). Findings underline that TBL is effective in achieving undergraduate nursing students' learning outcomes (Alberti et al., 2021), and is related to positive student experience, high levels of student engagement, and development of the ability to work within teams and collaborate (Considine et al., 2021).

Even though online TBL had already been documented in a fairly limited number of pre-pandemic studies (Whittaker, 2015; Palsole & Awalt, 2008; Franklin et al., 2016) because of the COVID-19 pandemic, there has been a growing body of knowledge related to its application (Malik & Malik, 2022; Arcila Hernández et al., 2020; Wong et al., 2020; Takizawa et al., 2021; Sannathimmappa et al., 2022; Al-Neklawy & Ismail, 2022; Govindarajan & Rajaragupathy, 2022, Subedi et al., 2022; Vannini et al., 2022),

The results of these studies describe the challenges of adapting the active, in-presence, collaborative TBL strategy to an online setting: internet connectivity issues, low engagement and poor communication among students and with the instructors have been seen as the main drawbacks in online TBL (Malik & Malik, 2022; Wong et al., 2020; Sannathimmappa et al., 2022). Soft skills such as the ability to communicate, listen and collaborate successfully are needed for teams to debate effectively and build knowledge together during the readiness assurance testing (Dorius et al., 2021). Since developing these interpersonal competencies in virtual settings might be challenging, its impact on student performance in online TBL needs to be explored.

Moreover, little is known about how students' experiences with online TBL may change over time, in particular in nursing education. For this reason, it would also be desirable to investigate students' changes in perceptions of online TBL after repeated exposures to that methodology.

The primary aim of this study is to examine the performance of 2nd-year undergraduate nursing students on iRAT and tRAT during online TBL. The secondary aims are to compare the students' attitudes about teamwork in online TBL and their accountability, preference and satisfaction between the first and the second year of the Nursing Degree.

Methods

Study design

A quasi-experimental study using one-group pretest-posttest design was conducted to evaluate the effect of repeated online TBL on undergraduate nursing students during the COVID-19 pandemic.

Setting

The setting of the study was the School of Nursing of a public University in the north of Italy (University of Bologna).

Participants

A convenience sample of undergraduate nursing students was invited to participate in this study. The sampling criteria were students who: (1) entered the School of Nursing in the 2020/21 Academic Year (AY); (2) during the 1st year attended online TBL sessions in Nursing courses; (3) during the 2nd year (2021/22 AY) attended online TBL sessions in Nursing courses.

As a result, students who dropped out or moved to another School of Nursing and those who accessed in the 2nd year have been excluded from this study.

Study intervention: online TBL

The implementation of online TBL began in 2020 due to the sudden shift to online education caused by the nationwide lockdown restrictions for the COVID-19 pandemic. During 2020/21 AY, the 1st-year nursing students attended nine online TBL sessions in the "Fundamentals of Nursing" and "Clinical Nursing" courses (see TBL sessions' topics in Supplementary Materials). During their 2nd year, they attended eight online TBL sessions in the "Medical", "Surgical", "Maternal Child", and "Chronic Care" Nursing courses (see TBL sessions' topics in Supplementary Materials).

The synchronous online TBL session consisted of seven steps that are presented succinctly in Table 1: (1) pre-class preparation, (2) iRAT, (3) tRAT, (4) instructor clarification review, (5) tAPP and class discussion, (6) appeal, and (7) peer evaluation.

Table 1
Description of the intervention—Online TBL session.

Step	Duration	Procedures
1. Pre-class preparation	1-2 h	At least a week before the online TBL session • learning outcomes and pre-assigned teaching materials (slides, readings or videos) uploaded to a Moodle Learning Management System (LMS) platform to be studied
2. iRAT	10-12 min	At the beginning of each online TBL session • 10/12 cognitive multiple-choice questions (MCQs) solved individually by students • closed books • no feedback on the correctness of the answers given
3. tRAT	20 min	• same quiz as iRAT solved by students in teams (5-7 students in each team) • team formation decided by the Faculty • in breakout rooms • immediate feedback by the computer system
4. Instructor clarification review	15 min	The content expert discusses challenging tRAT questions and answers student-generated questions that peers could not answer
5. tAPP and class discussion	25 min + 30 min	• realistic problems solved by students in the same teams in breakout rooms • simultaneous reporting of the answers through the chat of the main virtual class • discussion among teams facilitated by the content expert
6. Appeal	5 min	If a team disagreed with the teacher's responses to the RATs and tAPP, they could formalize an appeal and propose an alternative response, but only if it was accurately justified
7. Peer evaluation	5 min	• online peer evaluation form • criteria: contribution to the success of the team, flexibility, knowledge and respect for others' ideas

Note: TBL = Team-Based Learning; iRAT = individual Readiness Assurance Test; tRAT = team Readiness Assurance Test; tAPP = team Application.

Microsoft Teams® was used to communicate with students in the virtual class and to create breakout rooms in which students collaborated in group activities. In addition, a Moodle Learning Management System (LMS) platform was used to post pre-assigned teaching materials and to administer the tests required by the methodology.

Survey instruments

For the survey of the outcomes, different tools were used, and applied at different times: (1) iRAT versus tRAT performance, (2) the structured questionnaire by Parmelee et al., and (3) the Team-Based Learning Student Assessment Instrument (TBL-SAI).

1. iRAT and tRAT performance in online TBL: At the beginning of each online TBL session, after reaffirming the learning outcomes, the content expert and the facilitator announced the beginning of the iRAT.

Online iRAT was administered individually through the "Quiz" activity on the Moodle LMS platform. The test was composed of 10/12 cognitive multiple-choice questions (MCQs) to verify students' understanding of the main concepts reviewed before the online session. At that time, the correct answer to each question was not revealed to students.

Immediately after, students migrated from the main meeting room to the breakout rooms to discuss the same readiness assurance test in teams (tRAT).

Within each breakout room, a group's spokesperson shared his/her screen, filled in the tRAT quiz and submitted answers agreed upon within the group. After a defined time, the open attempts were submitted automatically.

To mimic the Immediate Feedback Assessment Technique (IF-AT) cards used in face-to-face TBL, the feedback option "Interactive with multiple tries" was used: it allows multiple attempts on the same question with a grade penalty. Through the "Check" and "Try again" buttons students could verify if their answers were correct and, if not, try a new response. Since MCQs had four possible answers, students could try again three times before being graded wrong with 0 points.

In online TBL, point allocation not only served as a motivator to students but it also allowed the facilitator to easily track attempts required to answer the question correctly by each group.

The iRAT and tRAT scores of each student were collected for all the online TBL sessions of the second year and their comparison was used to evaluate the effect of cooperative learning on student performance.

2. The structured questionnaire by Parmelee et al: The students' attitudes about working within teams in online TBL were measured through the anonymous questionnaire designed by Parmelee and colleagues (Parmelee et al., 2009). The questionnaire consists of 19 statements grouped in 5 categories: "Overall satisfaction with team experience," "Team impact on quality of learning," "Satisfaction with peer evaluation," "Team impact on clinical reasoning ability," and "Professional development." The instrument presents a 5-point Likert-type response format ranging from 1 "strongly disagree" to 5 "strongly agree."

The questionnaire was administered before (T0) and after (T1) the first implementation of online TBL in 2020/21 AY and after (T2) the online TBL sessions in 2021/22 AY.

3. TBL-SAI: Additionally, students' accountability, preference and satisfaction with online TBL were collected through the TBL-SAI (Mennenga, 2012) after the TBL sessions of both AYs (T1 and T2). The TBL-SAI represents a valid and reliable tool for measuring students' attitudes towards the TBL methodology. It is a self-administered questionnaire consisting of 33 items (with a total score ranging from 33 to 165) with a 5-point Likert-type response format that is scored from 1 to 5 (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and, 5 = strongly agree). The negative items (items 4, 11, 13, 14, 16, 18, 21, 22, 28, 30) were reverse scored.

The TBL-SAI consists of three subscales: "Accountability" (items 1 to 8), "Preference for lecture or TBL" (items 9 to 24) and "Student satisfaction" (items 25-33).

A higher total instrument score indicates a more positive experience regarding TBL. The positive perception of the use of TBL is attested by a score higher than 99 for the total score, >24 for the accountability subscale, >48 for the preference for lecture or TBL subscale, and >27 for the student satisfaction subscale.

The original TBL-SAI is a reliable scale with a total Cronbach $\alpha = 0.941$ and was validated with nursing students (Mennenga, 2012). Permission to use this copyrighted instrument was granted by the author of the scale.

The Italian versions of both questionnaires were administered online; participants' anonymity was guaranteed.

Statistical analysis

All data were entered into a database and analyzed using SPSS version 27 (IBM SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to analyze demographic variables. Assumptions of normal distributions were checked.

The primary outcome of the study was evaluated by comparing the average scores in the iRAT versus the tRAT in each 2nd-year online TBL session using the parametric test of significance t-test. Significance was indicated by a p-value < 0.05.

The internal structure validity of the Parmelee et al.'s questionnaire and the TBL-SAI was evaluated using Cronbach's alpha coefficient.

ANOVA within-subject test was used to compare the Parmelee et al.'s questionnaire scores at T0, T1, and T2.

With regard to TBL-SAI, a t-test was conducted to determine if changes in students' accountability, preference and satisfaction with online TBL occurred after the educational intervention of the 1st and the 2nd year. In addition to this, according to the author's instructions, the mean score obtained by the students in each subscale was compared with the neutral value to assess whether students' experience with online TBL was positive.

In order to handle multiple family-wise comparisons, applying the Bonferroni correction, the alpha level was reduced to the value of 0.003 in the analysis of the Parmelee et al.'s questionnaire and the TBL_SAI.

Ethical considerations

The study protocol was approved by the Bioethics Committee of the University of Bologna (No. 2022/0133580). Potential participants were provided with information sheets and verbal explanation of the project and written informed consent was obtained.

Participation in the study was voluntary and participants could withdraw at any stage without explanation or impact on academic progression.

Data were stored anonymously, transformed into assigned alphanumeric codes and then analyzed in aggregate form guaranteeing privacy according to the Italian Legislative Decree June 30, 2003, n.196 art. 13, modified by Legislative Decree 101/2018. Data were processed following the indications of art.13 and 14 of the General Data Protection Regulation—EU Reg. N° 2016/679.

Results

Participants' sociodemographic characteristics

A total of 33 students were included in the study. The age range was between 21 and 51 years, with a mean of 23.2 years (SD = 5.4) and most were female (81.8 %).

Intervention effects

Performance on iRAT and tRAT during online TBL

An improvement in students' performance between iRAT and tRAT was observed in all 8 sessions, with a statistically significant increase in 7 sessions; moreover, the performances obtained through group work had always been excellent, since they exceeded the score of 28 out of 30 (Table 2).

Students' responses to the Parmelee et al.'s instrument

In our study, the Parmelee et al.'s questionnaire presented an internal consistency value (Cronbach's Alpha) of 0.87. Table 3 shows means and standard deviations for individual items in the five categories of the Parmelee et al.'s questionnaire at T0 (N = 31), T1 (N = 33), and T2 (N = 33). A statistically significant increase was found by comparing overall mean scores in the category "Overall Satisfaction with team experience" and in the category "Team Impact on Clinical Reasoning Ability" ($p < 0.001$). Furthermore, the scores of item 9 of the "Satisfaction with Peer Evaluation" subscale are also statistically significantly different ($p < 0.001$). No items of the "Professional Development" and "Team Impact on Quality of Learning" subscales differed in a statistically significant way at the three time points.

Students' responses to the TBL-SAI

In this study, Cronbach's alpha for TBL-SAI was 0.87.

T-test of TBL-SAI mean scores after the 1st and the 2nd-year TBL sessions showed no statistical significance in subscales and total scores (Table 4). However, the total instrument scores at T1 and T2 were higher than the neutral value of 99 at both time points, indicating a generally favorable experience with online TBL. Moreover, whether the accountability and preference scores remained similar, students' satisfaction increased by two points after the second year.

Table 2
iRAT and tRAT performances in online TBL.

Session	N	iRAT		tRAT		t	p
		Mean	SD	Mean	SD		
TBL 1	33	25.00	2.72	29.87	0.30	-10.215	<.001*
TBL 2	31	20.81	6.24	28.12	1.98	-6.856	<.001*
TBL 3	31	27.10	4.80	29.84	0.37	-3.170	.004*
TBL 4	28	27.43	3.80	30.00	0.00	-3.576	.001*
TBL 5	33	24.55	5.48	29.15	0.76	-4.682	<.001*
TBL 6	32	28.69	3.23	29.88	0.34	-2.038	.050
TBL 7	32	27.66	2.50	29.94	0.25	-5.179	<.001*
TBL 8	32	23.81	2.74	28.19	0.78	-9.056	<.001*

Note: In the Italian academic grading system students are graded according to a scale ranging from 0 to 30, with 18 as a passing mark.
M = mean; SD = standard deviation; t = student's t-test; iRAT = individual Readiness Assurance Test; tRAT = team Readiness Assurance Test.
* $p < 0.05$.

Discussion

This study examined the performance of 2nd-year undergraduate nursing students in iRAT and tRAT during online TBL and compared students' attitudes about working within teams and their accountability, preference and satisfaction with online TBL between the 1st and the 2nd year of the Nursing Degree. Cronbach's Alpha of the Parmelee et al.'s instrument and the TBL-SAI was very good and, with respect to the latter, similar or even superior to other studies conducted on in-class TBL (Parthasarathy et al., 2019; Sharma et al., 2017; Nation et al., 2016).

The comparison of mean scores in iRATs and tRATs indicates that, in online TBL, students achieve statistically significant higher performances when collaborating and working together. This finding, which is in line with a meta-analysis of RATs performance with in-class TBL (Ngoc et al., 2020), could not be taken for granted in the online format. Low interaction and poor communication, indeed,

Table 3
Comparison of the mean scores of the Parmelee at al.'s questionnaire at T0 (N = 31), T1 (N = 33) and T2 (N = 33).

Parmelee et al.'s questionnaire subscales and items	T0		T1		T2		F	p
	Mean	SD	Mean	SD	Mean	SD		
Overall satisfaction with team experience	3.72	0.59	4.15	0.81	4.35	0.49	8.969	< .001*
1. I have found working as part of a team in my classes to be a valuable experience	4.32	0.75	3.97	0.98	4.21	0.60	1.020	.367
2. In most of the teams I have been on. the other team members have generally contributed as much as I have	3.23	0.67	3.76	1.23	3.97	1.05	8.023	< .001*
3. In most of the teams I have been on. the team has worked well together	3.26	0.68	4.45	0.87	4.30	0.77	29.169	< .001*
4. In most of the teams I have been on, I felt the other team members respected me	3.61	0.88	4.42	0.97	4.55	0.79	17.443	< .001*
5. I have found teamwork to be a productive use of course time	4.19	0.83	3.88	1.02	4.30	0.81	2.163	.124
Team Impact on Quality of Learning	3.47	0.55	3.49	0.88	3.72	0.89	1.401	.254
6. I have found that teams help me learn course material more than if I just studied alone	3.61	0.67	3.52	1.12	3.48	1.09	0.020	.980
7. I have learned more in courses where I have been a member if a team	3.39	0.72	3.24	1.15	3.61	1.00	1.442	.244
8. I have found being part of a team improves my course grades	3.42	0.67	3.45	0.87	3.76	1.06	3.435	.039
Satisfaction with Peer Evaluation	3.57	0.57	3.48	0.95	3.64	0.91	0.374	.690
9. I have found that my peers have been fair in judging my contributions to a team	3.32	0.60	4.03	0.95	4.00	0.90	11.512	< .001*
10. I have found that peer evaluation motivates me to work harder	3.52	0.93	3.06	1.25	3.18	1.19	1.071	.349
11. I have generally liked the use of peer evaluation as part of my team experience	3.58	0.85	3.39	1.12	3.58	1.03	0.775	.465
12. I have found that peer evaluation motivates me to work more collaboratively	3.87	0.76	3.33	1.16	3.58	1.12	2.030	.140
Team Impact on Clinical Reasoning Ability	3.70	0.51	4.10	0.79	4.28	0.51	8.672	< .001*
13. I have found that being on a team has helped me become better at problem solving	3.87	0.76	4.15	0.91	4.21	0.82	3.388	.040
14. I have found that teams make good decisions	3.19	0.65	3.85	0.97	4.12	0.89	14.391	< .001*
15. Being part of a team discussion has improved my ability to think through a problem	4.03	0.66	4.18	0.88	4.24	0.75	1.189	.312
Professional Development	4.04	0.61	3.87	0.87	4.09	0.71	1.298	.281
16. I have found that working with a team helps me develop skills in working with others	4.39	0.62	3.94	1.09	4.27	0.72	3.033	.056
17. I have found that working with a team has helped me develop cooperative leadership skills	3.84	0.97	3.91	1.01	4.03	1.02	0.561	.574
18. I have found that working with a team has helped me develop more respect for the opinions of others	4.26	0.73	3.88	1.29	3.94	1.17	1.328	.273
19. I have found that working with a team has enhanced my sense of who I am	3.68	0.79	3.55	1.30	3.73	0.98	0.501	.608

Note: T0 = before the 1-st year online TBL sessions; T1 = after the 1-st year online TBL sessions; T2 = after the 2-nd year online TBL sessions; M = mean; SD = standard deviation.
* $p < 0.003$.

Table 4
TBL-SAI parameters and mean scores (N = 33).

TBL-SAI Subscales	Number of items	Score range	Neutral	T1		T2		t	p
				Mean	SD	Mean	SD		
Accountability	8	8-40	24	30.30	4.18	29.82	3.19	0.666	.510
Preference	16	16-80	48	52.70	8.45	51.64	5.32	0.821	.418
Satisfaction	9	9-45	27	28.27	5.93	30.36	4.46	-1.993	.055
Overall	33	33-165	99	111.28	15.20	111.82	1.61	-0.237	.814

Note: TBL-SAI = Team-Based Learning Student Assessment Instrument; T1 = after the 1-st year online TBL sessions; T2 = after the 2-nd year online TBL sessions; M = mean; SD = standard deviation; t = student's t-test; neutral scores were established by Mennenga (2012) to represent scores at which there is no preference for TBL versus traditional lecture. Subscales and total scores greater than the neutral values indicate stronger affinity for TBL versus traditional lecture.
*p < 0.003.

have been identified as remarkable negative factors associated with online learning during the COVID-19 pandemic (Abdull Mutalib et al., 2022).

First, we speculate that this positive result should be traced back to the structure of the TBL methodology itself. Group activities provide the students with the opportunity to communicate with each other, be involved in consensus-building discussions and explain or defend their choices with peers and instructors (Parmelee et al., 2012). As a consequence, students develop communication and interprofessional collaboration competencies more than in traditional lessons (Alberti et al., 2021). In online TBL, however, the decrease in non-verbal communication hinders the development of solid relationships but leads to a compensatory increase in verbal communication that becomes more task-oriented; therefore, online learning does not reduce the effectiveness of collaborative learning in TBL (Shimizu et al., 2022).

Second, in line with a previous study on teamwork during the pandemic (Takizawa et al., 2021), we believe that breakout rooms created a more intimate environment that fostered students' capability to discuss problems and scenarios in groups. Finally, at the beginning of the 1st year, we conducted an orientation session on the methodology of TBL itself that allowed us to promptly identify and address potential internet connectivity and technological literacy problems. Since a good internet connection may facilitate good interaction and communication (Abdull Mutalib et al., 2022), our data leave open the possibility that in the synchronous online TBL we implemented, conditions analogous to those of the in-class TBL have been recreated, allowing similar results to be obtained (Malik & Malik, 2022).

In support of our finding, two studies on online TBL during the pandemic compared students' performance in iRAT and tRAT. Subedi et al. (2022) found that, in online TBL sessions, the median tRAT scores were significantly higher than iRAT scores. In Govindarajan & Rajaragupathy (2022), all the teams scored well in tRAT (score > 75% and higher than iRAT) and students' comments underlined the usefulness of RATs and their gain in knowledge through team discussion.

The comparison of the overall mean scores of the five categories of the Parmelee et al.'s questionnaire, collected at T0, T1 and T2, provides evidence that repeated online TBL sessions have a positive effect on students' attitudes about working within teams. In particular, students reported a statistically significant improvement in satisfaction with team experience and in their clinical reasoning ability thanks to the impact of their team. These findings are partially consistent with the original longitudinal study by Parmelee et al. (2009), with regard to the favorable attitudes of medical school students about their team experience. A subsequent study, aimed at identifying factors that determine satisfaction with TBL among nursing students, revealed the influence of five instructional design items, including team activity. The authors acknowledged that TBL in nurse education might be an effective student-centered learning strategy, because it appears to promote students' clinical problem solving

during the team-learning process (Roh et al., 2014). These results are in keeping with a recent systematic review that underlines the positive effect of in-class TBL in developing problem-solving and critical thinking skills in nursing students, even though the optimal duration of TBL implementation to reach this goal is still to be clearly identified (Yeung et al., 2023). A few studies on the implementation of online TBL during the COVID-19 pandemic tried to evaluate the effect of online TBL on different outcomes from the participants' point of view. Although using different questionnaires, some studies supported the usefulness and positive effect of the team on overall student satisfaction (Al-Neklawy & Ismail, 2022; Govindarajan & Rajaragupathy, 2022) and reported an increase in students' critical thinking, clinical reasoning and problem solving abilities in online TBL (Sannathimmappa et al., 2022; Feng et al., 2022).

No statistically significant evidence was produced from our cohort of undergraduate nursing students (N = 33) that accountability, preference and satisfaction with online TBL changed after repeated exposures in the 1st and 2nd year of the Nursing Degree; however, students reported total instrument scores higher than neutral values at both data collection points and this demonstrates a stronger affinity for online TBL vs lecture.

This result is consistent with other similar studies in which the TBL-SAI was used to assess students' perception of in-class TBL in different disciplines such as Physiotherapy (Teixeira et al., 2019; Macauley & Dirkes, 2017), Pharmacy and Biomedical Science (Parthasarathy et al., 2019), Pharmacy (Nation et al., 2016), and Occupational Therapy (Carson & Mennenga, 2019).

Although the online implementation of TBL described in this paper must be traced back to the significant adjustments imposed by COVID-19 restrictions, its findings may be valid and applicable even in the post-pandemic era. A recent national qualitative study that involved nine Italian universities offering a bachelor's degree in nursing identified a set of 18 specific recommendations to address and redesign nursing education based on the "lesson learned" during the COVID-19 pandemic (Bassi et al., 2023). In particular, faculty members, clinical nurse educators and students/new graduates involved in this research have agreed in affirming the need to recognize distance learning as a valuable complementary strategy to strengthen and supplement the traditional in-class learning. Therefore, restoring the face-to-face delivery mode of TBL established before the COVID-19 pandemic outbreak, without a proper reflection on its benefits, drawbacks and potential developments, could mean wasting the unexpected learning opportunities derived from this experience. Moreover, it is strongly advised to promote the digital transformation of nursing programs in favor of a more inclusive and sustainable approach to students (Bassi et al., 2023). This recommendation is in line with the WHO Global Strategic Directions for Nursing and Midwifery (2021-2025), according to whom increased investments in digital technologies, infrastructure and training of faculty in the use of digital technology for remote learning are needed (WHO, 2021).

Implications

The results of this paper suggest that the TBL methodology applied to an online synchronous setting produces positive effects that persist or even increase over time. Online TBL engages students through collaborative activities supported by technology that help them develop transferable skills such as critical thinking and teamwork, necessary for their future professional practice (Parrish et al., 2021).

After the pandemic, lessons learned from online TBL could be used to enrich the in-person TBL educational experience (Bender et al., 2021) or to promote a viable alternative.

Limitations

This study has several limitations relevant to the interpretation of results.

First, the study was conducted in a single School of Nursing, which could limit the extrapolation of the results, assuming that the setting and the characteristics of the students could differ between academic institutions. Moreover, the small convenience sample size may limit the generalization of the findings. Our participants were undergraduate students; thus, caution should be exercised when attempting to apply these findings to postgraduate students and practicing professionals.

Second, the Parmelee et al.'s questionnaire and the TBL-SAI were originally created for use with in-presence TBL, not for online TBL. Moreover, these instruments have not undergone a validation process in Italian.

Finally, this study only evaluated student perceptions combined with their performance in iRAT and tRAT and not higher levels of outcomes like learning and behavior.

To our knowledge, this is the first study of repeated online TBL among nursing students in Italy.

Conclusion

In dealing with the demands of the rapid changes in education due to the COVID-19 restrictions, nursing faculties all over the world adapted their programs to online formats to ensure the continuity of learning. A growing body of literature has underlined the positive effects of online TBL in academic education but rarely have they analyzed the possible change in students' attitudes over the years.

In our study on repeated online TBL, teamwork increased nursing students' satisfaction and clinical reasoning ability. Group performance in tRATs was significantly higher than individual results in iRATs. Students' accountability, preference and satisfaction with online TBL remained high even though no statistical difference was found between the 1st and the 2nd year of the Nursing Degree.

Further experimental studies with a larger sample size and multicentric design are needed to better analyze how students' perception of online TBL may change over time and to support nursing faculties in choosing whether to implement online TBL into their curricula, also in the post-pandemic era.

Ethical approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Bioethics Committee of the University of Bologna (2022/0133580).

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Valeria Vannini: Conceptualization, Investigation, Methodology, Writing − original draft. **Sara Alberti:** Data curation, Formal analysis, Software, Writing − review & editing. **Orietta Valentini:** Conceptualization, Investigation. **Paola Ferri:** Formal analysis, Methodology, Validation, Writing − review & editing, Supervision.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.teln.2024.04.022.

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